IRENA
International Renewable Energy Agency

Decentralised renewable energy for artisanal fisheries in Mauritania

ISBN: 978-92-9260-678-7

Citation: IRENA (2025), *Decentralised renewable energy for artisanal fisheries in Mauritania*, International Renewable Energy Agency, Abu Dhabi.

About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

www.irena.org

Acknowledgements

This report was developed under the guidance of Gürbüz Gönül (Director, IRENA Country Engagement and Partnerships), and Kavita Rai (IRENA), and authored by Babucarr Bittaye (IRENA), Mohamed Lemin Abdel Hamid and Ahmedou Ahmed Alem (consultants). The report was reviewed by Caroline Ochieng, Mamadou Goundiam, and Wilson Matekenya (IRENA). The report benefited from feedback provided by Zakaria Soumaré (Ministry of Energy and Petroleum), Mohamed Barham (Ministry of Fisheries, Maritime Infrastructures and Ports), Abou Malick Diaw (UNCECD-M), Hamadi Baba Hamadi (National Federation of Fishing), the National Federation of Artisanal Fishing, and Technical and Financial Partners.

Publications and editorial support were provided by Francis Field and Stephanie Clarke. Technical review was provided by Paul Komor. The report was edited by Erin Crum and designed by Elkanodata.

This report was made possible through the voluntary contributions from the Government of the United Arab Emirates and the Open Society Foundations.

For further information or to provide feedback, go to: publications@irena.org

Download from www.irena.org/publications

Cover photo: © Kaikups / Shutterstock.com

Contents

Figures

Tables

Abbreviations

CAPEC	Savings and Credit Union (*Caisses Populaire d'Épargne et de Crédit*)
CAPEX	capital expenditure
CO_2	carbon dioxide
CO_2eq	carbon dioxide equivalent
COP	Conference of the Parties
DRE	decentralised renewable energy
GDP	gross domestic product
GHG	greenhouse gas
GTA	Greater Tortue Ahmeyim
GW	gigawatt
GWh	gigawatt hour
hp	horsepower
IRENA	International Renewable Energy Agency
IRR	internal rate of return
KfW	German Development Bank (*Kreditanstalt für Wiederaufbau*)
kg	kilogramme
km^2	square kilometre
kW	kilowatt
kWh	kilowatt hour
kWp	kilowatt peak
L	litre
m	metre
m/s	metres per second
m^2	square metre
m^3	cubic metre
MEP	Ministry of Energy and Petroleum (*Ministère de l'Énergie et du Pétrole*)
MFI	microfinance institution
MPA	Marine Protected Areas
MPIMP	Ministry of Fisheries, Maritime Infrastructures and Ports (*Ministère de la Pêche, des Infrastructures Maritimes et Portuaires*)
MRU	Mauritanian ouguiya (*currency*)
MW	megawatt
MWh	megawatt hour
MWp	megawatt peak
NAP	National Adaptation Programme
NDC	Nationally Determined Contribution
NPV	net present value
O&M	operation and maintenance
OMVS	Organisation for the Development of the Senegal River Basin (*Organisation pour la Mise en Valeur du Fleuve Sénégal*)
PNBA	Banc d'Arguin National Park (*Parc National de Banc d'Arguin*)
PV	photovoltaic
RRA	renewables readiness assessment
SOMELEC	Mauritanian Electricity Company (*Société Mauritanienne d'Electricité*)
t	tonnes
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
W	watt

© Attila Jándi / Shutterstock.com

Executive summary

Mauritania's fisheries sector is one of the critical levers of the national economy. Contributing 2.8% of the country's gross domestic product (GDP) in 2023 and supporting 66 000 direct jobs and 300 000 indirect jobs, fisheries accounted for 14.9% of the primary sector's output and generated 19.9% of total export earnings. With over 720 kilometres of coastline, Mauritania ranks as the second-largest producer and exporter of fish products in Africa, accounting for 8.3% of total African production and 10.7% of total exports. Annual catches range between 845 000 tonnes (t) and 1.2 million t.

Artisanal fishing is particularly important, generating approximately 80% of the sector's added value and employment. Domestically, the subsector supplies 78 000 t of fish annually for local consumption, playing a key role in food security. Despite this importance, the artisanal fisheries value chain faces systemic energy challenges due to high reliance on fossil fuels, undermining profitability, inflating operational costs and exacerbating greenhouse gas (GHG) emissions. Meanwhile, Mauritania has largely untapped renewable energy potential (mainly solar and wind). Transitioning to decentralised renewable energy (DRE) technologies could potentially reduce operational costs, reduce carbon emissions, and enhance the livelihoods and resilience of sector players.

The report assesses the opportunities and barriers for deploying decentralised renewable energy solutions to power Mauritania's artisanal fishery value chain. It maps out opportunities for integrating renewable energy systems into specific segments of the value chain and proposes practical technical solutions to power critical operations for the economic development of the sector.

The study employed a holistic, participatory and iterative approach, designed to gather first-hand information directly from artisanal fishing stakeholders and identify energy needs and opportunities, using survey method and focus groups. Based on the identified needs and opportunities, the study proposes technical DRE solutions for different segments of the value chain, using key financial metrics (net present value and internal rate of return) to assess the viability of the proposed solutions. The study also explores the environmental impact of deploying these DRE solutions, quantifying potential carbon dioxide emission reductions.

The study reveals that the artisanal fishing sector is faced with key constraints, as follows:

- **Access to energy:** The primary challenges, reported by 95% of large consumers (processing factories, storage warehouses and ice plants) and 96% of small and medium-sized consumers (fishermen, fishmongers) are high fuel costs, unreliable supply and limited electricity access at the fishing zones.
- **Access to finance:** Stakeholders in Mauritania's artisanal fisheries value chain highlighted significant challenges in accessing financing, reported by 90% of wholesalers, 75% of fishermen, 66% of large-scale consumers (*e.g.* processing plants) and 57% of artisanal processors. The key barriers to accessing finance include high interest rates, stringent guarantee requirements, limited availability of tailored financial services in their areas and short repayment periods.

In terms of awareness and willingness to adopt DRE among fisheries players, up to 84% of large-scale consumers, 78% of fishermen and 46% of fish merchants demonstrated awareness of renewable energy technologies, particularly solar and wind power. Most stakeholders expressed interest in using DRE solutions for their activities if such technologies were more accessible, with 100% of large-scale consumers and artisanal processors indicating willingness to adopt DRE solutions. Similarly, 89% of fish merchants and 70% of fishermen expressed interest in integrating DRE into their operations. According to 94% of fishermen surveyed, DRE could be used to power retrofitted battery-powered motors and accessories on artisanal fishing boats (pirogues), while 4% suggested its use for operating refrigeration equipment on board. In terms of expected benefits, 44% of fishermen identified cost savings on operations as a main advantage of adopting DRE solutions.

Based on the energy demand assessment, stakeholder consultations and the DRE market ecosystem in Mauritania, the report proposes the following DRE solutions for large-scale consumers and small and medium-sized consumers, to meet the energy needs of the various segments of the artisanal fisheries value chain.

Large-scale consumers

- **Grid-connected solar photovoltaic for fish factories:** The analysis yields a positive net present value (NPV) for the consumer category, ranging from USD 33 348 to USD 166 740, demonstrating the viability of the proposed solar photovoltaic (PV) investments. The internal rate of return (IRR) is 12%, higher than the prevailing interest rate in Mauritania (7.7%). The discounted cash flow for each consumer category shows a break-even point of eight years.
- **Solar-powered ice factories:** The proposed scenario is based on the use of a small-scale unit with a daily production capacity of 2 t of ice, powered by a 5 kilowatt peak (kWp) solar PV refrigeration unit. Based on the analysis, the NPV is estimated at USD 39 246 with an IRR of 24%, demonstrating attractiveness of deploying solar PV for ice production, an input business in Mauritania's fisheries sector.

Small and medium-sized consumers

- **Solar-powered batteries to power retrofitted boat motors and accessories for fishermen:** The scenario is based on replacing the 15 horsepower (hp) outboard engine with an electric motor of equivalent power (12 kW), powered by lithium batteries. The total investment cost is estimated at USD 30 000, of which more than 90% is for the storage batteries, with a ten-year amortisation period. The analysis shows the NPV as USD 9 727.81, with an IRR of 14%, indicating viability for the proposed solution.
- **Solar-powered refrigeration units (freezers) for fish merchants:** This DRE solution is based on the use of a freezer powered by a 1 kWp solar unit, which produces 2 megawatt hours per year (MWh/year). The expected net avoided cost represents the expenditure saved on the purchase of the ice less the cost of maintenance. Based on the analysis, the NPV is estimated at USD 452 over the life of the investment with an IRR of 11%, indicating the viability of the proposed technical solution mainly for fish collectors, wholesalers and distributors.
- **Community-owned solar-powered cold room:** This scenario is based on the use of a refrigeration unit with a storage capacity of 800 kilograms (kg) per day, powered by a 5 kWp solar PV unit. Based on the survey analysis, the NPV is estimated at USD 7 955, with an IRR of 15%.

Total capital investment requirements

Based on the assessment, the total investment requirement is USD 163.12 million. The largest share of this investment, over 58%, targets retrofitting artisanal fishing boats (15 hp engines) with battery-powered motors, highlighting a strong focus on decarbonising artisanal fishing operations and potentially reducing fuel costs and GHG emissions. For the deployment of individual solar-powered freezers, USD 6.78 million is required to benefit collectors and distributors, who are most impacted by lack of adequate storage facilities leading to economic losses. Solar PV-powered cold storage, targeting freezing, chilling and ice factories, will require USD 48.2 million, underlining the critical need for reliable electricity in preserving fish quality and reducing postcatch losses.

Recommendations

Reviewing the energy needs analysis within the artisanal fishing value chain, the report proposes tailored DRE solutions, including grid-connected solar PV for large consumers, emobility for fishing boats, solar-powered refrigeration and ice production for fishing communities, and solar dryers for artisanal fish processors. These solutions are modular, allowing for scalability based on power requirements and load demands. The successful implementation of these solutions requires a concerted effort from the government with support from technical and financial partners to raise awareness among national stakeholders about the economic, social and environmental benefits of these technologies and to foster the development of a local entrepreneurial ecosystem. The following key actions are recommended:

- Develop a national strategy for decentralised renewable energy for productive uses that extends beyond the fisheries sector to encompass agriculture, livestock farming, trade and small-scale industry. Prioritise programmes and projects focused on building the capacities of women, young people and small producers within the fisheries value chain.
- Raise awareness and provide support for DRE stakeholders: Conduct targeted awareness campaigns to educate stakeholders in the artisanal fishing value chain about the benefits of renewable energy
- Support small-scale producers (artisanal fishermen, small-scale fishmongers, *etc.*) in adopting co-operative models (co-operatives, solidarity groups) to facilitate collective investment in renewable energy solutions, enhance financial viability and encourage community ownership through solidarity guarantees.
- Implement favourable tax policies: Remove import duties on all solar equipment, materials and maintenance inputs to improve market availability and reduce upfront investment costs.
- Develop and implement a national standards and certification system for DRE equipment and installations.
- Develop capacity building on DRE technologies to equip stakeholders with the knowledge and tools necessary to adopt renewable energy solutions and improve energy efficiency in their activities
- Encourage private sector investments in the sector, aligning with the national industrialisation strategy (2023-2030) by implementing an incentive-based tax system, introducing dedicated financing mechanisms, including microfinance solutions tailored to the needs of small producers, increasing the financing threshold granted to microfinance institutions, and revising the implementing regulations for the Electricity Code to allow for increased self-generation of electricity for large consumers, such as fishing factories.

1 Introduction

The fisheries sector plays a crucial role in the national economy of Mauritania, contributing 3-6% of national gross domestic product (GDP). Mauritania ranks as the second-largest producer and exporter of fish products in Africa, contributing 8.3% of total African production and 10.7% of total exports (FAO, 2024). In 2023, the sector contributed 19.9% of total export earnings, while supporting 66 000 direct jobs, of which 42 000 are in artisanal fishing, and an additional 300 000 indirect jobs. The artisanal fishing subsector is particularly significant, contributing 80% of the sector's employment.

However, the artisanal fishing sector faces significant energy challenges. Its heavy reliance on fossil fuels (mainly petrol and diesel) across upstream and downstream activities – from catch to preservation and distribution – results in high operational costs and environmental pollution. Given Mauritania's vast solar and wind energy potential, the country is well-positioned to produce electricity from renewable sources to meet the energy needs of various sectors, particularly artisanal fishing. Transitioning to renewable power could simultaneously reduce operational costs, reduce greenhouse gas (GHG) emissions and enhance the sector's resilience to climate change (Puri, *et al*., 2023).

In this study, the International Renewable Energy Agency (IRENA) assessed the opportunities and barriers for deploying decentralised renewable energy (DRE) solutions to power Mauritania's artisanal fishery value chain. The report maps out the most suitable DRE solutions for different segments of the value chain to support decarbonisation efforts and improve energy access in the sector.

1.1 Socio-economic context

Located at the crossroads of North and sub-Saharan Africa, the Islamic Republic of Mauritania borders the Atlantic Ocean to the west, Western Sahara and Algeria to the north, Mali to the east and Senegal to the south. A desert country, Mauritania covers an area of 1 030 700 square kilometres (km^2) and had a population of 4.9 million in 2023 (World Bank, 2024a), with 53.6% residing in urban areas (ANSADE, 2024a). The administrative structure of the country is divided into 15 regions (*wilayas*), 63 departments (*moughataas*) and 219 communes.

In 2016, the Mauritanian government launched its national development blueprint, Accelerated Growth and Shared Prosperity Strategy (*Stratégie Nationale de Croissance Accélérée et de Prospérité Partagée*) for the period 2016-2030. This strategy aims to enhance economic resilience and foster shared prosperity by leveraging three key strategic levers: i) promoting strong, sustainable and inclusive growth; ii) developing human capital and expanding access to basic social services; and iii) strengthening governance across all sectors (Government of Mauritania, 2017).

While the economy showed sustained growth reaching 6.3% in 2017, due to economic reforms and favourable commodity prices, the COVID-19 pandemic caused a 0.4% contraction in 2020. Recovery followed with 0.7% growth in 2021 and 6.8% in 2022, though 2023 saw a slight dip to 6.5% (Central Bank of Mauritania, 2024). At a sector level, the primary sector (*e.g.* agriculture, fisheries, etc.) contracted to 1% compared with growth of 8.7% in 2022. Growth in the secondary sector (*e.g.* manufacturing, construction, etc.) slowed to 5.8%, compared with 12.5% in 2022 and mainly due to the decline in manufacturing activities, excluding water and electricity. Growth in the tertiary sector (*e.g.* services, trade, etc.) in real GDP was expected to increase by 5.8% compared to 8.0% in 2022.

The tertiary sector dominates economic output at 43.8% of nominal GDP in 2023, driven by services (45.7%) and trade (24%), transport and communication (14%), and public administration (16.3%). The secondary sector contributes 30.6%, primarily through extractive industries (61.8% of sector output), followed by manufacturing (27.5%) and construction (10.7%). The primary sector accounts for 18.7%, with livestock farming leading (57.1%), followed by agriculture (28%) and fisheries (14.9%).

According to the World Bank Macro Poverty Outlook report for Mauritania, economic growth moderated to 5.2% in 2024 due to weaker public consumption and slowed extractives (gold and iron ore) production (World Bank, 2025). The medium-term outlook is favourable, with GDP growth projected to average 5.1% over 2025-2027, driven by the launch of gas production and exports under the Grand Tortue Ahmeyim (GTA) project, prudent fiscal policies and economic diversification efforts aimed at attracting private sector investment. Government reforms since 2010 have increased the productive sector GDP share, reduced food imports (notably rice since 2012) and improved debt sustainability through restructuring agreements. As a result, the risk of external and public debt distress is assessed as "moderate", with some room to absorb shocks (World Bank, 2024b).

1.2 Overview of the fisheries sector

Mauritania's coastline extends over 720 km, with an exclusive economic zone spanning 205 000 km^2 located in the northern fishing zone of Nouadhibou. This maritime territory hosts an exceptionally rich ecosystem, supporting over 600 fish species – 200 of which hold commercial value (Government of Mauritania, 2022). After Morocco, Mauritania ranks as the second-largest producer and exporter of fish products in Africa, contributing 8.3% of total African production and 10.7% of total exports (FAO, 2024).

The fisheries sector serves as a lever of the national economy, contributing 2.8% to Mauritania's GDP in 2023 and accounting for 14.9% of the primary sector's output (Central Bank of Mauritania, 2024). In 2023, the sector contributed 19.9% of total export earnings (ANSADE, 2024b), while supporting 66 000 direct jobs, of which 42 000 are in artisanal fishing, and an additional 300 000 indirect jobs (ANSADE, 2024b; Government of Mauritania, 2024a). Artisanal fishing is particularly crucial, generating approximately 80% of the sector's added value and employment opportunities. Domestically, the subsector supplies 78 000 tonnes (t) of fish annually, playing a lifeline role in food security. In 2023, per capita fish consumption was estimated at 14.6 kilograms (kg) per person per year.

Table 1 Contribution of fisheries to Mauritania's economy

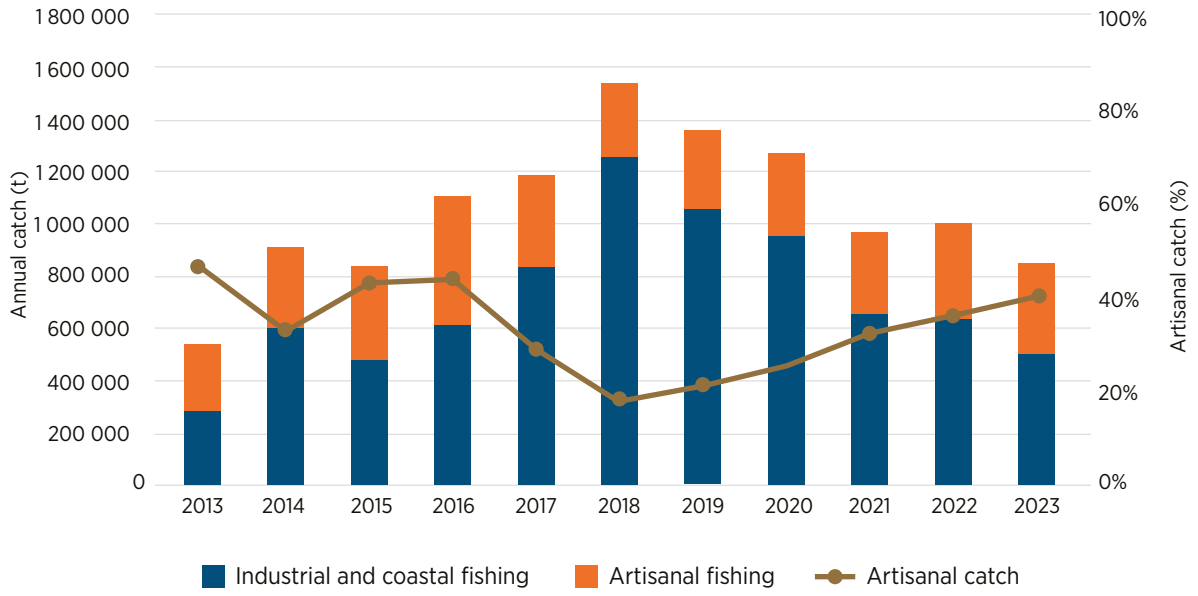
	2020	2021	2022	2023
Production (1 000 t)	1273	1010	995	845
Export volume (1 000 t)	762	629	656	614
Export value (million USD)	762	947	731	744
Revenue generated (million USD)	224	194	217	197
Contribution to GDP (%)	6.3	5.1	5.7	2.8

Source: (Government of Mauritania, 2024a).
Notes: GDP = gross domestic product; t = tonnes; USD = United States dollar.

In order to limit the quantity of fish stocks that can be harvested during a given period, a total allowable catch is set for the different fisheries categories by the minister responsible for fisheries, maritime infrastructures and ports. Fishing activities operate under a dual regulatory system: a *national regime* for vessels processing catches domestically and a *foreign regime* for nondomiciled operations. In 2023, the latter accounted for 50.7% of total revenue generated by the sector. The fleet comprises 182 deep-sea vessels, 99 inshore boats and over 8 000 artisanal boats (*pirogues*).

Annual catches across all species range between 1.2 million t in 2020 and 845 000 t in 2023, dominated by small pelagic species such as sardines and mackerel. This drop is largely attributable to the measures taken by the ministry to regulate fishery production, such as regulation of the fishing capacity of fleets operating in the artisanal fishing zone, and the reduction of coastal pelagic fishing, in accordance with the small pelagic fishery management plan approved in November 2022. This plan followed a commitment made under the implementation protocol of the Mauritania-European Union fisheries agreement signed in 2021.

Figure 1 Evolution of total annual fish catches in Mauritania



Source: (Government of Mauritania, 2024a).
Note: t = tonnes.

Most fish products are exported through the Mauritanian Fish Marketing Company (*Société Mauritanienne de Commercialisation de Poisson*). In 2023, export volumes decreased by approximately 6% compared with 2022, dropping from around 656 000 t to about 614 000 t. The main export markets for Mauritanian fishery products in 2023 are dominated by Africa countries (71.7%), followed by Asia (15.5%) and Europe (12.8%) in terms of volume. In 2023, the total value of exported fishery products was USD 744 million (Government of Mauritania, 2024a). Europe remained the leading market in terms of the value of exported products, accounting for 39% of the total value, compared with 40.5% in 2022. It was followed by the African continent, which accounted for 32% and continued to hold this position for the second consecutive year.

Legal and institutional framework of the fisheries sector

The fisheries and maritime economy sector in Mauritania is governed by the Policy and Planning Letter 2022-2024 (*Lettre de Politique et de Planification du Secteur des Pêches et de l'Economie Maritime*), which aims to preserve marine resources, create wealth and jobs, strengthen food security, and establish good governance. A key priority of this strategy is the development of value chains focused on high value-added processing of fishery products integrated into the national economy. The sector is regulated by two primary laws: Law No. 2015-017 on the Fisheries Code and Law No. 2013-029 on the Merchant Navy Code. The Fisheries Code outlines rules for fishing, development and marketing of fishery products in Mauritanian waters, emphasising the protection and sustainable exploitation of resources for future generations. The Merchant Shipping Code covers a wide range of maritime issues, including ship navigation, safety, security, transport, environmental concerns, licensing, maritime domain management and seafarer rights. It also addresses the implementation of international maritime conventions ratified by Mauritania, ensuring comprehensive regulation of the country's maritime activities.

The institutional framework of Mauritania's fisheries sector is primarily structured around the Ministry of Fisheries, Maritime Infrastructures and Ports (*Ministère de la Pêche, des Infrastructures Maritimes et Portuaires [MPIMP]*), which oversees central and decentralised structures of governmental departments, research institutions and operational entities, responsible for resource management, research, inspection and regulatory oversight of the maritime and fishing sectors.

The sector is further supported by critical infrastructure and marketing entities, which facilitate the processing, distribution and commercialisation of fishery products. The institutional landscape is complemented by robust socioprofessional organisations such as the National Fishing Federation (*Fédération Nationale de la Pêche*), Federation of Fish Exporters, Distributors and Collectors (*Fédération des Mareyeurs Exportateurs, Distributeurs et Collecteurs*), and the National Federation of Artisanal Fishing (*Fédération Nationale de la Pêche Artisanale*), which represent the interests of various stakeholders in the fishing industry.

1.3 Overview of the energy sector

Mauritania has a wealth of energy sources, both fossil and renewables. As far as renewable energy is concerned, solar and wind resources predominate in the country, while significant hydroelectric resources are exploited through the Organisation for the Development of the Senegal River Basin (*Organisation pour la Mise en Valeur du Fleuve Sénégal [OMVS]*). Due to the country's low population density and the widely dispersed settlements across a large land area, Mauritania's power system is highly fragmented, consisting of isolated, non-interconnected grids predominantly powered by diesel generators, currently covering 250 localities with electrical networks out of 2 600 potential sites. It consists of several isolated grids. Out of these, 21 clusters are operated by 6 private operators under regulated concession contracts supervised by the multisectoral regulatory authority, while the rest are managed under the mandate of the Mauritanian Electricity Company (*Société Mauritanienne d'Électricité [SOMELEC]*). However, recent memoranda of understanding signed for solar photovoltaic (PV) and wind projects suggest purchase prices below USD 0.06/kilowatt hour (kWh), which are expected to be further reduced by the introduction of gas, leading to a substantial decrease in overall costs (Government of Mauritania, 2024b).

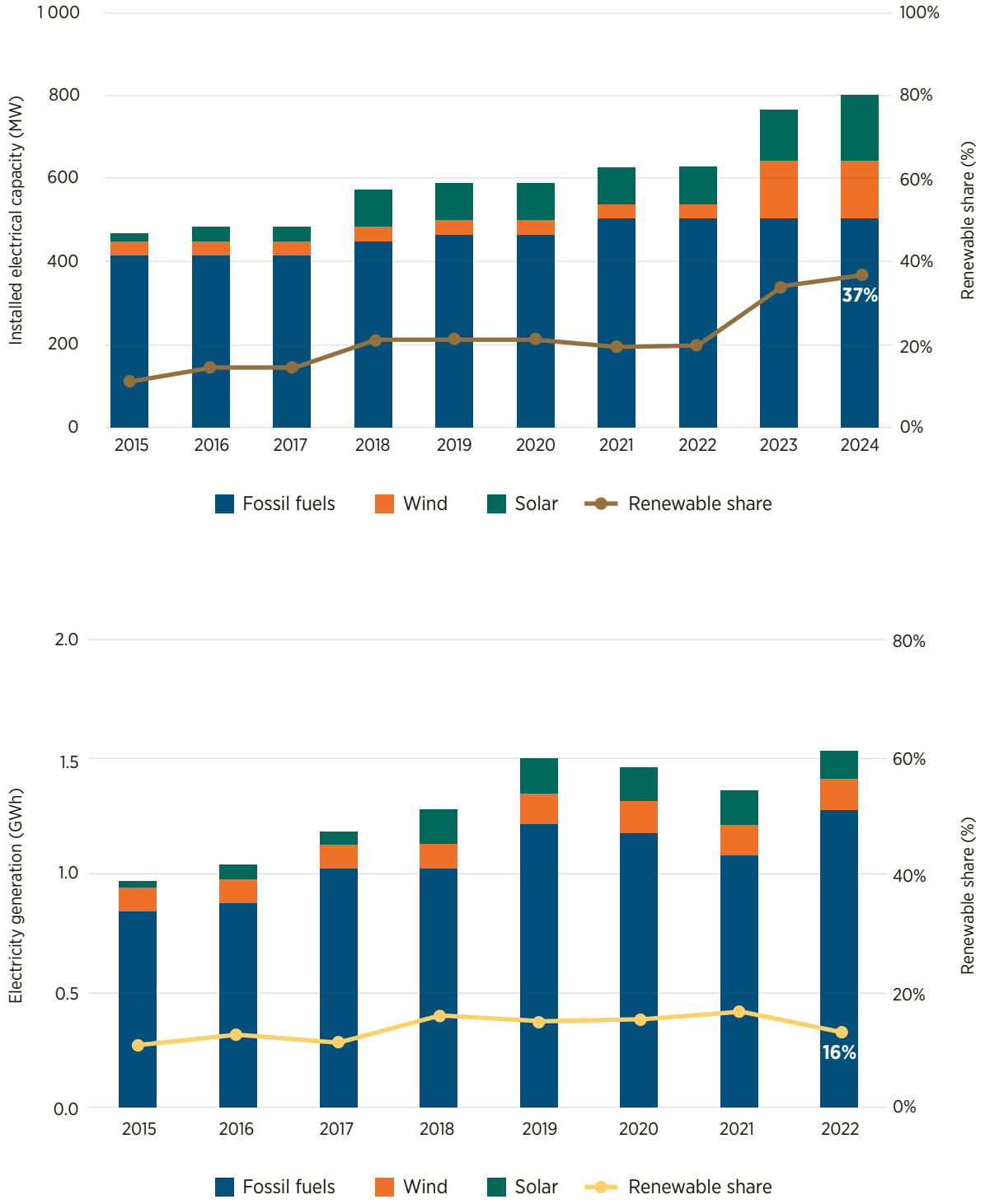
The hydrocarbons subsector has experienced significant developments in recent years, particularly with the discovery of oil and gas fields. A notable example is the GTA project, a joint venture between Mauritania and Senegal, based on a discovery made in 2015, that achieved first gas production in early 2025. Additionally, Mauritania has emerged as a leader in clean energy innovation, with four major green hydrogen production projects[1] currently under planning and development. These initiatives have positioned Mauritania as one of the most attractive destinations on the African continent for investors seeking renewable energy opportunities. According to an analysis of the International Energy Agency, Mauritania could emerge as sub-Saharan Africa's largest exporter of hydrogen fuel by 2030, supplying up to 35% of the continent's total hydrogen exports (IEA, 2023).

Mauritania's electricity system also includes the SOMELEC network, which operates power plants, including thermal, solar and wind facilities. The total installed capacity is over 800 megawatts (MW), while the available capacity (excluding isolated localities) currently aggregates to a little over 510 MW. Electricity access in Mauritania has grown significantly, rising from 41% in 2019 to 55% in 2024 (World Bank, 2024c), although there is a very large disparity between urban (92% access rate) and rural areas (6% access rate) (Government of Mauritania, 2024b; IEA *et al.*, 2024). The urban centres of Nouakchott and Nouadhibou account for almost 80% of electricity consumption. Renewable energy resources represent a significant opportunity that the government is committed to exploiting to drive sustainable socioeconomic development.

In December 2024, the government launched a national energy pact (*Pacte National de l'Énergie*), which aims to provide access to electricity for an additional 3.4 million people by 2030, thereby increasing the national access rate to 100% compared with the current rate of 55%, and to significantly increase the share of electricity generation from renewable sources to 70% by 2030 (World Bank, 2024d). The private sector is expected to play a key role in achieving these goals, with the ambition of mobilising USD 1.23 billion in private investment in electricity generation, transmission and distribution, as well as the deployment of DRE systems.

1 *Aman, Nour, Green Ammonia and Nasim projects*

Figure 2 Evolution of installed electrical capacity and electricity generation



Source: (IRENA, 2025a).
Notes: GWh = gigawatt hour; MW = megawatt.

Legal, political and strategic framework

Over the past few years, the Mauritanian government has adopted a policy and strategy for the energy sector, which aims to give the population of Mauritania universal access to a secure, low-cost electricity supply by 2030. This policy is structured around the following objectives:

- Accelerate access to electrical energy, with an ambitious target of universal access to energy by 2030 for the domestic, commercial and industrial sectors.
- Increase production capacity based on local resources, mainly natural gas and renewable energy resources (solar, wind), complemented by hydroelectricity through OMVS.
- Diversify the national energy mix by rapidly increasing the share of renewable energies in the production mix.
- Develop the national and regional electricity grids and interconnections.

Institutional framework

The main stakeholders are the Ministry of Energy and Petroleum (*Ministère de l'Énergie et du Pétrole [MEP]*), which is responsible for setting the policy direction of the electricity sector; the Multisectoral Regulatory Authority (*Autorité de Régulation Multisectorielle*), which is responsible for regulating the telecoms, water and electricity sectors; SOMELEC; the public services contractors (*Délégation de Service Public d'Eau et d'Électricité*), the prosumers (essentially the mining companies and large industrial companies); and the OMVS. The Rural Electrification Development Agency (*Agence de Développement de l'Electrification Rurale*), is responsible for co-ordinating and promoting rural electrification efforts. However, as part of the recent institutional restructuring in the energy sector, a significant portion of its rural electrification responsibilities have been transferred to SOMELEC.

Recent institutional reforms in the sector

The Mauritanian government, with support from technical and financial partners, is implementing reforms to enhance the energy sector's performance. These reforms aim to develop a modern and appropriate legal and institutional framework that addresses current bottlenecks, attracts private investments and clarifies the roles of various stakeholders.

A cornerstone of these reforms is the new Electricity Code, promulgated on 12 December 2022 (Government of Mauritania, 2024c). This legislation encourages private sector participation in electricity production and rural electrification, promotes energy transition through diversification of electricity sources, and focuses on developing renewable energy production, including green hydrogen. The code aims to improve sector performance for the benefit of the population and the national economy while strengthening subregional and regional interconnections.

The reforms also include a restructuring of SOMELEC by executive decree on 16 January 2024, into three public subsidiaries for electricity generation and transmission, distribution and commercialisation, and rural electrification, nested under a public holding company (Government of Mauritania, 2024c). This decision is complemented by efforts to strengthen the Regulatory Authority and extend its regulatory oversight of SOMELEC activities. Additionally, the government has created a dedicated renewable energy department within the MEP, further demonstrating its commitment to modernising and transitioning the energy sector.

1.4 Renewable energy development in Mauritania

Between 2013 and 2014, IRENA conducted a renewables readiness assessment (RRA) for Mauritania, which indicated that the country has significant renewable energy resources, particularly wind, solar, biomass and small hydropower (IRENA, 2015). Since then, Mauritania has made progress in deploying solar and wind capacities supplying the national grid, with more projects planned in the pipeline up to 2030 (World Bank, 2024d). Mauritania is part of the African Development Bank's Desert-to-Power Initiative, which aims to harness the solar energy potential of 11 countries across the Sahel (Burkina Faso, Chad, Djibouti, Ethiopia, Eritrea, Mali, Mauritania, Niger, Nigeria, Senegal and Sudan), with the goal to deploy 10 gigawatts (GW) of solar PV by 2030 and provide electricity access to 250 million people through a mix of on-grid and off-grid solutions (AfDB, 2020).

Solar energy

Mauritania possesses high solar potential, with the most favourable regions located in the central and northern parts of the country. The average daily global horizontal radiation ranges from 4.9 kWh per square metre (m^2) to 6.5 kWh/m^2, corresponding to an annual potential of 2 000 kWh/m^2 to 2 300 kWh/m^2. Solar irradiation follows a seasonal pattern, peaking during March to May and reaching its minimum from November to January. However, there is relatively little overall seasonality in monthly and yearly solar irradiation. The annual variability of PV production is less than 2%.

Mauritania's landscape can be divided into three distinct regions, each with unique characteristics:

- The north of the country, characterised by a hot, dry desert climate, offers the most favourable conditions for solar energy production.
- The south has a more humid climate with less solar resources compared with the north.
- Coastal areas exposed to lower temperatures but higher humidity levels.

Table 2 Installed solar PV power plants in Mauritania

Solar power plants	Installed capacity (MWp)	Maximum power injected (MW)	Average annual production (GWh)	Commissioning date
Sheikh Zayed solar power plant (Nouakchott)	15	11.5	18.3	2013
Solar power plant (Nouakchott)	50	42	72.9	2017
Zouerate solar power plant	12	10.5	-	2024

Notes: GWh = gigawatt hour; MWp = megawatt peak; MW = megawatt.

Wind

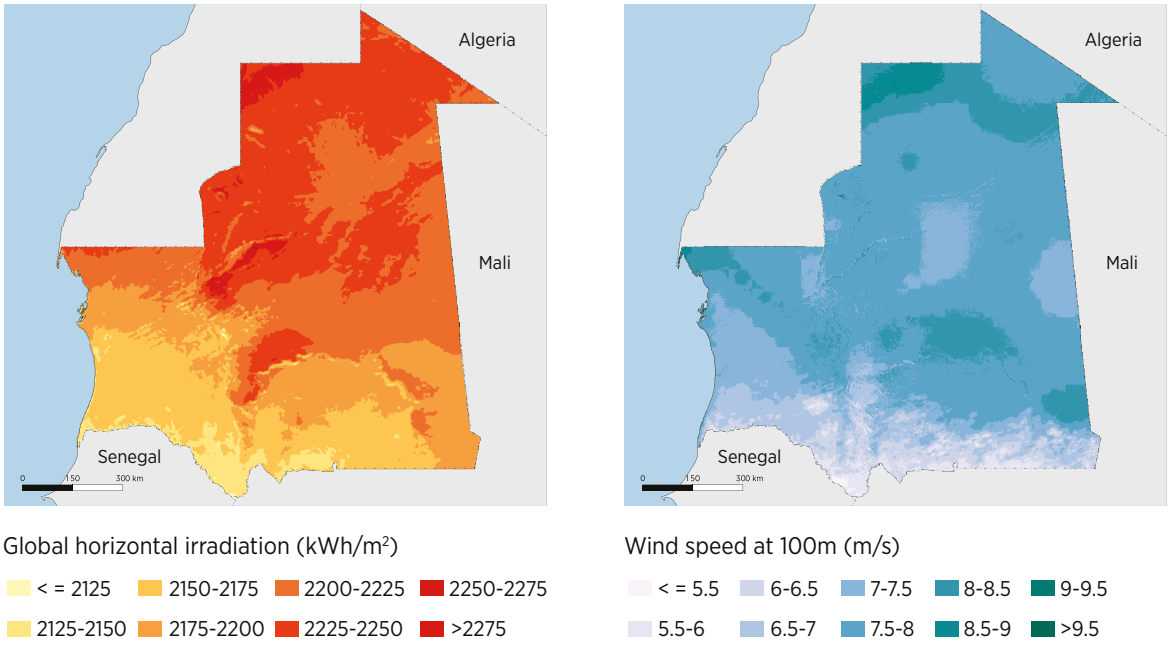
The wind resource in Mauritania is characterised by a dominant wind direction of east, north and north-east. In general, the strongest wind is found in the northern coastal regions (Nouadhibou) and weakens as one moves away from the coast and towards the south. Wind speeds vary between 8.3 metres per second (m/s) and 8.7 m/s in the northernmost coastal areas, such as Nouadhibou, where speeds even exceed 9 m/s. The values drop as you go down to the south of the country but remain above 7 m/s all along the coast. This demonstrates a high technical wind potential in the coastal zones, estimated at 175 GW (World Bank, 2020). Three wind farms currently feed power into the interconnected grid.

Table 3 Installed wind power plants in Mauritania

Wind farm	Installed capacity (MWp)	Average annual production (GWh)	Commissioning date
Nouakchott wind farm	30	109.6	2015
Boulenoir wind farm	100	465.8	2023
Nouadhibou wind farm (SNIM)	4	7	2023

Notes: GWh = gigawatt hour; MWp = megawatt peak.

Figure 3 Solar resource map (left) and wind resource map (right) of Mauritania



Source: (IRENA, 2025b).
Notes: kWh/m² = kilowatt hours per square metre; m/s = metres per second.
Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

1.5 Impact of climate change on fisheries sector

In Mauritania, climate change impacts are evident in declining fish populations and trophic levels within marine protected areas such as the Banc d'Arguin National Park. This decline jeopardises profitability and food security while further impoverishing fishing communities. Additionally, rising sea levels pose significant risks to Mauritania's coastline, exposing vast areas of land and infrastructure to flooding and silting. Coastal erosion is also intensifying, particularly along the Nouakchott coast, where noticeable morphological changes have already occurred.

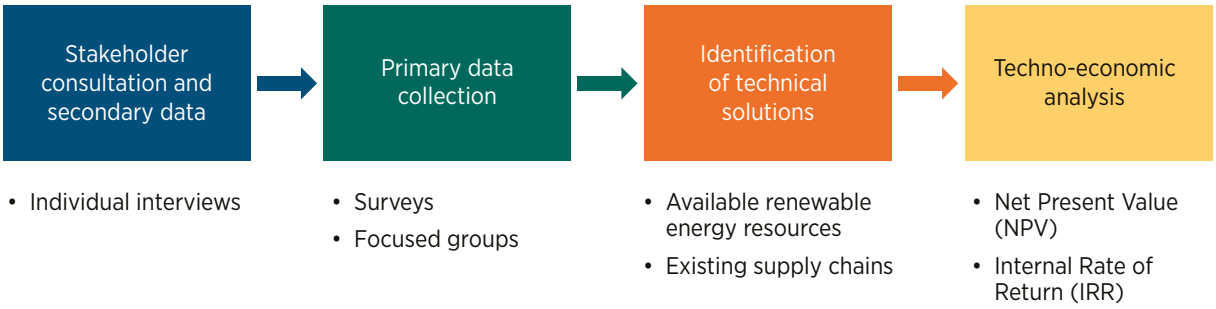
Given its high vulnerability to climate change, Mauritania is committed to the United Nations Framework Convention on Climate Change (UNFCCC) 21st Conference of Parties (COP21) Paris Agreement, aiming to reduce GHG emissions through renewable energy solutions. The country's updated Nationally Determined Contribution (NDC) targets an 11% reduction in emissions by 2030 and with more international support, the country could achieve carbon neutrality, up to a conditional 92% reduction compared with the business-as-usual scenario. Mauritania's commitment to renewable energy aligns with the global trend, positioning the country to reduce its reliance on fossil fuels and enhance its resilience to climate change impacts.

To enhance its climate resilience, Mauritania has expanded its adaptation ambitions under its National Adaptation Programme (NAP) to include ecosystem protection, sustainable agriculture and coastal management. The development of the fisheries sector stands as a key priority in Mauritania's updated NDC, highlighting its role in strengthening food security and alleviating poverty, particularly in the rural communities (Government of Mauritania, 2021).

2 Methodology

The methodology used for this assignment followed a holistic, participatory and iterative approach to ensure comprehensive and inclusive outcomes. It was designed to integrate different viewpoints, address identified needs and propose practical solutions. The assignment was structured into four key steps. First, stakeholder consultations and secondary data collection were conducted to establish a foundational understanding of the fisheries-energy context in Mauritania. This was followed by primary data collection through surveys and focus group discussions to gather detailed insights directly from artisanal fishing stakeholders. Based on identified needs and opportunities, technical solutions were proposed in the third step, followed by a techno-economic analysis to assess the economic viability of the proposed solutions (Figure 4).

Figure 4 Methodology of the assessment



2.1 Stakeholder consultation and primary data collection

IRENA conducted a comprehensive mission to Mauritania in February 2024, employing a multifaceted approach to stakeholder engagement and data collection. The process began with a series of individual interviews involving a wide range of stakeholders, including representatives from the MPIMP, the MEP, technical and financial partners, departments and agencies, private sector entities, socioprofessional organisations, renewable energy suppliers, and local financing institutions. These interactions facilitated the gathering of relevant documents, information and feedback pertinent to the study's objectives and scope.

Prior to conducting field surveys, a comprehensive survey methodology was developed. This included defining the survey areas, determining the overall sample size, and designing the questionnaire. The field surveys were then executed in accordance with this methodology, conducted simultaneously across different zones. The survey benefited from strong co-operation from all stakeholders, facilitated by the active involvement of socio-professional organisations. In total, 411 artisanal fishing actors were surveyed across various regions: 172 in Nouadhibou, 96 in Nouakchott, 51 in the central zone, 41 in the Banc d'Arguin National Park (PNBA) and 51 in the southern zone. This sampling ensured a representation of the data gathered across Mauritania's fisheries and energy sectors.

Table 4 Breakdown of the sample surveyed by area and value chain segment

Segments	Nouadhibou	PNBA	Centre	Nouakchott	South	Total
Fish factories	18	-	-	12	-	30
Fishmongers	45	-	-	45	-	90
Shipyards	6	-	-	7	-	13
Ice factories	3	-	-	2	-	5
Fishermen	90	10	10	30	10	150
Artisanal processors	10	-	10	-	10	30
Village heads	-	1	1	-	1	3
Households	-	30	30	-	30	90
Total	172	41	51	96	51	411

2.2 Technoeconomic analysis of DRE solutions

The profitability of the decentralised renewable energy solution options proposed for decarbonising main segments in the small-scale fisheries value chain is analysed using two main indicators: net present value (NPV)[2] and internal rate of return (IRR).[3] The analysis also considers the avoided carbon dioxide (CO_2) emissions. To do this, it is assumed that in the case of the substitution of fossil energy by the proposed DRE solutions, the current substituted energy costs of the various segments will be saved and are therefore considered as "avoided cost". The following table shows the main calculation parameters for the various segments of the study.

Table 5 Main assumptions used to calculate the profitability of the proposed solutions

Segments	Gross avoided cost	Operating costs
Plants/factories **Storage warehouses**	Gross avoided cost = Total annual energy consumption substituted x SOMELEC tariff	Operating costs = cost of operating and maintaining the solar systems, estimated at USD 20/kWp/year
Ice factories **Shipyards**	Total annual substituted energy consumption = Total annual consumption x solar penetration rate x SOMELEC tariff Penetration rate = Annual solar energy produced (MWh) x 100 / total annual consumption (MWh) / type SOMELEC tariff[1] = SOMELEC invoice value[2] /actual consumption invoiced	
Fishermen (15 hp engines)	Avoided cost = Petrol consumption (L) per trip x number of trips x petrol cost / L	Operating costs = annual cost of battery recharging + annual maintenance costs Annual cost of battery recharging = number of recharges x cost of recharging Maintenance cost = annual flat rate
Fish merchants (solar freezer)	Avoided cost = Total annual quantity of ice used to preserve fish in kg[3] x price per kg of ice	Operating costs are assumed to be negligible and limited to the maintenance of the solar unit.
Community solar cold rooms in fishing villages	Avoided cost = Total annual storage capacity in kg x storage cost per kg[4]	Operating costs = total cost of employees + cost of maintaining equipment
Community solar ice factory in fishing villages	Avoided cost = Total annual quantity stored[5] in kg x storage cost per kg	Operating costs = total cost of employees + total cost of water + annual cost of maintaining the unit
	Net avoided cost = Gross avoided cost - Operating costs	

Notes: [1] This rate includes all taxes, including the fixed premium.
[2] The value is converted into USD using an exchange rate of USD 1 = MRU 39.2 (Mauritanian ouguiya).
[3] It is assumed that preserving 1 kg of fish requires 0.29 kg of ice (29% of the live weight).
The average quantity of fish preserved and the average price of ice are calculated on the basis of field surveys.
[4] The tariff is assumed to be in force in similar villages in Mauritania.
[5] The average quantity stored is 700 kg/day and the storage charge is MRU 2/kg.
Also: kg = kilogram; kWp = kilowatt peak; L = litres; MWh = megawatt hour; USD = United States dollar.

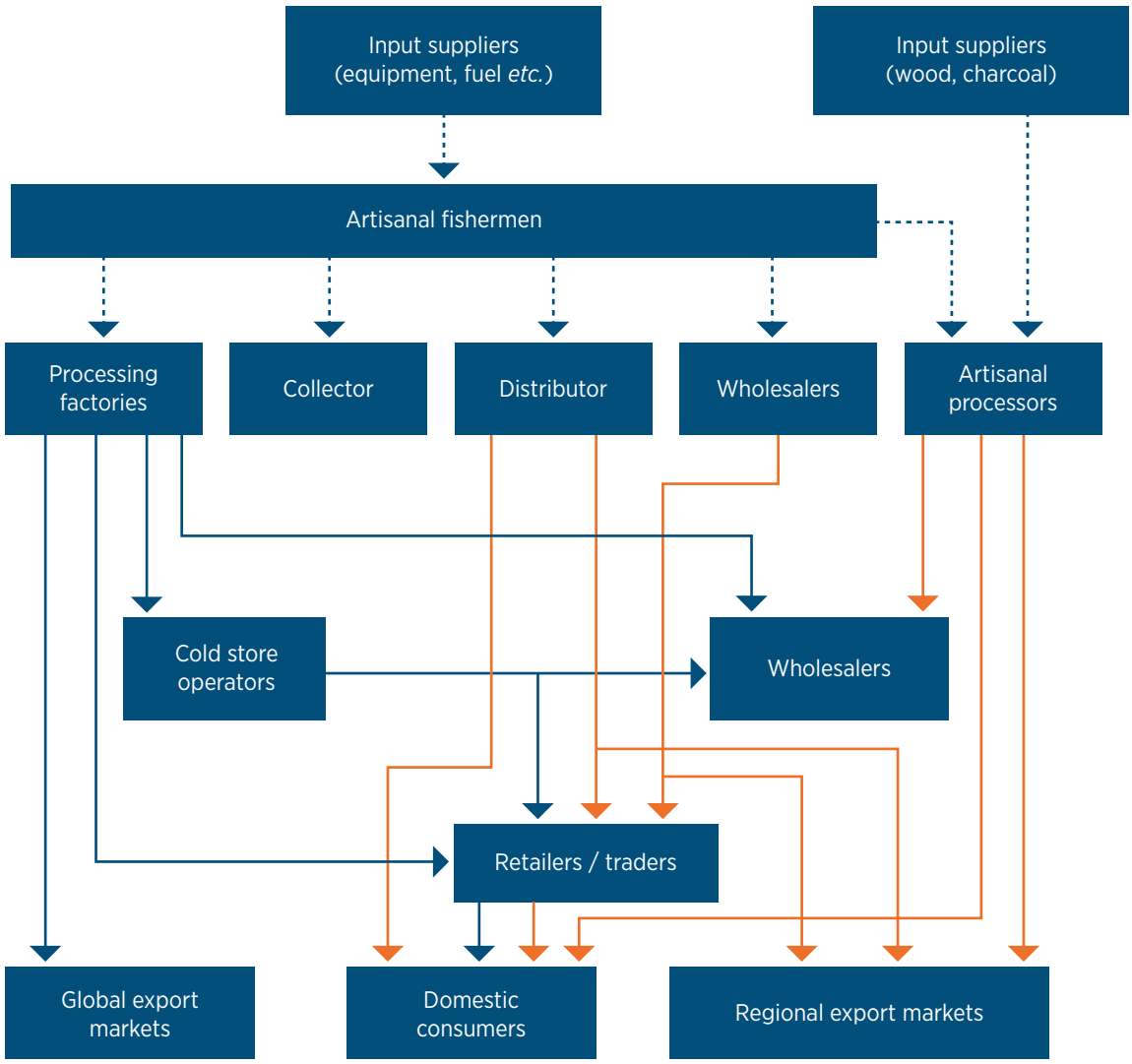
2 *NPV is the value of all expected future cash flows (both inflows and outflows) over the life of an investment, discounted to the present. As a financial metric, the NPV is useful tool for evaluating investments by assessing the current costs to start a project against the anticipated returns the investment will generate over time.*

3 *The IRR is the annualised rate of return expected from a project or investment, calculated as the discount rate that brings the NPV of all future cash flows to zero.*

3 Artisanal fishery value chain in Mauritania

The artisanal fisheries sector plays a crucial role in Mauritania's economy, contributing significantly to food security, employment and export earnings. The value chain comprises a diverse range of activities and actors, from input suppliers to end consumers. Key stages include fishing operations carried out by small-scale fishermen using traditional methods, postharvest handling and storage, processing (such as drying and smoking), and distribution through various marketing channels. Input suppliers provide essential materials such as boats, fishing gear and ice, while processors and merchants facilitate value addition and market access. Figure 5 illustrates the key actors and stages in the artisanal fishing value chain in Mauritania.

Figure 5 Illustration of artisanal fishing value chain in Mauritania



3.1 Input suppliers: Shipyards and ice factories

The input suppliers play a key role in the artisanal fishing sector of Mauritania, with shipyards (fishing equipment) and ice factories being the main components of upstream activities in small-scale fishing. In Nouadhibou, the main fishing hub, there is one formal shipyard, the *Chantier Naval de Mauritanie*, alongside about ten artisanal shipyards, which specialise in constructing plastic pirogues. Contrarily in Nouakchott, wooden pirogues are preferred due to the challenging sea conditions and their stability, ease of mooring and lower acquisition costs compared with the more expensive plastic pirogues. These wooden vessels are built on the beach by specialised carpenters, with owners supplying the necessary materials.

Ice factories form another major input to the value chain. Ice is used by fishermen to preserve their catch on board until landing and by wholesalers to maintain fish quality from landing to market sale. Recognising the importance of ice in maintaining fish quality and, consequently, its market price, the Mauritanian government has invested in ice-making units in the main landing centres of Nouadhibou and Nouakchott. The aim of these units is to ensure a continuous supply to small-scale and coastal fishing units while helping to maintain ice prices at affordable levels for fishermen. Currently, there are 20 ice factories in operation: 13 in Nouakchott and 7 in Nouadhibou, with 14 of these privately owned. This distribution of ice factories helps support the fishing industry's needs across the two main fishing centres.

3.2 Artisanal fish production and fleet

In 2023, the total recorded catch was 845 627 t, representing a 15% decrease compared with 2022 (Government of Mauritania, 2024a). The overall trend in catch volumes has shown a decline since 2018, primary attributable to the drop in offshore catches, particularly under the foreign regime. On the other hand, artisanal fish production has remained relatively stable, averaging 339 207 t in 2023, which accounted for 40% of Mauritania's total catches.

According to the latest monitoring report (IMROP, 2024a),the artisanal and inshore fishing fleet comprises 8 430 units, 95% of which are artisanal units (7 970). The spatial distribution of the artisanal fleet is primarily concentrated in the northern zone of Nouadhibou (57%). This is followed by Nouakchott with 19% of the fleet, and the Centre zone which accounts for 17%. The southern zone of Nouakchott and the Banc d'Arguin National Park together account for only 7% of the total artisanal fleet.

In terms of vessel type, plastic pirogues account for 67% of the total pirogue fleet, totalling 5 631 units, 98% of which are used for artisanal fishing. Wooden pirogues account for 26% of the fleet. Other vessel types include aluminium pirogues, sailing launches, canoes and decked pirogues, collectively accounting for 8% of the fleet.

Table 6 Artisanal fishing catches

Year	Catches from artisanal fishing boats (pirogues)	Total catches (t)	Artisanal boats (%)
2015	357 351	837 666	43%
2016	485 717	1103 550	44%
2017	347 908	1191 450	29%
2018	270 706	1533 231	18%
2019	289 138	1356 802	21%
2020	316 347	1272 866	25%
2021	308 186	969 690	32%
2022	357 681	995 072	36%
2023	339 207	845 627	40%

Source: (Government of Mauritania, 2024a).
Note: t = tonnes.

In terms of engine capacity for motorised boats, 40 hp motors, widely used in the North zone, account for 48% of the fleet with 3 541 units. These are followed by 15 hp motors, which account for 42% of the fleet (3 168 units), used mainly in the Nouakchott, Centre and southern zones. The predominant use of 15 hp engines in these three zones is explained by fuel-saving considerations, given the proximity of the fishing areas and the type of canoes used (mainly small wooden canoes). Conversely, the prevalence of 40 hp motors in the northern zone is due to the larger size of boats (12 metres [m] and over) and the greater distance to fishing grounds, with travel times generally ranging from 9 to 12 hours.

3.3 Storage and processing

There are a total of 155 approved factories operating along the entire Mauritanian coastline. Total freezing capacity is almost 4 000 t/day and storage capacity is estimated at 74 000 t. In addition to these active factories, there are several shut-down facilities and a large number of pending authorisations for new factories. The fish processing industry also includes 43 fishmeal and fish oil plants. The economic free fishing zone of Nouadhibou is home to most processing factories, holding over 70% of the total freezing capacity and around 92% of the storage capacity.

Fish processing is limited essentially to freezing of whole products and the production of fishmeal and fish oil. To a lesser extent, some facilities engage in deheading, gutting and filleting, which are typically coupled with freezing to inhibit spoilage. Recently, there has been a trend towards diversifying processing methods, particularly for small pelagic fish, with the establishment of three canning factories.

3.4 Fishmongers and merchants

The decree (No. 2009-172) relating to the profession of fishmonger defines fishmongers as "natural or legal persons who regularly market fishery and aquaculture products either from purchases made from producers, or from their own catches using their own means of production, after having fulfilled the conditions necessary for receiving and preserving these products and transporting them to places of sale, processing or export" (Government of Mauritania, 2009). This is a profession reserved exclusively for Mauritanians. In line with this definition, Article 5 of the decree further distinguishes among three main categories of wholesalers:

1. **Fish merchants (collectors):** These are individuals who operate at landing areas, purchasing fish products in small quantities from fishermen and reselling them without processing or packaging. They are required to have premises and equipment suitable for receiving products.
2. **Wholesale distributors:** These are natural or legal persons who buy fish products in bulk with a view of reselling them after packaging and transport.
3. **Exporting wholesalers:** These are legal entities that export fishery products in compliance with the laws and regulations in force.

There are a total of 2 291 fishmongers, including 1 263 in the North zone (Nouadhibou), 802 in the Nouakchott zone and 39 in the zone south of Nouakchott, 55 in the PNBA zone and 79 in the central zone (IMROP, 2024b). According to specialisation, there are 1 557 wholesale collectors, 563 wholesale distributors and 171 wholesale exporters.

3.5 Artisanal fish processing

Artisanal fish processing in Mauritania caters to both national and regional markets, primarily Ghana, Mali and Nigeria. These traditional processing methods employ techniques such as salting, drying, fermentation and smoking. Artisanal processors are mainly located in Nouadhibou, the PNBA and south of Nouakchott, relying heavily on wood and charcoal for fuel. These activities are mainly carried out by foreign nationals from neighbouring countries, including Ghana, Nigeria, Guinea-Bissau, Senegal and Mali, alongside a small number of Mauritanians, mainly Imraguen women. There are three main methods of traditional fish processing:

1. **Dried and salted products:** Made from tollo, rays and sharks, these products are primarily exported to Ghanaian and Nigerian markets.
2. **Dried fermented fish (known locally as guedj):** Made from catfish and other fish, this product supplies local markets and those of neighbouring countries, particularly Senegal and Mali.
3. **Tichtar, lekhliâ and d'hin:** These products are made by Imraguen women from the flesh and heads of yellow mullet, mainly for household consumption and sale. Lekhliâ is prepared using the thin strips of flesh that remain attached to the skeletal frame after the tichtar strips have been removed. D'hin is oil extracted from the head and viscera of fish by boiling in water.

3.6 Women in the artisanal fisheries sector

Women play an important role in the artisanal fishing sector of Mauritania, particularly in processing, distribution and retailing activities. However, their participation in the sector faces certain challenges such as limited access to resources (capital and equipment), and the demanding nature of the work, often requiring long journeys, late hours and prolonged absences, is a major factor that hinders a stronger female presence in the fishing sector.

Despite these challenges, certain occupations within the sector are almost exclusively dominated by women. Small-scale fish processing and retailing are prime examples of areas where women have established a strong presence: women account for 76% of fishmongers and 71% of national artisanal fish processors. This gender distribution highlights the important contribution of women to the artisanal fishing value chain of Mauritania, particularly in postcatch activities. It also underscores the potential for targeted interventions to support and enhance women's participation, thereby improving their livelihoods and ensuring greater gender equality in the sector.

© Babucarr Bittaye / IRENA

4 Energy requirements in the artisanal fishing value chain

This chapter presents an analysis of energy requirements in the artisanal fishing value chain in Mauritania, focusing on both large-scale and small to medium-scale consumers. The methodology employed considers various stages of production, processing and distribution, recognising that different processes have varying energy intensities.

The analysis categorises consumers into two main groups:

1. **Large-scale consumers:** This category includes fish processing plants, ice factories and shipyards. These facilities utilise energy-intensive equipment such as compressors, evaporators, tunnels, fans, boilers, scramblers, conveyors and pumps.
2. **Small and medium-scale consumers:** This group comprises fishermen and fish merchants, whose energy needs are generally lower but still significant in the overall value chain.

The analysis provides forecasts of annual electricity demand based on primary field data and peak demand for each segment of the value chain.

4.1 Large-scale consumers

The energy requirements in the artisanal fishing value chain vary significantly across different segments, with fish processing plants being the most energy intensive. The energy requirements were estimated based on field surveys data, quantity and type of equipment installed, and analysis of the monthly energy bills from SOMELEC.

- **Fish processing plants:**
  These facilities are the most energy-intensive segment of the value chain. Their energy consumption varies widely between plants, depending on the equipment used and its operating time. The equipment typically includes compressors, evaporators, tunnels, fans, boilers, scramblers, conveyors and pumps. In this study, five types of fish processing plants in Mauritania are considered: freezing/chilling; fishmeal; flour and fish oil; canning/tinning; and storage warehouses.

- **Ice factories:**
  Ice production is crucial for preserving fish from catch to sale. In this study, ice factories are considered across three levels:
  1. Those integrated within fish processing plants, considered part of the plant's overall energy demand.
  2. Stand-alone large units in electrified towns (Nouakchott and Nouadhibou), producing over 10 t/day of ice
  3. Small units in fishing villages producing 1-2 t/day with an electricity consumption of about 14 kWh/day.

The peak energy demand for ice production is approximately 7 kilowatts (kW) /t/day at full capacity. Equipment in the ice factories include compressors, evaporators and pumps.

- **Shipyards:**
  Shipyards are the least energy-intensive among large consumers. They primarily use equipment such as drills, saws, grinders, planers and fans, typically with power ratings of 1-3 kW. Their energy consumption is relatively low, mainly from tools and cutting machines with low-power single-phase motors.

Based on survey of 30 fish processing factories, 13 shipyards and 5 ice factories across Mauritania, the table below shows the energy requirement for each type of facility on the basis of the equipment used in these factories and their energy consumption load profile. This equipment includes compressors, evaporators, tunnels, fans, boilers, scrambler, conveyors and pumps. The peak season is from May to December and the low season from January to April. In the year, factories operate for average of ten months at full capacity.

Table 7 Estimated energy requirements for fish processing factories in Mauritania

Plant/factory type	Installed equipment capacity (kW)	Est. total electricity consumption (kWh/day)	Consumption (MWh/month)	Average annual consumption (MWh)
Freezing/chilling[1]	647	4 577	91.99	919.94
Fishmeal	355	2 394	48.13	481.27
Flour and oil	328	2 557	51.40	513.98
Canning/tinning	173	1 316	26.45	264.50
Storage warehouses	210	1 150	23.11	231.13
Ice factories	91	1 358	27.31	273.12
Shipyards	27	566	11.38	113.77

Notes: kW = kilowatt; kWh/day = kilowatt hour per day; MWh = megawatt hour.
[1] The estimated consumption of 91.99 MWh/month was comparable to the consumption recorded at a similar freezer/chiller plant of 73.75 MWh in November 2023 and 133.58 MWh in April 2024.

4.2 Small and medium-sized consumers

Fishermen

Fishermen in Mauritania rely on various energy-consuming equipment to support their operations, including motors, lighting systems and electronic devices. The type of equipment used varies depending on the size of the vessel and the nature of the fishing activities. Petrol outboard engines are the most-used engines by artisanal fishermen, mainly rated 15 hp engines for pirogues under 12 m and 40 hp for larger canoes measuring 12 m or more.

While 15 hp petrol engines can be relatively easily converted to battery-powered electric motors of equivalent power, larger engines (above 15 hp) may not be suitable for such retrofitting due to their high motive power needs. Alternative solutions, such as replacing traditional fuel with green hydrogen, could be explored for these larger vessels.

All surveyed fishermen use battery-operated or rechargeable lamps for lighting their pirogues and signalling to avoid collisions with larger boats. The lighting set-up typically includes a 100 watt (W) spotlight and four or five lamps, each with a power rating of 20 W. Other electronic equipment commonly used by artisanal fishermen include GPS, mobile phones and VHF radios.

Fish merchants

Most fish merchants are not connected to the national grid, relying instead on alternative methods to preserve their products. They typically refrigerate using ice stored in wooden crates and cold storage boxes, including old or broken freezers. Some merchants rent power sockets from neighbours, such as shops or grocery stores, to meet their energy needs. The primary energy requirement for fish merchants is product preservation, with electricity consumption depending on the storage volume. Refrigeration units used by fish merchants generally range in power from 1.5 kW to 2.5 kW for freezers and 10 kW to 20 kW for cold rooms.

Artisanal fish processors

In Mauritania, artisanal fish processors do not currently use electrical equipment for their activities. Fish is dried naturally in the sun and wind using wooden drying racks constructed by the processors themselves. For smoking, they rely on clay ovens fuelled by wood and charcoal. Energy consumption in this segment can be estimated based on the average quantity of fish processed per processor, which is approximately 285 kg/week. To modernise this process, processors could use solar-powered electric ovens with rated capacities of 500 W and two to three fans for drying, each with a power of 100 W.

Transitioning to sustainable artisanal processing methods could reduce the physical demands of the work, improve income for processors, enhance product preservation, and improve health by reducing smoke inhalation from wood burning. However, due to the nomadic nature of small-scale processors and their dispersed locations, implementing electrical drying equipment at this stage may not be practical. Instead, collective solutions such as modern solar drying systems could be explored in the future as part of developing centralised artisanal processing sites.

Coastal fishing villages and households

Mauritania's coastline is home to several fishing villages, distributed across three zones: nine within the Banc d'Arguin National Park (Nouamghar, Tenalloul, Iwik, Arkeiz, Teichott, Tissot, R'Gueiba, Awguedj and Agadir), four in the central zone (Mheyjrat, Tiwilit, Lemcid and Blawakh), and one in the southern zone near Nouakchott (Legweichich). These villages share common characteristics, including an average size of 100 households (approximately 600 residents), a population predominantly composed of fishermen, low education levels, limited basic services and minimal energy consumption. While some villages are already electrified, others are yet to be electrified (Legweichich, Lemcid, Nouamghar).

As of this time of this study, these three target localities (*i.e.* Legweichich, Lemcid and Nouamghar) have a combined population of 2 850 people across 478 households, with an average household size of six people. Apart from the individual household energy needs, described in the subsequent paragraph, key social infrastructure in the coastal fishing villages includes potable water supply; school, health centre; shops; mosques; and a community centre. The estimated total peak electrical demand of these social infrastructures is 60 kWp, with a daily energy requirement of 80 kWh, based on equipment usage duration and power ratings in similar electrified rural villages in Mauritania.

In unserved villages, households mainly use candles for lighting, batteries for radios and TVs, and mobile phone charging with solar kits. Cooking is mainly done using gas cylinders, often purchased in distant urban centres such as Nouakchott or Nouadhibou. The survey indicates that the peak household power demand is around 2.8 kW,[4] covering basic appliances such as lighting, televisions and refrigeration.

Addressing the energy needs of coastal fishing villages requires the use of decentralised renewable energy solutions tailored to local conditions, such as solar mini grids. Priority areas include integrating water supply and ice production into village grids to serve as anchor loads, thereby increasing the financial viability of these systems.

Table 8 Estimated energy requirements for fishing villages

User category	Total daily consumption by location (kWh)		
	Legweichich	Lemcid	Nouamghar
Households	200	258	404
Social infrastructures	80	80	80
Productive uses	126	126	126
Total	**406**	**464**	**610**

Note: kWh = kilowatt hour.

4 *Includes mobile phone chargers, radio, audio system, TV, fan, refrigerator, iron, stove and lighting.*

5 Barriers to uptake of DREs in Mauritania's artisanal fishing

This chapter presents the barriers to adopting DRE solutions and stakeholder perceptions within Mauritania's artisanal fishing sector, drawing on the survey findings across the value chain. Despite the sector's importance to Mauritania's economy, the survey reveals that the artisanal fishing sector is faced with systemic technical constraints such as high fuel costs, unreliable energy supply and lack of adequate infrastructure (for fish processing and storage), compounded by limited access to financing for both large-scale consumers and small and medium-scale consumers. While stakeholders demonstrate awareness of renewable energy technologies, particularly solar and wind, uptake remains hindered by high upfront costs, lack of tailored financial mechanisms, and insufficient technical capacity of the actors to operate and maintain these systems. The following sections expand on the identified barriers and opportunities for the DRE solutions in the fisheries sector.

5.1 Technical constraints

Large energy consumers (processing plants, storage warehouses and ice factories) face significant challenges. According to 95% of respondents, the key challenges are high costs, limited availability and unreliable supply. It is reported by surveyed factories that the cost of electricity is inflated by the fixed premium (an add-on independent of actual consumption), which represents an average of 32% of the monthly bill. Given their large installed capacity, the national grid is not always able to meet the electricity demand of these large consumers, forcing most of them to have their own backup generators. Based on the survey results, the average monthly electricity costs range between USD 1 481 for ice factories and USD 8 500 for processing plants (*e.g.* fishmeal factories). This constitutes a huge cost element in the operation of these facilities. For small- and medium-sized customers (fishermen), the main constraints are high fuel costs, unreliable supply and limited electricity access, reported by 96% of respondents. The average cost of fuel per trip for 15 hp pirogues is USD 26 (representing 34% of total trip cost); that goes to USD 492 for 40 hp fishing pirogues (representing 40% of the total trip cost) and up to USD 1 931 for large fishing boats (representing 43% of the total trip cost).

5.2 Access to finance in the fisheries sector

Financing for the fisheries sector in Mauritania presents a significant challenge, hindering the growth of businesses, particularly in the informal artisanal fishing subsector. To address this, the Mauritanian government, with the support of technical and financial partners, has over time implemented several financing initiatives, which have yielded mixed results. While banks are involved in financing large-scale consumers, their low-risk appetite makes it extremely rare for banks to finance artisanal fishing activities. Stakeholders surveyed in Mauritania's artisanal fisheries value chain highlighted significant challenges in accessing financing, reported by 90% of wholesalers, 75% of fishermen, 66% of large-scale consumers (*e.g.* processing plants) and 57% of artisanal processors. The key barriers to accessing finance, as identified by respondents, include high interest rates (reported by 84% of fishermen), stringent guarantee requirements (reported by 47% of large consumers), limited availability of tailored financial services in their areas (highlighted by 29% of respondents) and short repayment periods.

Funding sources vary by stakeholder group, with fish merchants serving as the primary financiers for 66% of fishermen. Some of the fish merchants own the fishing boats, which they lease to fishermen. Large-scale consumers, such as ice factories and shipyards, rely more on banks, with 37% securing loans through commercial banks. Small-scale artisanal processors, however, depend on family and friends as their main source of financial support. For government assistance, nearly all stakeholders reported little or no government funding support, reported by 99% of fish traders, 88% of large-scale consumers, 89% of small-scale processors and 83% of fishermen. Where this limited support exists, it is mainly the provision of equipment for artisanal processors and fishermen. Only 16% of fishermen reported accessing government subsidy on fuel.

Asset financing offered by some microfinance institutions (MFIs) in Mauritania is increasingly becoming an important instrument supporting small-scale fishermen. Since the emergence of the microfinance sector in Mauritania in 1989 with the establishment of the Association for Credit of Small and Medium Enterprises (Association pour le Crédit et la Petite et Moyenne Entreprise), significant progress has been registered. This includes the launch of the Savings and Credit Union (Caisses populaires d'épargne et de crédit [CAPEC]) network in 1997 and the promulgation of Law 00/98 regulating savings and credit co-operatives and mutuals.

In 2003, the Mauritanian government adopted a National Microfinance Strategy (Strategie national de la microfinance), which was operationalised by Ordinance No. 005/2007 promulgated in 2007 to separate microfinance regulations from those governing banks and financial institutions and end the operator monopoly favouring co-operative and mutual structures. Today, the microfinance sector comprises 31 MFIs approved by the Central Bank. Specifically, three MFI networks (PROCAPEC, Caisse Populaires d'Epargne et de Crédit Djiké-Mutuelle, and the Mutuelle de la pêche artisanale) are known to be directly involved in financing artisanal fishing operations. However, their portfolios are limited to meet the ever-increasing demand, especially because current MFI regulations cap lending at USD 12 500 per project. This amount is often insufficient for investment projects that typically exceed this threshold. Some MFIs are experimenting "solidarity guarantee" mechanisms, where the equity of co-operative groups is used to guarantee the loans of their members.

Since 2023, a new project[5] financed by the German Development Bank (KfW) has established a EUR 12 million revolving fund, managed by the Central Bank of Mauritania. The fund operates through three partner banks (Générale des Banques de Mauritanie, Banque Al Amana and Banque Nationale de Mauritanie), with the development objective of providing accessible credit to businesses across the artisanal fishing value chain. The key features of the fund include a preferential interest rate of 6% and a seven-year repayment period, whereas current market interest rates range from 15-24% with repayment periods limited to 3-24 months. The successful implementation of this project holds strong potential for bridging the access to finance constraints, highlighted in this report, particularly the lack of affordable, long-term financing for artisanal processors, fishermen and related businesses.

5.3 Awareness and willingness to adopt DRE among stakeholders

Among those surveyed, 84% of large-scale consumers, 78% of fishermen and 46% of fish merchants demonstrated awareness of renewable energy technologies, particularly solar and wind power. Most stakeholders expressed interest in using DRE solutions for their activities if such technologies were more accessible, with 100% of large-scale consumers and artisanal processors indicating willingness to adopt DRE solutions. Similarly, 89% of fish merchants and 70% of fishermen expressed interest in integrating DRE into their operations. According to 94% of fishermen surveyed, DRE could be used to power retrofitted battery-powered motors and accessories on pirogues, while 4% suggested its use for operating refrigeration equipment on board. In terms of expected benefits, 44% of fishermen identified cost savings on operations as a main advantage of adopting DRE solutions.

For those small and medium-size consumers that have expressed willingness to acquire DRE solutions, 84% are willing to use their own resources supplemented with concessional bank loans to finance such investments. Despite this strong interest, more than 90% of artisanal stakeholders identified obstacles that need to be addressed to encourage their adoption. The obstacles identified include limited availability of DRE technologies in the market, high initial investment costs, lack of financing options, insufficient skills and training in renewable energy systems, and challenges related to quality of equipment, servicing and maintenance. It was reported that there is a law on tax exemption for renewable energy equipment promulgated in 2000, but its decree of execution has not been applied. These constraints underscore the need for targeted interventions to promote the adoption of DRE technologies in Mauritania's artisanal fishing sector.

5 *EUR 19 million grant funded by the German Development Cooperation (BMZ) through KfW to support development of artisanal fisheries value chain, where the Ministre de la Pêche et des Infrastructures Maritimes et Portuaires will work with three commercial banks to offer credit lines to fishermen at below market rates of 6%. Line of credit is EUR 12 million (revolving fund), capacity-building component is EUR 3.5 million. Government in negotiations with KfW for an additional EUR 15 million to serve as guarantee fund.*

6 Analysis of DRE solutions for artisanal fishing in Mauritania

Building on the energy demand assessment and stakeholder perspectives presented in Chapters 4 and 5, respectively, this chapter examines the potential of DRE technologies to address the needs of Mauritania's artisanal fishing sector. The analysis begins by proposing specific DRE solutions tailored to the expressed needs of stakeholders and the unique opportunities presented by renewable energy technologies in Mauritania. This is followed by a comprehensive techno-economic evaluation, assessing the viability of these proposed solutions through two key financial indicators: NPV and IRR. Importantly, this chapter explores the environmental impact of deploying these DRE solutions, quantifying potential CO_2 emissions reductions and associated monetary savings. This approach ensures alignment between the economics of the proposed solutions and their potential contribution to Mauritania's climate goals as defined in its updated NDC.

6.1 DRE solution options for the artisanal fishing sector

To meet the energy needs of the various segments of the artisanal fisheries value chain in Mauritania, the following DRE technology options are available for large-scale consumers and small and medium-sized consumers, depending on the size and characteristics of each consumer category.

- **Large scale consumers:**
  - Grid-connected solar PV for processing plants and factories

- **Small and medium-sized consumers:**
  - Solar-charged battery systems to power boat motors and accessories for fishermen
  - Solar-powered refrigeration units (freezers) for fish merchants
  - Solar PV mini grids for nonelectrified coastal fishing villages for household consumption, productive uses (ice making, cold rooms) and social infrastructures
  - Solar drying for artisanal fish processors.

Grid-connected solar photovoltaic system

This solution is suitable for large-scale consumers in the artisanal fishing sector. It involves installing solar power plants on the premises or rooftops of factories, connected to the national grid. This can significantly reduce the factories' electricity bill through self-generation and consumption (*i.e.* prosumer) and improve operations by reducing dependence on the national grid, which is currently unreliable. There are two possible options for implementing this solution:

- **Grid-connected system without storage:** This option produces and immediately consumes solar energy without storing excess energy. While a simple and economical solution, it does not completely cover electricity needs due to the intermittency of solar production.
- **Grid-connected system with storage:** To address the intermittency of solar production and utilise surplus energy produced during peak times, a storage solution can be added to the grid-connected systems. While suitable for ensuring consistent energy supply, this option is more expensive, with the storage system typically representing around 60% of the total installation cost. This solution allows for energy independence and stable electricity supply, but the higher investment costs must be carefully weighed against the long-term benefits.

The proposed unit is a modular 50 kWp solar PV system, with the total installed capacity depending on the energy requirements of the respective large-scale consumers (*i.e.* processing plants, ice factories). The cost of such a system includes the solar array, inverter, metering and protection system, and an optional battery bank (capacity determined based on the target consumption).

Solar-powered battery to power retrofitted boat motors and accessories

Up to 94% of surveyed fishermen in Mauritania expressed the need to find alternatives to fuel-powered boats due to high fuel costs. Retrofitting petrol outboard motors with electric motors powered by solar-charged batteries could address this challenge while decarbonising this segment of the value chain. Similar systems for river transport have been piloted in neighbouring Senegal showing considerable potential. The charging infrastructure for these systems serves as a potential anchor load for mini grids in fishing communities. The choice of electric motors depends on factors such as the boat's gross weight,[6] dimensions and required speed.

There are three potential options for powering retrofitted electric motorised boats in the context of Mauritania:

- **Rechargeable battery system:** This involves installing on-board batteries charged at embarkation stations. The battery system must be sized to match the engine's power and operational demands, ensuring sufficient capacity to support both propulsion and on-board equipment during fishing trips. This solution is deemed particularly suitable for smaller 12 kW electric motors (equivalent to 15 hp petrol engines).
- **Hybrid battery + hydrogen fuel cell system:** This combines batteries and hydrogen fuel cells, offering several advantages such as much lower emissions, higher efficiency, reduced noise and vibration, scalability, and extended range for fishing. This option is more suited for larger boats (40 hp and above) requiring sustained power over long distances.
- **Wave energy:** This involves using wave energy to generate electricity from ocean swells. Mauritania's geographic location offers significant potential for wave energy, with an average power output of 25 kW to 45 kW per linear metre of wavefront. While promising, this option is not yet commercially viable for use in dugout fishing boats due to its limited technological maturity.

The most practical solution involves a phased approach of deploying lithium battery storage systems to power the electric motors. For instance, a 120 kWh lithium battery capacity can power a 12 kW electric motor and on-board equipment. Batteries can be recharged through solar-powered charging stations that will be installed in electrified coastal fishing villages or in the towns of Nouakchott and Nouadhibou.

In the second phase, the battery system can be hybridised or replaced by hydrogen fuel cells as Mauritania intensifies efforts to be a hub for green hydrogen production in West Africa. This phased approach aligns with Mauritania's renewable energy goals, leveraging immediate battery technology while preparing for future hydrogen integration to decarbonise the artisanal fishing fleet.

Solar-powered refrigeration units (freezers) for fish merchants

Two solar-powered refrigeration systems are recommended to meet the varying needs of fish merchants to conserve fish stocks, thereby reducing losses:

- **Individual solar freezers (20°C):**

  Proposed for small-scale fish merchants, these units require 1 kWp of solar PV and a 14 kWh battery to ensure one day of autonomy. They are suitable for storing 150 kg to 300 kg of fish products for up to two days. The compactness and simplicity of solar freezers make them suitable for fish merchants in decentralised or off-grid locations.

- **Modular solar-powered cold stores:**

  These are self-contained units (of 10 cubic metres [m^3] to 25 m^3) tailored for medium- to large-scale merchants with storage capacities of 200 kg to 800 kg. A 5 kWp solar PV system can generate electricity for the cold store while simultaneously recharging the batteries to ensure self-sufficiency. The modular design allows scalability, accommodating different storage volumes and ensuring long-term preservation of larger catches.

6 *This includes the mass of the boat, equipment, crew and provisions.*

Solar mini grids for coastal fishing villages

During the primary data collection, it was observed that several villages, particularly those in the Banc d'Arguin National Park and various fishermen's camps, do not have access to grid electricity, and require solutions to meet their energy needs. For these communities, solar mini grids are a possible option to address the following energy needs and provide opportunities for socioeconomic development:

- **Households:** Providing electricity for lighting, audiovisual equipment and mobile phone charging in fishing households
- **Productive uses:** Incorporating stand-alone ice plants to serve as the main anchor load, improving the financial viability of the mini grids. The proposed units are modular 5 kW ice production plants with production capacities of 1.5-2 t/day.
- **Social infrastructure:** Powering essential community facilities such as schools, health centres, shops, mosques, community centres, water supply and street lighting. The estimated total peak electrical demand for these social infrastructures is 60 kWp, with a daily energy requirement of 80 kWh.

Solar drying for artisanal fish processors

To improve on the traditional fish-drying methods used mainly by female artisans, the deployment of solar dryers offers a viable option. These significantly improve upon conventional techniques by offering more efficient, hygienic and reliable preservation of fish products. Unlike traditional methods that expose fish to open-air sun drying (a process vulnerable to weather, insects and contamination), modern solar dryers incorporate design elements that make the drying process more efficient.

6.2 Technoeconomic analysis of proposed DRE solutions

This section analyses the viability of the decentralised renewable energy solution options proposed for decarbonation of the main operations in the small-scale fisheries value chain. The main indicators used are NPV and the IRR. It is assumed that in the case of the substitution of fossil energy by the proposed DRE solutions, the current substituted energy costs of the various links will be saved and are therefore considered as avoided cost linked to the decarbonation of equipment.

Viability analysis of grid-connected solar PV for large consumers

The category of large consumers includes factories (freezing/chilling, fishmeal and oil, ready meals, canned food), storage warehouses, private ice factories and shipyards. The table below summarises the technical parameters and investment costs of the proposed solutions for the various large-consumer categories and the corresponding substitution rates offered by deploying solar PV. Based on recent projects in Mauritania, the average annual yield of 1 kWp solar PV ranges from 1680 kWh/year to 1750 kWh/year, taking into consideration system and soiling losses. Global average soiling loss of annual PV energy production ranges from 3-5% but can reach up to 20% in arid regions such as Mauritania (IEA, 2022). For the present analysis, the lower range of the annual yield curve (*i.e.* 1680 kWh/year) is used.

Table 9 Technical parameters and investment costs of the proposed solutions for large consumers

Type	Design capacity (kWp)	Annual energy produced (MWh)	Current average annual consumption (MWh)	Solar penetration rate (substitution)	Capital investment costs (USD)
Freezing/chilling	250	420	920	46%	500 000
Fishmeal	200	336	481	70%	400 000
Flour and oil	150	252	514	49%	300 000
Canning/tinning	100	168	265	64%	200 000
Storage warehouses	100	168	231	73%	200 000
Ice factories	50	84	273	31%	100 000
Shipyards	50	84	114	74%	100 000

Notes: kWp = kilowatt peak; MWh = megawatt hour; USD = United States dollar.

Investment costs

To calculate the investment costs, the capital expenditure (CAPEX) of USD 2 000/kWp is used for solar units without storage and USD 3 000/kWp for units with storage, based on quotes from local solar installers. It is important to highlight that while the global weighted average CAPEX for utility-scale solar projects was USD 758/kW in 2023 (IRENA, 2024), actual installation costs in nascent markets are generally much higher due to economies of scale, financial terms and local market conditions. Batteries typically add 30-60% to the total solar PV installation costs. Given the difference in costs, the selected option for the analysis is solar PV units without storage with an estimated operating expenditure of USD 20/kWp/year. The lifetime of the equipment is estimated at 20 years. Table 9 above shows the investment costs for the various large-scale consumers.

Estimated cost savings from deployment of solar PV systems

As shown in Table 10, the savings calculation is based on the assumption that the expenses related to the current energy consumption that will be substituted by solar energy represent gross avoided cost for the consumers, from which the operating costs are deducted to obtain net savings.

Table 10 Estimated annual savings expected from the proposed solutions for large consumers

Type	Consumption substituted by solar energy (MWh)	SOMELEC tariff (USD/kWh)	Gross avoided cost (USD)	Annual O&M costs (USD)	Net avoided cost (USD)
Freezing/chilling	420	0.17	71 400	5 000	66 400
Fishmeal	336	0.17	57 120	4 000	53 120
Flour and oil	252	0.17	42 840	3 000	39 840
Canning/tinning	168	0.17	28 560	2 000	26 560
Storage warehouses	168	0.17	28 560	2 000	26 560
Ice factories	84	0.17	14 280	1 000	13 280
Shipyards	84	0.17	14 280	1 000	13 280

Notes: kWh = kilowatt hour; MWh = megawatt hour; O&M = operation and maintenance; USD = United States dollar.

Viability analysis of proposed solar PV solution for large consumers

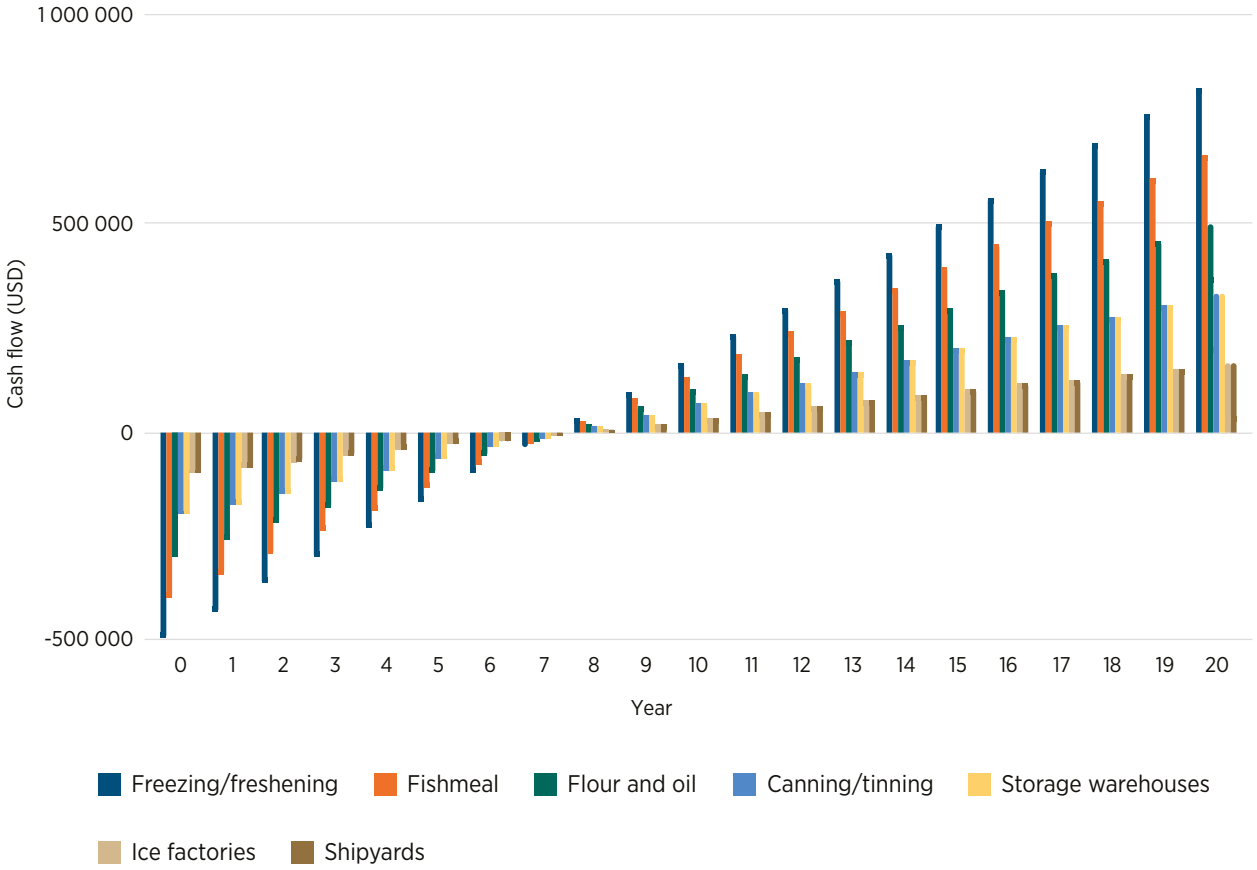
The NPV is the sum of discounted net avoided costs over the life of the project (20 years) less the initial investment. An interest rate of 7.7% is used based on data from the Central Bank of Mauritania (Central Bank of Mauritania, 2024). The analysis gives a positive NPV for all the consumer category, demonstrating the viability of the proposed solar PV investments (Table 11). Similarly, the IRR is 12%, which is higher than the prevailing interest rate in Mauritania (7.7%). Figure 7 illustrates the discounted cash flow for each consumer category, showing break-even periods of the proposed solar PV systems of eight years.

Table 11 Viability indicators for large consumers

Types	NPV (USD)
Freezing/chilling	166 740.17
Fishmeal	133 392.13
Flour and oil	100 044.10
Canning/tinning	66 696.07
Storage warehouses	66 696.07
Ice factories	33 348.03
Shipyards	33 348.03

Notes: The IRR for all the consumer categories is 12%; NPV = net present value.

Figure 6 Solar PV investment discounted cash flow for each large-consumer category



Viability analysis of retrofitting fishing boats with battery storage

The proposed scenario is based on replacing the 15 hp petrol engine with an electric motor of equivalent power (12 kW), powered by lithium batteries. The total investment cost is estimated at USD 30 000, of which more than 90% is for the storage batteries, with a ten-year payback period.

The calculation of expected avoided cost is based on the assumption that substituting the electric motor for the petrol engine will enable fishermen to save on petrol costs. According to the fishermen surveyed, petrol consumption is 30 L/trip for 15 hp motors. Multiplying this quantity by the price per litre (USD 1.44) and the number of trips (*i.e.* 246) gives the total fuel costs per year (USD 11 000), including an annual maintenance cost of USD 380.

Operating costs relate to battery recharging and engine and battery maintenance. The cost of recharging the batteries is based on the SOMELEC rate per kWh (*i.e.* USD 0.17/kWh) + a margin of 6% multiplied by the number of kW and the number of recharges. It is assumed that the batteries will be recharged on each trip, *i.e.* 246 trips/year.

The cost of recharging per trip is USD 21. This is less than the current cost of fuel per trip, which is USD 25.7 with the subsidy in force and USD 42.3 without the subsidy, giving fishermen a gain of USD 4.55 per trip if the subsidised price is applied and USD 21 if the price of petrol at the pump is applied (without the subsidy).

As far as maintenance is concerned, the cost of maintaining electric motors is generally low compared with fossil fuel motors. It averages USD 200 a year. The total annual operating expenses of electric motors is USD 5 517. The expected net saving is USD 5 484, *i.e.* total fuel costs less the cost of recharging the batteries and the cost of maintenance.

The analysis shows that the NPV is USD 9 727.81, with an IRR of 14%, indicating a highly satisfactory level of viability for the proposed investment.

Table 12 Electric motor viability indicators

Financial parameter	Value
NPV	USD 9 727.81 > 0
IRR	14% > prevailing interest rate

Notes: IRR = internal rate of return; NPV = net present value.

Viability analysis of individual solar refrigerators

The proposed scenario is based on the use of a freezer powered by a 1 kWp solar unit, which produces 2 MWh/year. The sizing of this unit is based on the quantity of fish stored and the power requirements. Based on survey data, it is estimated that total annual energy consumption for this consumer category is 1.5 MWh. To calculate the investment requirements, the CAPEX cost of USD 3 000/kWp for a solar unit with storage is applied. Thus, the total cost of the investment including the freezer and the solar unit was estimated at USD 3 000 for a ten-year lifetime.

The calculation of "avoided cost" assumes that the use of the solar freezer will enable the fish processor to save on the purchase of ice for preserving fish. Based on survey data, the quantity of ice is estimated based on the quantity of fish processed per day, estimated at 29 kg of ice per 100 kg of fish processed per day. The operating costs are limited to the cost of maintaining the solar refrigeration unit, estimated at USD 127.55. The expected net avoided cost represents the expenditure saved on the purchase of the ice (USD 635.10) less the cost of maintenance, estimated at USD 507. Based on the above data, the NPV is estimated at USD 452 over the life of the investment with an IRR of 11%, indicating the viability of the proposed technical solution.

Viability analysis of community solar-powered cold room

The proposed scenario is based on the use of a refrigeration unit with a storage capacity of 800 kg/day, powered by a 5 kWp solar PV unit. The size of this unit is based on the needs of the villages to preserve perishable products (meat, vegetables, *etc.*), up to 2 kg/household/day. The investment cost includes the cost of the refrigeration unit (USD 8 000) and the solar unit (USD 15 000), for a total investment cost of USD 23 000. The cost of the solar unit was estimated by multiplying the installed capacity by the CAPEX price with storage/kWp.

The estimate of gross avoided cost is based on the assumption of 80% capacity utilisation, *i.e.* 600 kg stored per day and a prevailing storage tariff of USD 0.05/kg, which corresponds with an annual cost of ice of USD 11 174. Operating expenses are employee costs and equipment maintenance costs, estimated USD 6 622.45/year. The expected net avoided cost is estimated at USD 4 551/year.

Based on the above data, the NPV is estimated at USD 7 955, with an IRR of 15%. These indicators point to a good level of viability for the proposed solar-powered cold room.

Viability analysis of solar-powered ice factories

The proposed scenario is based on the use of a small-scale unit with a production capacity of 2 t/day of ice, powered by a 5 kWp solar PV refrigeration unit. The investment cost includes the cost of the plant (USD 30 000) and the solar PV unit (USD 15 000), totalling USD 45 000. The cost of the solar unit was estimated by multiplying the installed capacity by the CAPEX price with storage/kWp.

The gross avoided cost estimate is based on the assumption of 80% capacity utilisation, *i.e.* 1600 kg of ice blocks per day, and a selling price of USD 0.5/kg. Operating expenses include employee costs, the cost of water supply and equipment maintenance costs. The cost of water is calculated on the basis of a quantity of 2.3 t/day needed to produce 1.6 t of ice at a price of USD 1.25/t. Maintenance costs are calculated at an annual flat rate of USD 1000. Expected net savings is estimated at USD 12 386/year. Based on the above data, the NPV is estimated at USD 39 246 with an IRR of 24%.

6.3 Avoided CO_2 emissions

This section estimates the total amount of CO_2 emissions avoided for the various consumer categories in the fisheries value chain covered by the study. The study assumes a carbon intensity of electricity generation of 380 grams (g) /kWh and 2.3 kg for 1 L of petrol. On this basis, the total quantity of CO_2 avoided is estimated at 96 196.86 t/year (Table 13). Meanwhile, gas combined cycle plants release 490 g of carbon dioxide equivalent (CO_2eq) per kWh, and utility-scale solar PV systems emit 48 g CO_2eq/kWh, showing how solar energy reduces greenhouse gas emissions.

Table 13 Estimate of CO_2 emissions avoided by deploying the proposed DRE solutions

Consumer categories	Type	Quantity of CO_2 avoided (t/unit)	Total number of units in Mauritania	Total amount of CO_2 avoided (t)
Factories	Freezing/chilling	120.96	88	10 644.48
	Fishmeal	107.47	1	107.47
	Flour and oil	74.17	41	3 041.09
	Canning/tinning	52.73	1	52.73
	Storage warehouses	54.13	10	541.33
	Ice factories	20.45	20	408.98
	Shipyards	27.14	1	27.14
Fishermen	15 hp engine	25.19	3 168	79 786.10
Fishmongers	Freezer	0.68	2 291	1 567.04
Fishing villages	Cold room	3.42	3	10.26
	Ice factories	3.42	3	10.26
Total				**96 196.86**

Notes: CO_2 = carbon dioxide; t = tonnes.

The artisanal fishing segment (especially the 15 hp engine boats) represents the greatest opportunity for CO_2 emissions reductions within the fisheries value chain in Mauritania, accounting for over 80% of the total CO_2 emissions that can be avoided by transitioning to alternative solutions (*e.g.* retrofitted battery-powered engines). Piloting projects, awareness raising, investment and policy support in this area can provide substantial climate benefits to Mauritania (in line with its NDC), while supporting sustainable livelihoods in the sector.

6.4 Total capital investments requirements

Table 14 below presents the investment requirements of the various solar-powered technical solutions for enhancing the productivity and development of the artisanal fishing value chain in Mauritania. The proposed interventions span from large-scale grid-connected solar PV systems for artisanal processing factories to individual solar-powered freezers for fishmongers and battery-powered motors for artisanal fishing boats.

Based on the assessment, the total investment requirement is USD 163.12 million. The largest share of this investment, over 58%, targets retrofitting artisanal fishing boats (15 hp engines) with battery-powered motors, highlighting a strong focus on decarbonising artisanal fishing operations and potentially reducing fuel costs and GHG emissions. For the deployment of individual solar-powered freezers, USD 6.78 million is required to benefit collectors and distributors, who are most impacted by lack of adequate storage facilities leading to economic losses. Solar PV-powered cold storage, targeting freezing, chilling and ice factories, will require USD 48.2 million, underlining the critical need for reliable electricity in preserving fish quality and reducing postcatch losses.

Table 14 Total capital investment requirement for proposed DREs in artisanal value chain

Technical solution proposed	Targeted value chain actors	Unit cost (USD)	Total number of units	Total investment requirement (USD)
Grid-connected solar PV system (capacities ranging from 50 kWp to 200 kWp) without battery storage)	Fish processing factories (flour and oil, canning, tinning *etc.*)	100 000 – 400 000	44	13 000 000
Solar PV-powered cold storage (capacities ranging from 5 kWp to 250 kWp)	Storage cold rooms, freezing, chilling, ice factories	100 000 – 500 000	124	48 204 000
Individual solar-powered freezers (1 kWp)	Fishmongers (collectors and distributors)	3 000	2291	6 783 000
Retrofitted fishing boats 15 hp outboard engines battery-powered motors	Artisanal fishermen	30 000	3168	95 040 000
Total				**163 117 000**

Notes: hp = horse power; kWp = kilowatt peak; PV = photovoltaic; USD = United States dollar.

The analysis prioritises both large-scale solarisation of fishing factories and the adoption of decentralised solar-powered solutions across the artisanal fisheries value chain. This approach promises significant environmental benefits (as highlighted in the preceding section) but will also support the livelihoods for a broad spectrum of stakeholders, including fishermen, processing factories, fish collectors and wholesalers.

7 Conclusions and recommendations

Mauritania's fisheries sector, particularly artisanal fishing, is a cornerstone of the national economy, contributing significantly to job creation, food security and macroeconomic indicators. However, high energy costs (up to 40% of operating expenses) and unreliable energy supply pose significant challenges across the value chain. These costs are exacerbated by fixed premiums on grid power, independent of actual consumption, often forcing larger consumers to rely on costly backup generators. The study findings demonstrate the relevance and viability of transitioning to DRE solutions for powering the artisanal fishing value chain. Stakeholders (fishermen) show a general awareness of renewable energy sources, particularly solar and wind power, and express a strong willingness to adopt these technologies to reduce operating costs and improve profitability. Key barriers to adoption include limited market availability, high initial investment costs, lack of access to financing, and insufficient skills for servicing and maintenance.

Based on the analysis of the energy needs within the artisanal fishing value chain, this study proposes tailored DRE solutions, including grid-connected solar PV for large consumers, emobility for fishing boats, solar-powered refrigeration and ice production for fishing communities, and solar dryers for artisanal fish processors. These solutions are modular, allowing for scalability based on power requirements and load demands.

Technical and economic analyses demonstrate a strong return on investment for the proposed DRE solutions, with positive NPV across all segments, and IRRs ranging from 12% for large consumers to 24% for community solar ice factories. Furthermore, the deployment of these solutions will result in substantial reductions in CO_2 emissions, estimated at 96 196.86 t/year. The artisanal fishing boats (especially the 15 hp engines) represent the biggest opportunity for CO_2 emissions reductions within the fisheries value chain in Mauritania. Piloting alternative emobility solutions (*e.g.* retrofitted battery-powered engines), awareness raising, investment and policy support in this area can provide substantial climate benefits to Mauritania (in line with its NDC), while supporting sustainable livelihoods in the sector.

The successful implementation of these decentralised renewable energy solutions requires a concerted effort from the government with support from technical and financial partners to raise awareness among national stakeholders about the economic, social and environmental benefits of these technologies and to foster the development of a local entrepreneurial ecosystem.

Recommendations:

To address the barriers identified and unlock the potential of DRE to transform Mauritania's fisheries sector, the following key actions are recommended:

✓ **Develop a national strategy for decentralised renewable energy for productive uses**

Elaborate a comprehensive national strategy for DRE that extends beyond the fisheries sector to encompass agriculture, livestock farming, trade and small-scale industry. This strategy should be developed in close consultation with all relevant sectoral departments, the private sector, and technical and financial partners. Prioritise programmes and projects focused on building the capacities of women, young people and small producers within the fisheries value chain.

✓ **Raise awareness and provide support for DRE stakeholders**

Conduct targeted awareness campaigns to educate stakeholders in the artisanal fishing value chain about the benefits of renewable energy. These campaigns should:

- educate the public about the benefits of renewable energy, emphasising energy savings, reduced greenhouse gas emissions and economic opportunities
- organise community events and outreach in fishing villages, leveraging local stakeholders to raise awareness of renewable energy initiatives
- support small-scale producers (artisanal fishermen, small-scale fishmongers, *etc.*) in adopting co-operative models (co-operatives, solidarity groups) to facilitate collective investment in renewable energy solutions, enhance financial viability and encourage community ownership through solidarity guarantees.

✓ **Implement favourable tax policies**

Remove import duties on all solar equipment, materials and maintenance inputs to improve market availability and reduce upfront investment costs.

✓ **Establish a national control and certification system for renewable energies technologies**

Develop and implement a national certification system for DRE equipment and installations to combat counterfeiting and ensure quality, given the current absence of national standards in this area. This should be coupled with a mechanism for monitoring operators supplying, installing and maintaining DRE systems.

✓ **Develop capacity building on DRE technologies**

Establish a comprehensive training programme to support the development of renewable energies in Mauritania, and particularly within the fisheries sector. This programme should include:

- training on the various applications of renewable energies within the artisanal fishing value chain
- training in the servicing and maintenance of renewable energy electricity generation systems
- workshops on the development and financing of renewable energy projects
- training to assess the key parameters of renewable energy and energy efficiency projects, such as production, costs and profitability
- equipping stakeholders with the knowledge and tools necessary to adopt renewable energy solutions and improve energy efficiency in their activities.

✓ **Encourage private sector investment in the renewable energy sector**

Provide specific incentives for private sector participation in the renewable energy sector, aligning with the 2023 national industrialisation strategy. These incentives should include:

- implementing an incentive-based tax system
- introducing dedicated financing mechanisms, including microfinance solutions tailored to the needs of small producers
- increasing the financing threshold granted to microfinance institutions to adequately address the investment needs of stakeholders in the artisanal fishing value chain
- revising the implementing regulations for the Electricity Code to allow for increased self-generation of electricity for large consumers, such as fishing factories.

References

AfDB (2020), *Desert-to-Power Roadmap for Mauritania*, African Development Bank, www.afdb.org/sites/default/files/2024/08/23/desert-to-power_dtp_mauritania_roadmap_en_oct2020.pdf

ANSADE (2024a), *Annuaire socio-démographique: Edition 2024*, National Agency for Statistics, Demographic and Economic Analysis, https://ansade.mr/fr/annuaire-des-statistiques-sociodemographiques-2024

ANSADE (2024b), *Annuaire des statistiques économiques 2023*, National Agency for Statistics, Demographic and Economic Analysis, https://ansade.mr/fr/annuaire-des-statistiques-economiques-2023

Central Bank of Mauritania (2024), *Annual Report 2023*, https://api-web.bcm.mr/uploads/Rapport_annuel_de_l_exercice_2023_v_FR_c51cf3f306.pdf

FAO (2024), *Fishery and Aquaculture Statistics – Yearbook 2021*, ood and Agriculture Organization of the United Nations, Rome, https://openknowledge.fao.org/handle/20.500.14283/cc9523en

Government of Mauritania (2009), "Decree relating to the profession of fishmongers in Maurtania", www.peches.gov.mr/IMG/pdf/decret_n_2009-172_modif_decret_exercie_poff_marey.pdf

Government of Mauritania (2017), "Stratégie Nationale de Croissance Accéléré et et de Prospérité Partagée 2016-2030", https://finances.gov.mr/fr/node/55

Government of Mauritania (2021), "Contribution Determinee Nationale Actualisee (CDN) 2021-2030", https://unfccc.int/sites/default/files/NDC/2022-06/CDN-actualis%C3%A9%202021_%20Mauritania.pdf

Government of Mauritania (2022), "Lettre de Politique et de planification du secteur des pêches et de l'économie maritime 2022-2024", www.peches.gov.mr/IMG/pdf/version_finale_de_la_l2p_adoptee_en_cm_en_juillet_2022_fr_-_final.pdf

Government of Mauritania (2024a), "Annual Report of Fisheries Statistics in Mauritania 2023", www.peches.gov.mr/IMG/pdf/Fr%20Rapport%20Annuel%20OESP%202023%20VF2.pdf

Government of Mauritania (2024b), "Pacte national de l'énergie pour la République Islamique de Mauritanie", https://mission300africa.org/energysummit/wp-content/uploads/2025/01/Mauritanie-National-Energy-Compact.pdf

Government of Mauritania (2024c), "Loi N° 2024-012 portant restructuration de la Société Mauritanienne d'Electricité (SOMELEC)", https://somelec.mr/sites/default/files/D%C3%A9cret%20restructuration%20SOMELEC%201.pdf

IEA (2022), *Soiling Losses – Impact on the Performance of Photovoltaic Power Plants*, https://iea-pvps.org/wp-content/uploads/2023/01/IEA-PVPS-T13-21-2022-REPORT-Soiling-Losses-PV-Plants.pdf

IEA (2023), *Renewable Energy Opportunities for Mauritania*, https://iea.blob.core.windows.net/assets/64c7f915-a7a2-4ede-a971-89e1203c3bf6/RenewableenergyopportunitiesforMauritania.pdf

IEA, *et al.* (2024), *Tracking SDG7: The energy progress report 2024*, International Energy Agency, International Renewable Energy Agency, United Nations Statistics Division, the World Bank and World Health Organization, Geneva, www.irena.org/Publications/2023/Jun/Tracking-SDG7-2023

IMROP (2024a), *Framework survey report 2023*, www.imrop.mr/wp-content/uploads/2024/12/Rapport_Enquete-cadre_decembre2023.pdf

IMROP (2024b), *Report of the 10th working group of Mauritanian Institute of Oceanographic Research and Fisheries (IMROP)*, www.imrop.mr/wp-content/uploads/2024/12/GT-2023_IMROP-VF.pdf

IRENA (2015), *Renewables readiness assessment: Mauritania*, International Renewable Energy Agency, Abu Dhabi, www.irena.org/publications/2015/Sep/Renewables-Readiness-Assessment-Mauritania

IRENA (2024), *Renewable power generation costs in 2023*, International Renewable Energy Agency, Abu Dhabi, www.irena.org/Publications/2024/Sep/Renewable-Power-Generation-Costs-in-2023

IRENA (2025a), *Renewable capacity statistics 2025*, International Renewable Energy Agency, Abu Dhabi, www.irena.org/Publications/2025/Mar/Renewable-capacity-statistics-2025

IRENA (2025b), "Global Atlas for Renewable Energy", https://globalatlas.irena.org/workspace

Puri, M., *et al.* (2023), *The small-scale fisheries and energy nexus: Opportunities for renewable energy interventions*, Food and Agriculture Organization of the United Nations, www.fao.org/documents/card/en/c/cc4903en

World Bank (2020), "Technical potential for off-shore wind in Mauritania", https://documents1.worldbank.org/curated/en/133091586840671666/pdf/Technical-Potential-for-Offshore-Wind-in-Mauritania-Map.pdf

World Bank (2024a), "Population of Mauritania", https://data.worldbank.org/indicator/SP.POP.TOTL?locations=MR

World Bank (2024b), *Islamic Republic of Mauritania Joint World Bank-IMF Debt Sustainability Analysis*, https://documents1.worldbank.org/curated/en/099031725160533553/pdf/BOSIB-7a77b050-6b4f-4ca4-9464-96f755f7f305.pdf

World Bank (2024c), "Access to electricity (% of population) - Mauritania", https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=MR&utm_medium=email&utm_source=govdelivery

World Bank (2024d), "Pacte national de l'énergie pour la republique islamique de la Mauritanie", https://thedocs.worldbank.org/en/doc/bf4b3195c7438ae5e9c1c299cd263a66-0010012025/original/M300-AES-Compact-Mauritanie.pdf

World Bank (2025), "Macro Poverty Outlook for Mauritania", https://thedocs.worldbank.org/en/doc/bae48ff2fefc5a869546775b3f010735-0500062021/related/mpo-mrt.pdf

IRENA
International Renewable Energy Agency

www.irena.org