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Roadmap for the energy transition in EU aquaculture

Accompanying the document

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Vision 2040 for fisheries and aquaculture

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Table of contents

EXECUTIVE SUMMARY 2

1. INTRODUCTION 2

2. THE STATE OF PLAY IN EU AQUACULTURE 4

2.1. Sources of greenhouse gas emissions 4

2.1.1. Overall trends 5

2.1.2 Emissions by production system 6

2.1.3. Emissions by farming stage 7

2.2. Structural challenges and enabling conditions for the energy transition 8

2.3. Progress made on the energy transition 9

2.3.1. Progress through the Energy Transition Partnership 9

2.3.2. Initiatives on the energy transition 10

3. KEY AREAS FOR ACTION TOWARDS THE ENERGY TRANSITION OF THE EU AQUACULTURE SECTOR 11

3.1. Strengthen energy and resource efficiency 11

3.2. Optimise feed systems 12

3.3. Transition to renewable energy and enabling infrastructure 12

3.3.1. Facilitate the deployment of on-site renewable energy 12

3.3.2. Accelerate the uptake of low-carbon propulsion systems for support vessels 13

3.3.3. Strengthen energy infrastructure systems 14

3.4. Promote low-trophic low-carbon aquaculture 14

3.5. Promote the standardisation of greenhouse gas emission monitoring 15

3.6. Financial solutions for the energy transition 15

3.7. Energy transition skills and knowledge 15

4. CONCLUSIONS 16

Annex 1: Progress through the Energy Transition Partnership 17

Annex 2: Joint Considerations - EU Energy Transition Partnership for Fisheries and Aquaculture 19

www.parlament.gv.at

EXECUTIVE SUMMARY

The European Commission Communication on the Vision 2040 for fisheries and aquaculture sets out a future for sustainable, resilient and competitive fisheries and aquaculture sectors by 2040. As part of that ambition, it highlights the importance of reducing these sectors' dependence on fossil fuels through the energy transition. To support progress on this objective, the Vision 2040 includes a dedicated roadmap for the energy transition of fisheries and aquaculture. This roadmap aims to provide additional guidance to the European Union (EU), its Member States and stakeholders on how to advance this transition in a coordinated and realistic way.

This staff working document (SWD) accompanies the Communication on the Vision 2040 for fisheries and aquaculture. It provides the underlying analysis for the roadmap on the energy transition of EU aquaculture, which forms an integral part of the Vision 2040. It also takes stock of the work carried out with stakeholders in preparing the roadmap, in particular through the Energy Transition Partnership for EU fisheries and aquaculture and brings together data on the aquaculture dimension of the transition.

Data presented in this SWD shows that the energy transition in EU aquaculture is both an environmental and an economic challenge. While the sector's direct emissions remain limited in the wider EU context, aquaculture is exposed to rising and volatile energy and input costs, and its greenhouse gas (GHG) emissions are strongly influenced by feed use, electricity demand and the energy intensity of certain production systems. Advancing the energy transition is therefore important not only for reducing emissions, but also for improving the sector's resilience, competitiveness and long-term viability, particularly in the face of competition from non-EU aquatic food producers.

The analysis set out in this SWD points to a number of priority action areas to advance the energy transition in EU aquaculture:

- boosting energy and resource efficiency across production systems;
- optimising feed use;
- promoting the deployment of renewable energy solutions and the necessary enabling infrastructure;
- supporting the development of low-trophic and lower-carbon forms of aquaculture;
- improving the monitoring and transparency of greenhouse gas emissions;
- facilitating access to appropriate financing instruments;
- strengthening skills and knowledge throughout the value chain.
-

Together, these elements underline the need for a gradual, economically viable and socially fair transition, tailored to the diversity of aquaculture production models and regional circumstances in the Union.

1. INTRODUCTION

In 2021, the Commission strategic guidelines for a more sustainable and competitive EU aquaculture (the 'strategic guidelines')[1] set the objective of minimising 'any potential negative contribution made by aquaculture to climate change'. To achieve this, the guidelines state that

([1]) SWD(2021) 102 final. These guidelines are now accompanied by a mid-term assessment of the implementation of the Strategic Guidelines for EU aquaculture and the multiannual national strategic plans published in 2026.

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‘energy consumption and carbon emissions from production, transport and processing must be reduced as much as possible’.

In February 2023, the Commission adopted a Communication on the energy transition in EU fisheries and aquaculture[2] as part of the fisheries and oceans package[3]. The Communication set the ambition for both sectors to become more resilient and carbon-neutral by 2050. This initiative responds to a combination of pressures, including energy security concerns, rising energy and operating costs, and the need to meet environmental targets, all affecting the sector’s long-term sustainability and competitiveness.

In this sense, the Vision 2040 positions EU aquaculture as a strategic sector within the EU food system, with a growing role in supplying aquatic food to EU consumers through sustainable production expansion and complementing fisheries. For the roadmap, this implies that emission reductions must be achieved in parallel with sectoral growth, so that higher output does not lead to higher overall emissions. Environmental sustainability underpins long-term economic and social performance, requiring attention not only on the carbon footprint but also on freshwater and land use, dependence on marine resources, and biodiversity conservation. Nature-positive and restorative forms of aquaculture, such as low-trophic and non-fed systems, can play an important role by combining low emission intensities with wider ecosystem services. Diversification of farmed species and production models can reduce input needs and improve resilience to disease and environmental stress.

The Vision 2040 also points to increased demand for space at sea and in coastal areas, including for conservation, protection and restoration of the marine environment, for transport, offshore renewable energy and other uses. This creates both constraints and opportunities for the energy transition in aquaculture. Multi-use and co-location with renewables can facilitate the deployment of aquaculture and on-site renewable energy solutions, provided that maritime spatial planning, permitting and infrastructure frameworks are supportive and innovation is encouraged. More broadly, the transition of fisheries and aquaculture must be realistic, affordable and socially just, attract young people to work in the sector, and take into account the diversity of segments through a comprehensive approach that addresses structural constraints, investment needs, skills gaps and value chains.

Since the adoption of the 2023 Communication on the Energy Transition of the EU Fisheries and Aquaculture sector, several initiatives have been launched to better understand the sector’s needs, support its transition, and provide relevant information to inform the Vision 2040. The Commission established the Energy Transition Partnership (ETP) for EU fisheries and aquaculture, bringing together stakeholders to develop recommendations through a collaborative process. In parallel, as part of the implementation of the Strategic Guidelines, the Commission published a Staff Working Document (SWD)[4] that provided an overview of solutions categorised by aquaculture production system, to improve energy efficiency and increase the uptake of renewable energy, in turn reducing the carbon footprint of primary aquaculture operations. Other studies, such as the ‘techno-economic analysis for the energy transition of the EU fisheries and aquaculture sector’ and ‘the study on EU aquaculture: greenhouse gas reduction costs and pathways to net zero by 2050’ have examined the technical and economic feasibility of different transition pathways.

([2]) COM(2023) 100 final on the energy transition in EU fisheries and aquaculture. The fisheries and oceans package also includes the common fisheries policy (CFP) communication, the common market organisation (CMO) report and the maritime action plan.

([3]) Common fisheries policy (CFP) - oceans and fisheries - European Commission.

([4]) SWD(2024)280.

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Building on these efforts, this SWD provides the analytical background and presents the technical solutions that can support implementation of the roadmap for the energy transition in EU aquaculture. The roadmap is presented in the Annex to the Vision 2040 and runs alongside the parallel roadmap for EU fisheries[5]. It offers a structured framework for action and identifies strategic priorities and guidelines to support the sector's pathway towards energy resilience and reduced dependence on fossil fuels by 2050. The SWD is structured around four main objectives.

1) Embed the energy transition within the wider Vision for fisheries and aquaculture by 2040 as a core dimension of the long-term transformation of the EU aquaculture sector. While this roadmap focuses on energy transition, it should be viewed as a part of the broader EU strategy for the future of the aquaculture sector, alongside fisheries, to ensure its economic, environmental and social sustainability, as outlined in the Vision 2040.

2) Identify the key challenges and solutions to the energy transition in order to develop a common understanding of the current situation and of the actions needed to implement the energy transition.

3) Set out a realistic and feasible pathway for the energy transition towards 2050, sequencing key actions and enablers.

4) Develop a coordinated approach involving public authorities, stakeholders and value-chain actors, in order to ensure common ownership, policy coherence and clearer investment signals.

This SWD provides analysis underpinning the actions set out in the roadmap for the energy transition in EU aquaculture as presented in the Annex of the Vision 2040 for fisheries and aquaculture. It is composed of four chapters including this introduction.

The introduction outlines the implications of the Vision 2040 for EU aquaculture and explains how these shape an energy-transition pathway aligned with the sector's broader environmental, economic and social objectives. Chapter 2 presents the state of play in EU aquaculture, including greenhouse gas emission trends, structural challenges and the progress achieved since the 2023 Communication. Chapter 3 identifies the main areas of action and enabling conditions for the energy transition. Chapter 4 sets out the conclusions.

2. THE STATE OF PLAY IN EU AQUACULTURE

2.1. Sources of greenhouse gas emissions

This section provides an overview of the trends in GHG emissions in the EU aquaculture sector and identifies the key sources of emissions across production systems and farming stages. Its objective is to provide a basis for a common understanding of the main issues to address in order to advance the energy transition, and to identify priorities for decarbonisation efforts that help maintain the sector's competitiveness and resilience.

(5) It accompanies, alongside a parallel staff working document on the energy transition in EU fisheries, the roadmap annex for fisheries and aquaculture.

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2.1.1. Overall trends

In 2024, the EU aquaculture sector's total GHG emissions were estimated at 2.8 million tonnes of CO_2-equivalent (CO_2e), representing around 0.1% of the EU's total GHG emissions for that year. Between 2005 and 2024, these emissions rose by 14.6%, a modest increase in the EU-wide context but significant for a relatively small sector that is expected to grow further[6].

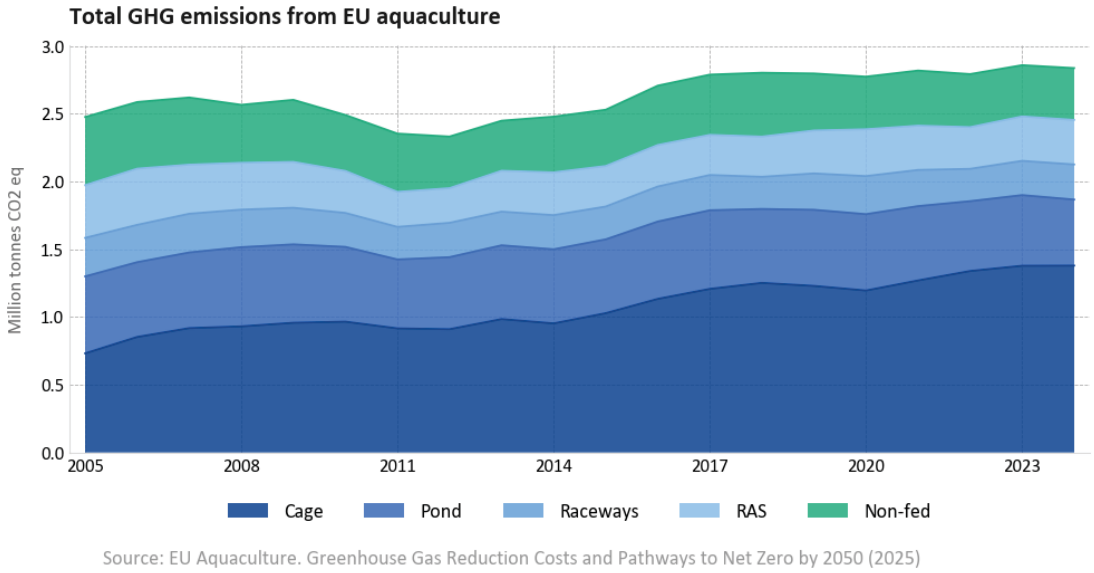


Figure 1 Trends in GHG emissions from the EU aquaculture sector by production system

Meanwhile, the growth trajectories of EU aquaculture production have varied significantly across its main production types. Between 2008 and 2023, total EU aquaculture output fell from 1.27 to 1.12 million tonnes (-13%), yet this overall trend masks a sharp expansion of marine finfish production, which grew by 49% over the same period. By 2023, this segment had become the sector's most valuable, accounting for 50% of its total value, despite representing just 25% of production volume.

(6) https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20260123-1

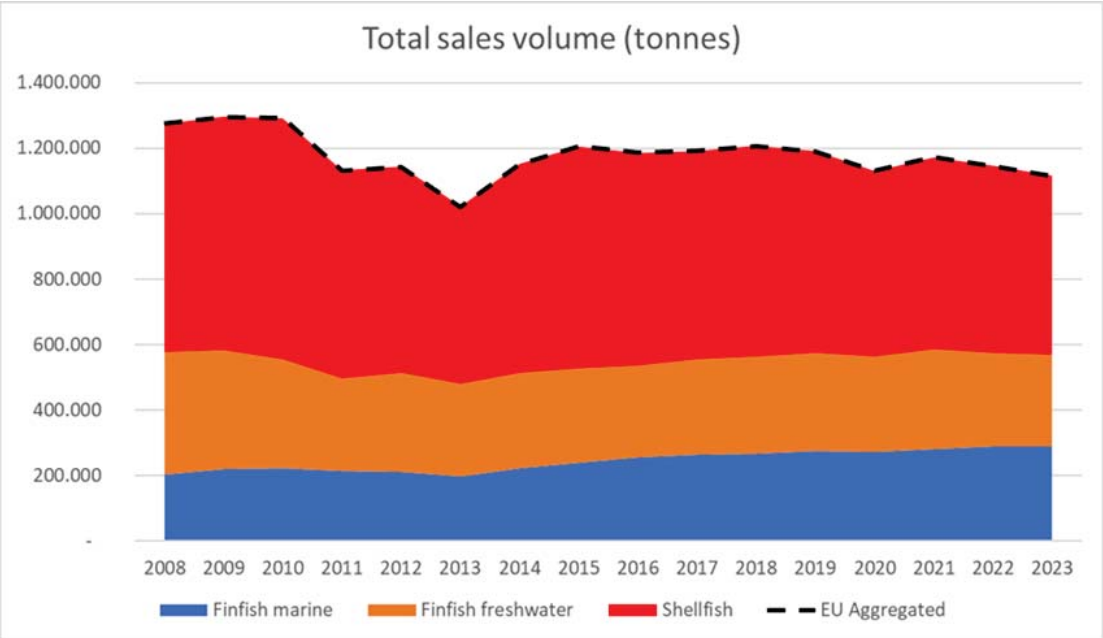


Figure 2 Trends in production volume from the EU aquaculture sector by production system

By contrast, shellfish production, though still representing 48% of total volume in 2023, fell by 22% over the same period. Meanwhile, freshwater aquaculture, which represented 27% of volume and 24% of value in 2023, fell by 25%. Algae remained marginal, contributing less than 1% of both value and volume. The shift towards more fed- and energy-intensive production systems is a key factor in understanding the sector's recent economic and emission trends.

2.1.2 Emissions by production system

The EU aquaculture sector is highly diverse in terms of species and farming methods. Therefore, emission intensities vary widely across production systems. Over the past 20 years, GHG emissions from intensive fish farming systems were substantially higher than those related to shellfish farming. Indeed, cage and recirculated aquaculture systems (RAS) were the most energy-intensive production systems, accounting for 22% and 2%, respectively, of the EU production volume but for 40% and 12%, respectively, of the EU emissions in the sector. Non-fed aquaculture (e.g. shellfish and algae) was the most energy-efficient production method, accounting for 54% of production and 18% of total emissions[7]. This difference can be seen in the average emission intensity per unit of live weight (LW), where emission intensity from finfish farming (e.g. carp, rainbow trout, seabass) can be 10 to 20 times higher than that of shellfish farming (e.g. clam, mussels, oyster)[8].

(7) Techno-economic analysis for the energy transition of the EU fisheries and aquaculture sector

(8) Techno-economic analysis for the energy transition of the EU fisheries and aquaculture sector. The difference is less marked when considering edible weight, but still important (approx. 4 to 10 times).

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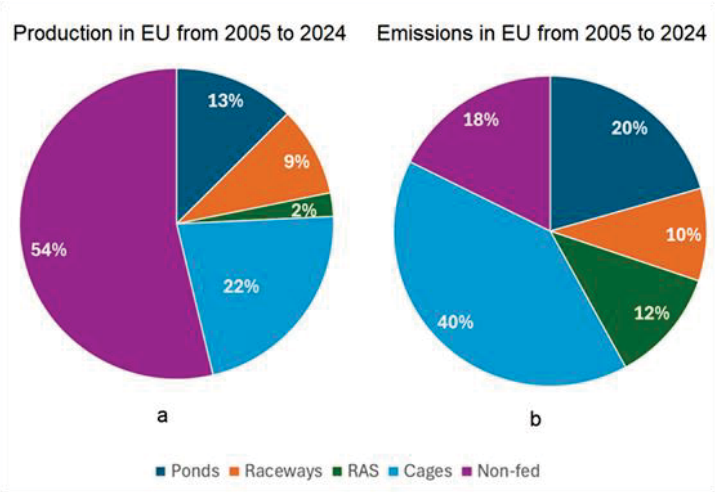


Figure 3 Aquaculture production (a) and associated emissions (b) from different production methods in EU from 2005 to 2024. Source: EU Aquaculture: Greenhouse Gas Reduction Costs and Pathways to Net Zero by 2050 (2025)

2.1.3. Emissions by farming stage

These varied emission profiles reflect differences in farming practices, energy requirements and the use of upstream inputs, particularly feed. Over the past 20 years, the largest share of GHG emissions stemmed from feed production and transportation (54%), followed by the grow-out stage (28%) and hatchery (9%), whereas emissions from boat trips to the aquaculture sites contributed to only 2% of emissions[9]. This pattern is especially striking for cage and tank and raceways production methods, where feed accounted for respectively 71% and 50% of total emissions. In marine fish production, feed accounts for a larger share of emissions, partly because feed conversion ratios (FCR) are around twice those observed for trout.[10] In RAS, the main driver of emissions is the grow-out phase because of the high amount of electricity needed to run the system, but feed-related emissions remain an important source[11]. Energy use in the grow-out stage is mainly related to the use of fuel in support vessels in marine segments, while in land-based trout farming it is mainly due to electricity use[12].

([9]) EU Aquaculture: Greenhouse Gas Reduction Costs and Pathways to Net Zero by 2050 (2025)
([10]) Techno-economic analysis for the energy transition of the EU fisheries and aquaculture sector
([11]) Techno-economic analysis for the energy transition of the EU fisheries and aquaculture sector
([12]) Techno-economic analysis for the energy transition of the EU fisheries and aquaculture sector

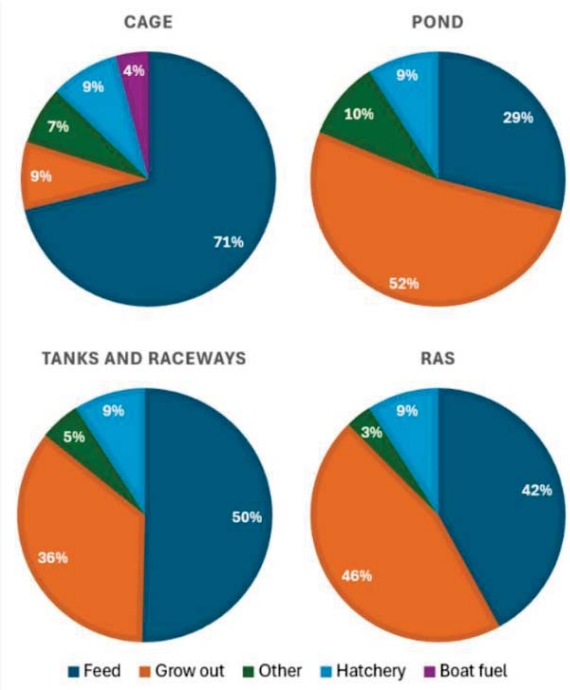


Figure 4 Contribution to fed aquaculture emissions in EU Member States of different processes and stages during the last 20 years for specific production systems. Source: EU Aquaculture: Greenhouse Gas Reduction Costs and Pathways to Net Zero by 2050 (2025)

2.2. Structural challenges and enabling conditions for the energy transition

The energy transition of the EU aquaculture sector is shaped by two key structural factors: (i) the **expected growth** of the sector, which will influence future energy demand, and (ii) its **fragmented structure**, which affects investment capacity and knowledge diffusion.

As previously stated, the EU's aquaculture policy has a dual objective: to expand the sector's role in food provision while simultaneously reducing its environmental impact. However, increasing production is likely to drive higher energy demand, challenging the reduction in GHG emissions in the aquaculture sector. Therefore, emission savings will need to **offset the additional emissions associated with increased production and energy demand**.

Furthermore, the **fragmented structure and the fact that small-scale businesses dominate** the EU aquaculture sector have several implications for the energy transition. First, small-scale business operators often have limited financial capacity, which can hinder technological upgrading[13]. The substantial upfront investment required for decarbonisation, such as on-site renewable energy generation infrastructure or low-carbon feed alternatives, may be beyond the financial reach of small business operators.

Another important structural feature is that a large share of aquaculture's carbon footprint arises from indirect, upstream sources related to other sectors, in particular feed production and transport, electricity generation and fuel supply. Under the EU Climate Law[14] and related climate and energy legislation, emission reductions are primarily targeted in key sectors.

([13]) EU Aquaculture: Short Economic Overview and Outlook to 2040 (STECF, 2026).

([14]) Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') (OJ L 243, 9.7.2021, p. 1, ELI: http://data.europa.eu/eli/reg/2021/1119/oj).

Consequently, aquaculture's transition not only depends on on-farm measures but also on the decarbonisation of its broader value-chain segments.

The study on EU aquaculture: greenhouse gas reduction costs and pathways to net zero by 2050 (GHG study)[15], estimated relatively high marginal abatement costs for several technologies and offsetting measures, which are therefore challenging to adopt for SMEs. Moreover, these business operators may lack the financial buffers, collateral, or risk absorption capacity needed to secure long-term financing. In addition, fragmentation can limit the emergence of learning networks and collective knowledge diffusion, slowing the adoption of best practices which tend to spread faster through vertically integrated value chains or coordinated producer associations[16]. Moreover, unlike larger, vertically integrated firms, small-scale operators have limited opportunities to achieve economies of scale. This fragmentation can delay the sector's uptake of resource- and energy-efficient solutions, even where they should be technically and economically viable. However, even when consolidation and integration can help attract investment, they may have social and economic implications, given the importance of small-scale producers for local economies. Any future policy or support measures to enable the energy transition will therefore need to take account of these distributional aspects and ensure that smaller business operators are not left behind.

2.3. Progress made on the energy transition

2.3.1. Progress through the Energy Transition Partnership

Since its inception in June 2023, the Energy Transition Partnership has been successfully mobilising stakeholders around the energy transition of EU fisheries and aquaculture. They have made significant efforts to prepare the grounds for the energy transition, facilitating discussion. This includes organising thematic working groups on inland aquaculture and on offshore aquaculture.

The ETP's inland and offshore aquaculture working groups developed joint considerations and sector-specific recommendations for the energy transition towards climate neutrality by 2050.[17]. These recommendations, together with the results of in-depth analysis and studies, the **SWD on the energy transition of EU aquaculture[18], the ETP joint considerations, and sector recommendations form the backbone of the roadmap for the energy transition of the EU aquaculture sector towards 2050**.

In addition to facilitating stakeholder collaboration, the ETP has become a key hub for energy-transition topics in fisheries and aquaculture. It provides practical resources to support stakeholders in the transition, including:

- a compendium of best practices[19],
- a guide on financing the energy transition[20],
- regular updates on relevant projects and Member State initiatives,

(15) https://cinea.ec.europa.eu/publications/digital-publications/study-eu-aquaculture-greenhouse-gas-reduction-costs-and-pathways-net-zero-2050_en
(16) EU Aquaculture: Short Economic Overview and Outlook to 2040 (STECF, 2026)
(17) https://atlantic-maritime-strategy.ec.europa.eu/en/news/joint-considerations-and-sectoral-recommendations-energy-transition-eu-fisheries-aquaculture
(18) Brussels, 13.12.2024 SWD(2024) 280 final
(19) https://op.europa.eu/en/publication-detail/-/publication/23464c13-b1c0-11ed-8912-01aa75ed71a1
(20) https://aquaculture.ec.europa.eu/knowledge-base/guidelines/guide-financing-green-energy-transition-fisheries-and-aquaculture

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- and an interactive online tool guiding stakeholders towards financing opportunities for the green energy transition in fisheries and aquaculture[21].

Box I – **ETP recommendations on aquaculture and how they inform the roadmap**

The joint considerations and the aquaculture working groups of the ETP identify several priorities for the energy transition of the EU aquaculture sector.

- Need to make funding for the energy transition more accessible, especially for smaller operators, including through public guarantees that de-risk private investment and support pilot and demonstrator projects.
- Importance of targeted capacity-building and training programmes along the value chain to equip the workforce with the skills required to operate new technologies.
- Central role of feed as a driver of emissions and the need to promote low-trophic aquaculture and develop strategies and pilot projects for sustainable, low-carbon feed ingredients.
- Value of awareness-raising, guidelines, good practices and case studies to support energy-efficient and low-carbon solutions, and to improve understanding and implementation of EU rules.

To make this information more accessible, the ETP also publishes a quarterly newsletter, which has been available online since October 2025[22].

2.3.2. Initiatives on the energy transition

Action on the energy transition has now extended beyond the ETP. Many other private and publicly financed initiatives have emerged since 2023, including by the aquaculture sector, public authorities and research institutes. Many of them are listed in the ETP's[23] repository, which compiles best practices to support the energy transition in the fisheries and aquaculture sector. This includes measures to improve the efficiency of pumps and aeration systems, on-site renewable power for aquaculture facilities, digital monitoring to optimise feeding and oxygen management, and better insulation and heat-recovery solutions in hatcheries and recirculating systems.

(21) https://maritime-forum.ec.europa.eu/theme/blue-economy-and-fisheries/blue-energy/energy-transition-partnership_en#news
(22) https://maritime-forum.ec.europa.eu/theme/blue-economy-and-fisheries/blue-energy/energy-transition-partnership_en#newsletter
(23) Best practices - Maritime Forum - European Commission.

3. KEY AREAS FOR ACTION TOWARDS THE ENERGY TRANSITION OF THE EU AQUACULTURE SECTOR

3.1. Strengthen energy and resource efficiency

In the short- to medium-term, energy and resource efficiency are the most effective and economical ways to reduce direct emissions, as they should also reduce operating costs. The GHG study, the 2024 'Techno-economic analysis for the energy transition of the EU fisheries and aquaculture sector' (the techno-economic study), and the SWD on the energy transition of aquaculture identify energy efficiency improvements as key measures for the energy transition given their potential for rapid implementation and substantial emissions reduction within a relatively short timeframe. Some of these measures (e.g. improved insulation) can be particularly attractive and beneficial to small and medium enterprises (SMEs), which may lack the financial resources or knowledge to adopt certain new technologies. **Energy efficiency measures** typically represent improvements in energy management. They can also include (i) improved process design and the deployment of cost-effective technologies, such as optimised **pumps and aeration systems**; (ii) improved **feed conversion ratios;** (iii) **selective breeding** for climate adaptation**;** (iv) increased **digitalisation** and investment in **precision fish farming** tools; (v) more efficient **motors** and **controls**; or (vi) improved **insulation**.

More generally, the energy transition is significantly driven by economic stakes. Despite their opportunities, energy-efficiency measures have not always been perceived as a priority by business operators, as energy inputs were not historically regarded as a main operational cost item, due to relatively stable energy prices and the modest energy requirements of many production systems. Nevertheless, recent sharp increases in energy costs have increased the importance of resilience to energy-price volatility for aquaculture operators. This may also strengthen incentives to invest in energy-efficiency measures[24].

In practice, there are several key areas of intervention on energy and resource efficiency.

- **Energy management** and **optimisation:** systematic energy audits, monitoring and benchmarking of energy use, processes and equipment upgrades, including optimisation of pumping, aeration and heating/cooling regimes, more efficient blowers, improved insulation and heat-recovery.
- **Digitalisation, AI and precision aquaculture**, including the deployment of sensors, using imaging and Internet-of-Things devices together with AI-based decision tools to monitor oxygen, temperature, pH and fish behaviour in real time, and to optimise feeding strategies and equipment operation. This can significantly reduce feed waste and energy consumption while maintaining growth and welfare.
- **Genetic improvement and husbandry practices,** particularly breeding programmes that improve feed conversion ratios, growth rates and resilience to environmental stressors, together with husbandry measures that reduce energy and resource use per unit of output.
- **Operational** and **organisational measures**, in particular staff training on energy management and digital and AI tools, preventive maintenance to keep equipment operating efficiently, and improved planning of production cycles and farm logistics to reduce energy peaks, downtime and other operational inefficiencies. For example,

(24) https://maritime-forum.ec.europa.eu/study-techno-economic-analysis-energy-transition-eu-fisheries-and-aquaculture-sector_en

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aligning pumping, aeration and feeding schedules to off-peak periods or avoiding unnecessary vessel trips.

3.2. Optimise feed systems

Decarbonising feed inputs stands as one of the most impactful actions to lower emissions in the aquaculture sector. Indeed, the use of feed accounts for the largest share of emissions in the sector due to its energy-intensive production, transport and delivery to aquaculture operators. Overall, the sector is highly reliant on these carbon-intensive inputs, and alternative low-carbon feed sources (e.g. single-cell proteins, agricultural by-products) have been identified as critical solutions to decarbonise the sector[25]. However, the use of low-carbon feed alternatives remains limited in the short term due to limited commercial availability, higher costs, and biological constraints linked to the nutritional needs and physiological limits of alternative fed fish[26]. In line with these findings, the GHG study highlights that alternative feed materials will need to play a critical role in the energy transition, but only in the medium to long-term, once these solutions achieve commercial viability.

Current assessments suggest that for now sourcing low-trophic pelagic species for feed remains more cost-effective than large-scale production of alternative protein sources, such as insect meal or fermented mycoproteins[27]. Furthermore, many of these novel ingredients still require relatively high energy inputs throughout production. As a result, significant reductions in both costs and greenhouse gas emissions will depend on greater access to low-carbon electricity and further process optimisation.

Even under those conditions, any long-term savings are likely to require significant upfront investment in new production facilities and in the renewable-energy capacity needed to power them.

3.3. Transition to renewable energy and enabling infrastructure

3.3.1. Facilitate the deployment of on-site renewable energy

A priority for accelerating the energy transition in EU aquaculture is to enable the deployment of renewable energy across both marine and land-based systems, including pond-based and recirculating aquaculture farms. However, complex and protracted permitting and licensing procedures for renewable-energy infrastructure and grid connections remain a well-documented barrier to progress. Delays in issuing such permits and licences, often due to high application volumes and procedural complexity, can delay returns on investment, create financing uncertainties and risks, and hinder progress towards decarbonisation. In this context, the EU ports strategy[28], which refers to the EU grids package and the guidance on efficient and timely grid connections[29], will accelerate grid connections for viable projects, including those in ports

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([25]) https://maritime-forum.ec.europa.eu/study-techno-economic-analysis-energy-transition-eu-fisheries-and-aquaculture-sector_en

([26]) For example, salmon, trout, seabass etc. **need specific amino acid and fatty-acid profiles**, so you cannot just replace fishmeal/oil with any 'low-carbon' ingredient without affecting growth, health or welfare https://pubmed.ncbi.nlm.nih.gov/38315337/.

([27]) https://knowledge4policy.ec.europa.eu/publication/small-pelagic-fish-supply-abundant-affordable-micronutrients-low-middle-income_en

([28]) EU ports strategy COM(2026) 112.

([29]) The 'EU grids package', COM(2025) 1005 final, and the Commission Notice 'guidance on efficient and timely grid connections' (C/2025/6703). European grids - European Commission; see also the Renewables Energy Directive 2018/2001/EU.

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of all sizes. This, in turn, can support faster and more reliable electricity supply for coastal and port-based aquaculture operations.

In addition, unclear or fragmented rules on on-site renewable installations, connection to the grid, and the use of shared infrastructure can further discourage investment in technologies. This includes investments in solar PV for ponds and land-based farms, or renewable-powered equipment and support vessels for marine systems. Maritime spatial planning (MSP) frameworks are designed to manage competing uses and create synergies between sectors, including offshore renewables and aquaculture. In this context, the TEN-E Regulation[22] is the key piece of legislation governing offshore renewable energy development, with obligations to, inter alia, adopt offshore network developments plans (ONDPs) in line with requirements for maritime spatial planning, stakeholder consultations, co-existence and environmental and climate law[23]. In practice, the way MSP and other planning tools allocate space and define conditions for multi-use will strongly influence where and how on-site renewable energy can be deployed for aquaculture. Looking ahead, the European Ocean Pact and the announced proposal for an Ocean Act are expected to further support a more integrated and forward-looking approach to combining aquaculture and marine renewable energy. This includes spatial planning.

The climate benefits of switching from grid electricity to locally produced renewable energy vary by Member State, depending on the carbon intensity of their electricity grids. In Member States where the grid is already largely decarbonised, the additional emission reductions may be relatively modest, compared to those with more carbon-intensive power mixes. This underlines the importance of assessing on-site solutions in their broader energy-system context, while still recognising their value for reducing exposure to energy-price volatility and improving the resilience of aquaculture operations.

3.3.2. Accelerate the uptake of low-carbon propulsion systems for support vessels

The adoption of low-carbon propulsion systems for **aquaculture support vessels**, particularly their electrification and, where technically and operationally feasible, wind-assisted propulsion technologies, has been identified as a potential measure to reduce GHG emissions in relevant production systems[30]. Emissions from these vessels represent a small share of sectoral emissions (around 2%, see Figure 3). The use of electric or hybrid support vessels is technically more feasible for near-shore farms, where shorter distances and easier access to charging infrastructure reduce constraints linked to battery capacity and recharging needs.

However, some aquaculture segments are expected to move further offshore, which might limit the situations in which full electrification of support vessels is realistic with current technologies. Operational measures aimed at reducing energy demand, including voyage optimisation, improved logistics planning and the use of digital tools to minimise unnecessary vessel trips, can further contribute to lowering emissions and enhancing the effectiveness of low-carbon propulsion technologies. Beyond GHG reductions, moving away from fossil fuels can also reduce exposure to fuel-price volatility and in turn boost the resilience of these aquaculture production systems. However, the cost-effectiveness of such measures may be limited due to high marginal abatement costs. Significant upfront investments are needed to adapt propulsion systems, while the resulting emission cuts are relatively modest at sector level (GHG study).

([30]) Techno-economic study, SWD(2024) 280, GHG study.

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3.3.3. Strengthen energy infrastructure systems

The energy transition, particularly the electrification of operations, depends on the availability of suitable infrastructure. Limited grid connections and infrastructure gaps in rural and coastal areas can hinder the adoption of low-carbon technologies in aquaculture. Similarly, land-based support systems and port facilities play a critical role in enabling electrification, both in terms of reliable power supply and storage capacity. Since much of this infrastructure is shared with other sectors and embedded in broader energy and transport systems, aquaculture's decarbonisation progress will depend heavily on wider efforts in these areas, efforts the sector can make use of where feasible.

3.4. Promote low-trophic low-carbon aquaculture

Promoting the expansion of low-trophic and low-carbon production systems can also support the overall energy transition in EU aquaculture. Given the wide variations in emission intensities across species[31], the composition of EU aquaculture production plays an important role in determining the sector's GHG emission trajectory. Low-trophic and low-carbon species, such as bivalves, offer an effective strategy to reduce GHG emissions while increasing production. These species are associated with the lowest emission intensities and deliver broader environmental benefits (e.g. habitat provision), indirectly supporting climate mitigation efforts.

Moreover, even when modelling the implementation of energy transition measures, non-fed aquaculture systems exhibit the lowest-carbon footprint in the sector, 4 to 13 times lower than fed production systems (see Figure 5).

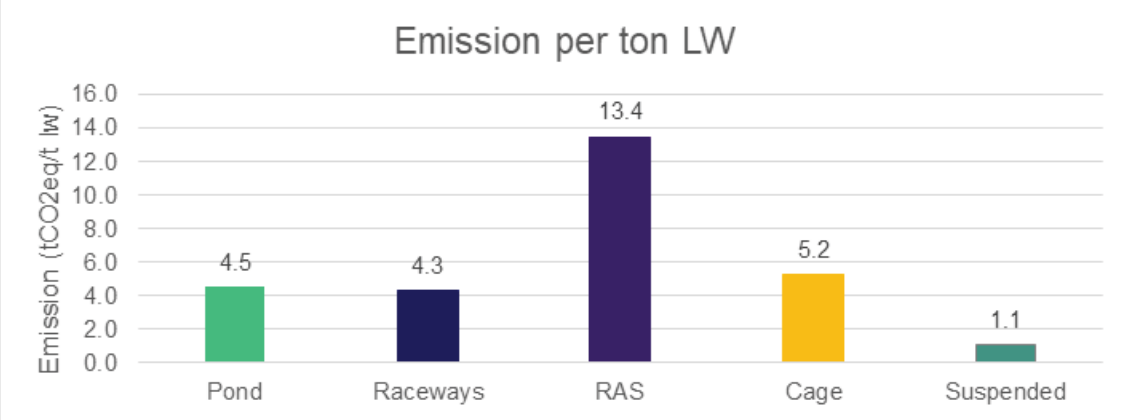


Figure 5 Total emission forecast per tonne of LW, 2026-2050 across production systems

However, the growth of low-trophic aquaculture remains limited by little overall market demand, which is partly explained by the low consumer awareness of the environmental benefits associated with these production systems. On the supply side, producers may also lack the financial incentives, such as market premiums, to adopt or expand these practices. Addressing these demand-side barriers through market-based instruments (e.g. labelling schemes, certification, consumer awareness campaigns) could stimulate demand for low-trophic species and provide operators with the financial means to invest in renewable energy and increase energy efficiency.

(31) Jessica A. Gephart et al., 'Environmental Performance of Blue Foods,' Nature 597, No 7876 (2021): 360-65, https://doi.org/10.1038/s41586-021-03889-2.

3.5. Promote the standardisation of greenhouse gas emission monitoring

GHG emission monitoring is essential to inform the energy transition of the aquaculture sector. To be effective, transition strategies will need to be supported by sufficiently robust measurement and reporting to track progress over time.

Recent analytical work, including the aquaculture GHG study, has for the first time provided a coherent baseline and a common methodological reference to estimate emissions across production systems and at Member State level.

Building on this methodological baseline, additional data streams – such as farm-level activity data, STECF[32] and EUMOFA[33] economic datasets, and more detailed energy-use records – would help to (i) refine emission factors; (ii) improve comparability between production types and Member States; and (iii) better capture the effects of decarbonisation measures. However, limited availability of farm-level data may hinder efforts to design targeted policy incentives, monitor progress, and evaluate the effectiveness of decarbonisation measures.

In this context, efforts to address remaining data gaps and promote simple, proportionate indicators for energy use and emissions in aquaculture, aligned with broader EU climate and energy reporting frameworks, could improve transparency and provide a stronger evidence base for designing effective policies and support measures to accelerate the energy transition. This approach can build on existing tools and practices, including voluntary energy audits and decision-support approaches, without imposing disproportionate burdens for business operators, particularly on SMEs.

3.6. Financial solutions for the energy transition

Facilitating access to suitable financial solutions is an important lever to advance the energy transition, particularly given the fragmented structure of the sector. As outlined in Section 2.2, a substantial share of business operators, especially small-scale farms, have relatively low investment capacity. This restricts their ability to adopt capital-intensive, low-carbon technologies required for decarbonisation. Financial barriers include high upfront costs for system design and installation, limited collateral, and uncertainty around return on investment, particularly where payback periods are long.

To mitigate these challenges, a combination of public and private instruments can be used to reduce risk and improve access to capital. For example, by blending targeted grants with loans and guarantees, or by using risk-sharing instruments that lower collateral requirements for smaller business operators. In addition, setting aside specific funding for the energy transition in existing EU and national funding programmes can help aquaculture operators, including SMEs, to access the support they need. Overall, such approaches should aim at making well-designed decarbonisation projects financially viable and attractive, while keeping procedures as simple and proportionate as possible.

3.7. Energy transition skills and knowledge

The aquaculture sector is expected to undergo significant operational changes and, in some segments, structural changes. These changes include (i) the wider use of digital monitoring systems and AI; (ii) the uptake of renewable-energy solutions; and (iii) a gradual shift further offshore for certain production models. Shifting further offshore will increase the need for remote-operation tools and digital supervision of farms, as well as longer and more complex

(32) Scientific, Technical and Economic Committee for Fisheries (STECF)
(33) European Market Observatory for fisheries and aquaculture (EUMOFA)

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support-vessel operations. To support this transition, the sector must address existing skill gaps, particularly in areas such as energy management, digital monitoring and control, operation and basic maintenance of renewable-energy systems, and energy and emissions accounting. This highlights the need for new expertise and underlines the importance of ensuring that the next generation of aquaculture operators receives appropriate training. This includes developing and promoting training programmes to equip the workforce with the skills needed to manage, repair and maintain these technologies across the value chain, as well as familiarising them with carbon and energy accounting and related reporting requirements.

4. CONCLUSIONS

This SWD provides the analytical background and presents the main technical solutions that could support the implementation of the energy transition roadmap for EU aquaculture, as set out in the Annex to the Vision 2040. The Annex sets out a pragmatic pathway for the fisheries and aquaculture sectors to become more resilient, competitive and aligned with the EU's climate and environmental objectives.

This SWD shows that, while aquaculture's overall contribution to EU greenhouse gas emissions remains limited, the sector faces specific challenges linked to energy use, adaptation to climate change impacts, strong dependence on feed, infrastructure constraints and a highly fragmented structure. Addressing these challenges will require a combination of measures that:

- improve energy and resource efficiency;
- optimise feed systems and promote the use of alternative low-carbon feed ingredients;
- support the deployment of renewable energy and enabling infrastructure;
- promote low-trophic and low-carbon forms of aquaculture;
- improve and harmonise greenhouse-gas-emissions monitoring;
- facilitate access to finance, skills and knowledge.

There is no one-size-fits-all approach: transition pathways must reflect the diversity of species, production systems and regional contexts, and remain realistic, economically viable and socially fair.

Successful implementation will depend on coordinated action by public authorities, producers, value-chain actors, and financial institutions, as well as alignment with broader initiatives, such as the Vision 2040 for fisheries and aquaculture, the European Green Deal and future ocean governance frameworks. If these conditions are met, the energy transition can strengthen the long-term resilience and attractiveness of EU aquaculture, boost its contribution to sustainable food systems and help position the sector as a strategic component of the EU blue economy.

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Annex 1: Progress through the Energy Transition Partnership

Arguably, it was not the recent developments in terms of energy consumption and intensity since 2023 that were more important for the energy transition in the short term, but rather the significant efforts made by stakeholders preparing the ground for making the energy transition in the long run.

Since its inception in June 2023, the **Energy Transition Partnership** (ETP) has successfully mobilised over 690 stakeholders for the energy transition of EU fisheries and aquaculture in an innovative and inclusive way. They are cooperating with each other to face the key challenges for making the energy transition in the sector.

In figures: key achievements of the **Energy Transition Partnership** for EU fisheries and aquaculture

- **690** members cooperating under the Energy Transition Partnership
- **10** support groups, with stakeholder-led coordinators
- **2** high-level conferences
- **14** thematic workshops and 40 working group meetings under the ETP
- Presence in key forums and conferences, including the **European Maritime Days**
- **600+** subscribers to the ETP newsletter

In 2024, the Commission appointed 10 support group coordinators for thematic groups representing all key stakeholders: i) small-scale coastal fisheries (SSCF), ii) large-scale fisheries (LSF), iii) distant water fleet (DWF), iv) non-governmental organisations (NGOs), v) research and academia, vi) shipbuilding, vii) inland aquaculture, viii) offshore aquaculture, ix) fishing ports, and x) the processing sector[34]. The support group coordinators have been key in facilitating discussions and directly involving the subsectors and stakeholders in the work of ETP and its different working groups.

The ETP working group delivered a set of joint considerations and 10 sectoral recommendations for energy transition in 2050. Together with the results of in-depth analysis and studies, the **ETP joint considerations and sector recommendations form the backbone of the roadmap for the energy transition**. For reference these joint considerations and recommendations are included as an integral part of **Annex 1** to the SWD. The key outcomes were also presented and discussed by the working group coordinators at the high-level conference on the energy transition and fisheries and aquaculture, held on 17 February 2026.

Beyond collaboration, the ETP serves as a key hub offering practical resources to support fisheries and aquaculture stakeholders in their transition: a best practices compendium[35], an interactive financing guide[36], updates on relevant projects and Member State initiatives. A quarterly newsletter (600+ subscribers since October 2025) showcases these initiatives and informs the sector about the latest developments.

In May 2026, the ETP launched its pilot ambassador programme – building on ETP knowledge – appointing contacts in Member State administrations to provide on-the-ground guidance to fishers and operators, facilitate access to funding and technical support, and channel national

([34]) ETP Support Group - Maritime Forum - European Commission.
([35]) Best practices - Maritime Forum - European Commission.
([36]) Guide on Financing opportunities for the Green Energy Transition of Fisheries and Aquaculture - Maritime Forum.

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feedback into ETP activities. Lessons learned from the pilot will inform decisions on the programme's continuation and expansion of its network after September 2026.

Initiatives on the energy transition

The action on the energy transition has extended far beyond the Energy Transition Partnership. Many other private and publicly financed initiatives have emerged since 2023, including from the fisheries sector, public authorities, research institutes and beyond.

Institutional stakeholders have been constructive in making progress on the transition. In 2024, Parliament adopted, by a large majority, a resolution on the decarbonisation and modernisation of EU fisheries[37] and recently prepared an own-initiative report on the decarbonisation and modernisation of EU fisheries (92024/2123(INI)). The AGRIFISH Council adopted conclusions on the energy transition, among other things. In March 2026, on the initiative of the Cyprus presidency, EU ministers responsible for fisheries and aquaculture held an exchange of views on advancing the energy transition in EU fisheries and aquaculture. The discussion focused on how to accelerate the shift away from fossil fuels while maintaining the sector's economic viability and competitiveness.

Member States and regional authorities have deployed their own tailored plans for making the energy transition in the sectors. They have been proactive in working at EU and regional level on creating the conditions needed to progress on the transition in the fisheries and aquaculture sectors. Some have launched specific funding opportunities for improving the energy efficiency of their fishing fleet within the possibilities of the EMFAF, with substantial uptake by the sector.

A major achievement has been launching a range of pilot projects throughout the EU. Parliament, together with the Commission, launched its own Zero Emission Demonstrative Fishing Vessel powered by a hybridised system of hydrogen fuel cell and batteries (Hy2Fish)[38]. Other Horizon Europe projects[39] [40,] have focused on digital technologies, energy efficiency and small-scale fishing vessels. The ETP website contains a continuously updated repository of demonstrators and other projects relevant for making the energy transition in the sector[41].

(37) https://oeil.europarl.europa.eu/oeil/en/procedure-document-summary/pdf?id=1881375.
(38) HY2FISH | The Future starts today.
(39) HORIZON-MISS-2025-03-OCEAN-03 Digital technologies and energy transition in fisheries and/or aquaculture.
(40) HORIZON-MISS-2023-OCEAN-01-05 Lighthouse in the Baltic and the North Sea basins - Green and energy-efficient small-scale fishing fleets.
(41) Best practices - Maritime Forum - European Commission

Annex 2: Joint Considerations - EU Energy Transition Partnership for Fisheries and Aquaculture

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Background

The ETP Support Group is a collaborative advisory body that supports the Energy Transition Partnership (ETP) in advancing the energy transition for EU fisheries and aquaculture. It is organised into ten working groups, each focused on a core segment of the sector: distant water fleet, large-scale fisheries, small-scale coastal fisheries, inland and offshore aquaculture, ports, fishing shipbuilding, processing and trading, research and academia, and NGOs.

From February to September 2025, these working groups, guided by their coordinators, convened stakeholders to identify challenges and develop sector-specific solutions. Over this period, 38 online meetings brought together nearly 400 participants, contributing to the formulation of sector specific recommendations for the energy transition roadmap.

The first phase of the process concludes with a coordinated set of cross-sector considerations that complement the sector-specific guidance. Acknowledging that a "one-size-fits-all" approach is not suitable, the support group calls for regionally tailored policies that reflect ecological, cultural, technical, and economic diversity, as well as different gear types, production systems, and infrastructure.

Guiding principles

A successful energy transition in European fisheries and aquaculture requires a holistic approach focusing on reducing energy use and carbon emissions across the food system; while ensuring marine ecosystems are in good health so they provide optimal natural sequestration and storage. It must integrate ecological restoration and conservation, technological innovation, vessel and infrastructure capabilities, and social equity while addressing climate pressures, biodiversity loss, ageing fleets, competitiveness challenges, and ecosystem degradation. Policies should be regionally tailored, aligned with EU and international frameworks, and provide long-term certainty, while being consistent with ending overfishing, **sustainable stock recovery** and supporting coastal communities through **inclusive**, socially just approaches.

Advancing the transition requires **coordinated governance**, stronger research collaboration, and improved information sharing, alongside practical testing of **cleaner propulsion systems**, **energy audits,** and the development of **resilient port and fuel infrastructure**, as well as appropriate **support for the industries underpinning the transition**, such as shipyards and maritime equipment suppliers. For the seafood processing and trading sector, this also includes improving energy efficiency, optimising logistics, and supporting low-carbon supply chain solutions**.** It is key to

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provide policy certainty to all segments, in particular the small-scale sectors for enabling a viable future which at the same time addresses its generational renewal. **Fleet modernisation**—through energy efficiency, impacts reduction, renewal and targeted retrofits—should prioritise **profitable**, **modular**, **adaptable**, safe, and future-proof vessel designs. **Regulatory simplification** and alignment with climate and maritime objectives are essential, including evaluating relevance of fishing capacity measurement and certification frameworks to accommodate emerging technologies.

Effective **financing and investment incentives**—through financial instruments, guarantees, and tax measures—are needed to support clean-technology uptake, while **skills development**, **training**, and **generational renewal** will build the workforce required for new energy systems and digital tools. By embedding these principles, the transition can reduce fossil-fuel dependence, strengthen **environmental resilience**, and secure a **competitive**, **sustainable future** for European fisheries and aquaculture.

1. ***De-risk investments with EU funding to incentivise decarbonisation in fisheries and aquaculture and unlock capital for the energy transition.***

High costs and perceived risks in the fisheries and aquaculture sector limit funding and private investment in the energy transition. Although the European Commission's proposes to relax eligibility conditions in the 2028–2034 MFF, current funding—especially EMFAF until 2029— remains restrictive, with caps on retrofitting and thresholds.

Targeted reform is needed to unlock funds quickly and equitably, including easing restrictions on newbuilding and retrofits, enabling pilots and demonstrators, allowing pre-financing, and simplifying access for small operators. Grants should complement loans and guarantees and be tied to clear sustainability, climate, and biodiversity objectives.

In parallel, State aid frameworks should be made more flexible to allow targeted national support for decarbonisation, innovation, and fleet modernisation, while ensuring a level playing field. Stronger engagement of the European Investment Bank (EIB)—through guarantees, blended finance, and tailored instruments—can further crowd in private capital and reduce risk.

Transparent, accountable funding is essential to support a fair and just transition toward energy-efficient, low-impact, and resilient fisheries and aquaculture while safeguarding food security.

How the Roadmap can address this:

- Discuss the current EMFAF rules to remove retrofitting and fleet renewal restrictions and simplify access for all operators, including pre-financing and reduced reporting.

- Establish a ring-fenced, meaningful funding window in the EU budget for small or capital-constrained operators.

- Support regional and community demonstrators, cooperative financing, and shared infrastructure projects.

- Define policies that can provide public guarantees to de-risk private investment, complemented by grants for the riskiest projects.

- Facilitate flexible State aid for decarbonisation and innovation and strengthen EIB support to de-risk private investment and scale clean technologies.

2. Demonstrate technical and economic feasibility of the energy transition through EU demonstration programme to strengthen business case in the sector

Fisheries and aquaculture have limited experience with low-carbon propulsion and energy efficient, low-impact technologies, slowing adoption due to uncertainty. Demonstration programmes tested under real operating conditions are essential to build confidence, assess technical and economic feasibility, and accelerate the transition to cleaner, more efficient operations.

Regionally tailored, participatory approaches—actively involving the entire fisheries and aquaculture value chain, and local authorities—ensure technologies meet real needs. Demonstrators should integrate port and onshore infrastructure, creating "living labs" for holistic testing of innovation ecosystems. For aquaculture, programmes should include energy-efficient systems, renewable integration, and low-carbon processing. Results should feed into the Knowledge Hub and guide wider replication across the EU.

How the Roadmap can address this:

- Launch co-designed EU demonstration programmes for low-carbon propulsion, energy-efficient, and low-impact technologies, including prototype vessels and aquaculture systems, validated under real-world conditions.

- Implement regionally tailored "living labs" that integrate vessel technologies, port infrastructure, and renewable solutions, reflecting environmental, operational, and socio-economic diversity.

- Support pilot projects and collaborative initiatives that actively involve industry, research, and local communities, ensuring validation of environmental, social, and economic performance, as well as practical relevance and cross-sector learning.

3. Establish a Decision-Support Programme for energy efficiency assessment in the entire value chain of fisheries and aquaculture

Entire EU fisheries and aquaculture value chains lack a systematic way to assess energy use, identify inefficiencies, and guide technology adoption. Existing audits are fragmented, inconsistent, and often inaccessible, limiting evidence-based investment and slowing sector wide efficiency gains.

Without a coordinated approach and an appropriate baseline, opportunities for quick improvements, cost reductions, and low-carbon, low-impact adoption may be missed, and policy decisions risk being uninformed. A structured, EU-wide system could

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generate comparable data, support planning and assess progress, and provide a foundation for equitable, technically feasible, and economically viable energy transition measures across the sector.

How the Roadmap can address this:

- Establish a coordinated EU-wide energy audit programme and funding support for operators, including a methodology, tools and devices that enable assessment and efficiency improvements.

- Establish a baseline that takes into consideration direct emissions and impact, indirect emissions, impacts on biodiversity and emissions related to the destruction of carbon sinks and that takes into consideration the entire value-chain. It should also take into account: the reduction previously made by the fisheries and aquaculture sectors since 1990 in accordance with the Climate Law.

- Conduct regional audits and pilot studies to reflect different environmental and operational conditions, informing targeted decision-support tools and national energy transition strategies.

- Engage industry actors in testing and implementing energy-efficiency measures and collective approaches, while integrating results into shared knowledge systems to track progress and support wider adoption.

4. ***Strengthen energy infrastructure and supply systems for fisheries and aquaculture to support the uptake of clean fuels, electrification, and renewable energy.***

Fisheries and aquaculture lack the port and energy infrastructure needed to adopt cleaner fuels and low-emission technologies, creating a major barrier to the energy transition. Investments in port electrification, renewable energy connections, and bunkering infrastructure for low-carbon fuels are therefore essential to enable modern, low-impact operations.

Planning must be based on a clear understanding of existing infrastructure, future energy needs, and regional differences, covering both maritime - ports and inland aquaculture facilities. Reliable access to renewable electricity, smart grid systems, and small-scale local generation will be key, particularly for small-scale operators.

A coordinated rollout—supported by (EU-level) funding and integration into broader clean transport and energy strategies—will ensure cost-effective, regionally adapted infrastructure development and support cross-border operations for fleets operating beyond national waters.

How the Roadmap can address this:

- Map existing ports, piers, quays and landing sites used for fishery and aquaculture operations, landing site, and energy infrastructure, and assess fleet, aquaculture and processing energy needs to guide targeted investment and planning.

- Integrate fisheries and aquaculture into EU sustainable transport and energy strategies, prioritising renewable and low-carbon fuels, charging, and refuelling infrastructure.

- Promote interoperable, scalable, and regionally adapted infrastructure solutions through pilot projects, public–private partnerships, and stakeholder engagement.

- Coordinate across ports, fleets, and aquaculture operators to align infrastructure development with operational realities, regional contexts, and the broader energy transition.

5. ***Establish a progressive and incentivised transition plan for the fleet that promotes tailored solutions.***

European fisheries and aquaculture operate some of the oldest fleets in the maritime domain. Heavy retrofits on end-of-life vessels offer limited long-term benefits compared with strategic fleet renewal. Fleet renewal, however, is not just an energy transition measure — it also provides opportunities to reduce climate and biodiversity impacts, enhance crew safety, improve working conditions, and support inclusivity and the attractiveness of maritime professions.

A progressive, incentivised fleet transition plan should prioritise renewal of older vessels while targeting retrofits for mid-life vessels where technically and economically viable. New vessels should integrate advanced propulsion, circular design, safety features, lower impact gears diversifications and accessibility considerations. Financial support must address the limited investment capacity of small-scale coastal fleets, ensuring a fair and inclusive transition. Coordinated renewal and retrofitting, aligned with the broader energy transition roadmap, will contribute to deliver environmental, social, and operational benefits across the sector.

How the Roadmap can address this:

- Develop a European Fleet Transition Strategy integrating energy transition, profitability, climate and biodiversity impacts, safety, circularity, and inclusivity, with clear eligibility and prioritisation criteria for vessel renewal, retrofitting, and prototype development.

- Establish coordinated funding mechanisms, including EMFAF, Horizon Europe, and EIB facilities, and later the Competitiveness Fund, with facilitated support for small-scale operators.

- Promote regional demonstration clusters and shared retrofitting/maintenance facilities to test and deploy new designs adapted to local fleet and operational needs.

- Support training, capacity building, and partnerships to ensure adoption of safe, low carbon, inclusive, and circular vessel designs across the sector.

6. ***Strengthen the workforce and attract new generations through education, training, and upskilling in advanced technologies.***

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The fisheries and aquaculture sectors face a critical need for workforce renewal and skills development to support the energy transition. Technological innovation is accelerating, but the workforce often lacks the expertise to operate, maintain, and manage clean technologies. At the same time, an ageing workforce and limited recruitment of young professionals threaten knowledge transfer and the social and economic resilience of coastal communities.

A future-oriented strategy must combine technical training, generational renewal, and inclusivity, ensuring stable and rewarding careers. Education and upskilling should equip workers to manage hybrid vessels, alternative fuels, digital tools, and circular economy practices, while embedding gender equality and equal opportunities across the value chain. Lifelong learning, entrepreneurial skills, and awareness of climate, biodiversity, and sustainability issues will empower workers to lead the transition toward energy-efficient and low-emission operations.

Mentorship, apprenticeships, and demonstration projects can bridge experience gaps, fostering knowledge transfer and trust between generations. A comprehensive, inclusive skills strategy is essential to ensure that the energy transition delivers economic opportunities, social resilience, and a sustainable future for fisheries and aquaculture.

How the Roadmap can address this:

- Assess workforce gaps in energy transition relevant areas and integrate together with digital, and sustainability skills into education, training, and upskilling programmes, including apprenticeships and mentoring schemes.

- Promote gender equality, inclusivity, and practical skills development through targeted funding, micro-credentials, and innovation-driven training initiatives.

7. Integrate energy transition of fisheries and aquaculture into broader EU policies and harmonise regulatory frameworks

Fisheries and aquaculture face regulatory fragmentation across ports, shipbuilding, trading, processing, and maritime sectors, creating uncertainty and limiting access to EU funding for energy transition. Integrating the energy transition of fisheries and aquaculture into broader EU strategies—such as the Green Deal, Clean Industrial Deal, Industrial Maritime Strategy, the Industrial Accelerator Act, the Sustainable Transport Investment Plan, and the Circular Economy Act—is essential to simplify procedures, build trust, and enable coordinated sector wide transition.

Clear regulatory alignment, supported by expert review, can harmonise rules on fuels, licensing, and infrastructure, reduce administrative complexity, and facilitate technology adoption. Harmonised frameworks will support both short-term efficiency measures and long-term initiatives, including fleet renewal, low-emission fuels, and low-impact technologies, while providing a stable environment for investment and innovation.

How the Roadmap can address this:

- Align EU maritime, transport, climate, and industrial strategies with fisheries and aquaculture energy transition needs, and harmonise regulations across fleets, ports, shipbuilding, and processing industries.

- Ensure regional and national authorities coordinate implementation, accounting for local ecological, technical, and socio-economic conditions.

8. ***Strengthen EU shipyards and technology suppliers to drive innovation and competitiveness in clean maritime solutions and energy-efficient seafood production.***

EU shipyards and their suppliers face growing international competition, with many foreign operators benefiting from lower environmental standards and greater government support. Strengthening Europe's industrial base in cleaner and energy-efficient vessel technologies will boost competitiveness, retain the benefits of the energy transition domestically, and create skilled jobs.

Shipyards will have to scale up their capacity to handle newbuilding or retrofitting of fishing and aquaculture vessels in Europe. This requires significant productive investment in facilities and production efficiency, which are capital-intensive and now very attractive to traditional banks. Public support for these investments is necessary to ensure it is viable for the shipyards.

How the Roadmap can address this:

- Support EU shipyards and technology providers with funding and incentives for clean vessel technologies for fisheries and aquaculture, energy-efficient production, modular design, and circular manufacturing processes.

- Prioritise industrial competitiveness and innovation by aligning EU and national programmes, fostering SME participation, and facilitating collaboration between shipyards, research centres, and seafood producers.

- Develop and adopt EU-wide modular and adaptable vessel design standards for fisheries and aquaculture, covering multi-fuel capability, hybrid propulsion, multi-use and diversified low-impact operations, and safety integration.

9. ***Evaluate how the fishery capacity measurement system is fit for purpose for energy transition***

Current CFP capacity metrics (GT/kW) were designed to limit fishing effort and prevent overexploitation. However, low-emission technologies—such as batteries and alternative-fuel systems—add weight and take up space, with potential to push vessels beyond these thresholds. This creates a practical barrier to adopting clean technologies.

Capacity control remains crucial for conservation. The capacity ceilings are also currently crucial for social safeguards, as they are linked to fishing entitlements, vessel value, and retirement benefits. Changes to accommodate energy transition risk unintended biological, economic, and social consequences. Safety and classification concerns also arise with new fuels and batteries, requiring compliance with design, stability, and port regulations.

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A fit-for-purpose capacity system is needed—one that is sector-specific balances support for clean technology with effective fisheries management, accounting for fishing effort, catching efficiency, auxiliary power, and technological creep, not allowing overfishing and preventing fraud. Any revisions should be evidence-based, segment-specific, and sensitive to regional differences, building on the ongoing CFP evaluation process.

How the Roadmap can address this:

- Examine the definition of fishing capacity and GT/kW restrictions in the CFP evaluation, considering evidence-based amendments to support the energy transition while maintaining conservation and social safeguards.

- Convene an expert task force (e.g., STECF/ICES) with meaningful engagement of relevant stakeholders to assess the fitness of current metrics, explore alternative capacity measurement options indicating its social, economic and environmental consequences, evaluate safety and space implications of low-emission technologies, and produce time-bound recommendations; complement with fleet- and sea-basin level technical studies.

10. Establish the Energy Transition Partnership (ETP) for EU fisheries and aquaculture value chain as a permanent platform to implement the roadmap

Policymaking for the energy transition in fisheries and aquaculture is fragmented, causing duplicated efforts, misaligned standards, and missed opportunities for technology transfer. A central, light governance mechanism is needed to coordinate R&D, harmonise standards, and consolidate best practices in a public Knowledge Hub.

The ETP should serve as this mechanism, with a concise mandate to implement the roadmap, coordinate R&D, forecast investment needs, build collaborative investment plans, and oversee time-limited workstreams such as Standards & Interoperability, Innovation, and Regional Pilots. A two-tier structure—Strategic Board (Commission, Member State focal points, and representative stakeholders) supported by a technical secretariat—would combine strategic oversight with technical delivery, with national focal points ensuring domestic coordination.

The ETP should prioritise regional differentiation and technology flexibility and neutrality, set clear targets with an annual dashboard, and secure predictable funding for pilots, infrastructure, and innovation. Stakeholder engagement should be streamlined via umbrella representation, a single portal, digital consultations, and predictable schedules, ensuring equitable participation of all fisheries and aquaculture sectors, NGOs, research and academia, ports, shipyards, energy suppliers, and supply-chain actors.

How the Roadmap can address this:

- Establish the ETP as a single-entry platform with a Strategic Board and Technical Secretariat to implement the roadmap, coordinate R&D, and oversee time-limited workstreams with clear milestones, KPIs, and deadlines.

- Expand the Knowledge Hub to consolidate vetted project dossiers, lifecycle assessments, and best practices, requiring standardised submissions and linking outputs across EU-funded projects.

- Develop a comprehensive baseline and monitoring system for the fisheries and aquaculture sector, covering fleet and production facilities, energy use, emissions, biodiversity, carbon sinks, and socio-economic indicators, while integrating life-cycle assessments of new technologies and operational impacts.

- Engage stakeholders through umbrella organisations, digital consultations, and timeboxed workshops, ensuring equitable participation across all fisheries and aquaculture sectors, industry, research, and coastal communities.

- Promote regional pilots, cross-sector learning, and coordination with existing EU fora to test interoperability, fuel supply chains, retrofitting solutions, and to avoid duplication and silos.

WGs recommendations main recommendations.

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This section is anticipating the full recommendations coming from the 10 Working Groups set up under the ETP. Please revise also the full documents as they contain more details, analysis and recommendations.

See below the main actions recommended by each WG and links to the full documents issued by its members.

Fishing shipbuilding Working Group main recommendations – ***see here*** ***the full document***

- Policies can provide public guarantees to **de-risk private investment**, complemented by grants for the riskiest projects.
- The fishing sector should forecast its modernisation/renewal needs, **allowing the shipbuilding industry to plan capacity** along a long-term roadmap.
- Launch a legislative amendment to **resolve the technical bottleneck**, incorporating input from naval architects and mitigating potential negative effects, such as overcapacity or overfishing.
- Launch and finance a demonstrators programme to **showcase new technologies in real-world and business conditions**, involving fishers directly to secure their buy-in.

Small Scale Fisheries Working Group main recommendations – ***see here the full document***

The Small-scale Fishing sector (SSF) has reached a tipping point in decline. Therefore, issuing a binding Plan of Action to support SSF in Europe is needed to provide the necessary certainty for a brighter viable future which will act as a key enabler not just for the Energy Transition but also for its generational renewal. If that is done, SSF are well placed to keep leading the energy transition thanks to their already very low carbon footprint, creating an opportunity to revitalise the sector and provide better working

conditions. Prioritising public funding for the energy transition of this sector (which is ring-fenced, meaningful, accessible and tailored to them) is essential to achieve a fair level playing field.

Large Scale Fisheries Working Group main recommendations– see here the full document

The Large-Scale Fleet (LSF) deeply believes that an energy transition is necessary to achieve the goals of the CFP, support the EU Green Deal objectives and the general aim of transition to sustainability, while securing a future for fisheries as contributor to food security by providing benefits to society through blue food: low-carbon, sustainable, and highly nutritious source of protein.
This requires a forward-looking and socio-economically viable approach that not only encourages innovation but also ensures that regulatory constraints do not hinder progress. By fostering a policy environment that supports adaptation and modernization, through fleet renewal and removal of the fishing capacity, the EU can facilitate the European fishing sector to be both sustainable and competitive.

Distant Water Fleet Working Group main recommendations– see here the full document

- **Regulatory constraints:** Current rules, including fishing vessel registry limits on gross tonnage (GT) and engine power (kW), can restrict upgrades and retrofits. Addressing these barriers— through regulatory review, exemptions for low-carbon technologies, or targeted compliance pathways—is essential to enable modernization.
- **Financing and capital availability:** Insufficient access to funding hampers both retrofits of existing vessels and the construction of new, energy-efficient ships. A blended finance approach is needed, combining grants (e.g., EMFAF) with loan guarantees and concessional credit to de-risk investments and improve bankability.
- **Pilot projects and capability building:** Launching pilot programs is critical to build confidence and know-how in retrofit design. These should develop technical and economic models, standardize methodologies, and provide practical guidance to help vessel owners assess feasibility, costs, and expected performance of their energy transition projects.

Aquaculture Working Groups main recommendations- See here the full document

Offshore Aquaculture:

- Operators require a review of funding mechanisms for ET to make them **more easily accessible also by small companies.** Funds should be made available **sufficiently to promote green reconversion.** The operators require that a single level playing field for fund access is guaranteed at EU level.
- The development of tailored capacity building and training programs is needed **to equip the offshore aquaculture workforce with the necessary skills** to manage the new technologies, all along the blue value chain. Support training courses that are adaptable across Member States, with EU-level recognition **to ensure consistency and relevance.**
- Developing targeted strategies **to optimise feed production methods and sourcing of raw materials** is another important goal, together with **the implementation of pilot projects to supply feed industry with novel and**

sustainable raw materials. Low trophic aquaculture should be consistently promoted.

Inland Aquaculture:

- Targeted awareness raising, training, guidelines, good practices and case studies for the aquaculture and related sectors could **improve understanding and provide more just grounds for energy transition**.
- A roadmap and policies could enhance public guarantees **to de-risk private investment, complemented by grants for the riskiest projects**.
- More research on environmental and economic sustainability of specific energy transition cases could **support financial decision making**.
- Guidelines, case studies and good practices from the EU could ensure a better understanding of EU rules and regulations and encourage countries to adapt them, **ensuring a fairer ground for aquaculture producers.**

NGOs Working Group main recommendations – ***see here the full document***

The NGO segment underlines that the energy transition of fisheries and aquaculture requires a **holistic, system-wide approach**, integrating climate mitigation, biodiversity protection, social justice and economic resilience. The transition must address the **entire value chain**, covering direct and indirect emissions, impacts on marine ecosystems and carbon sinks, and links with food systems and coastal communities. A **just transition** is essential, supporting fishers and aquaculture producers—especially small-scale actors—through clear regulation, funding, training and innovation. A **clear and coherent regulatory framework**, aligned with existing EU legislation and strategies, is essential to provide certainty, ensure coherence across policies and enable investment. Robust **scientific baselines, mapping and monitoring** are needed to assess progress, guide decision-making and ensure accountability. The roadmap must be backed by **adequate funding, fiscal incentives, skills development, research and innovation**, with improved access for small-scale actors and safeguards against overcapacity. Finally, a **just and inclusive transition**, supported by permanent stakeholder dialogue and effective governance, is identified as key to delivering lasting climate, biodiversity and socio-economic benefits.

Processing industry Working Group main recommendations – ***see here the full document***

- Develop harmonised EU templates and protocols for collecting energy and emissions data.
- Provide guidance and tools to help companies meet sustainability reporting obligations, particularly in light of CSRD delays.
- Improve data comparability to support investment decisions and sector-wide monitoring.
- Conduct coordinated EU–Member State assessments of grid capacity, spatial constraints, and permitting challenges in processing sites, logistics hubs, and ports.
- Support investments in energy hubs, renewable energy deployment, onshore power systems, and expanded charging infrastructure.
- Promote shared logistics solutions and optimisation of cold chains to reduce fuel use and emissions.
- Align infrastructure planning across ports, shipyards, fisheries / aquaculture, and trading & processing industries.

- Expand EU funding for pilot and demonstration projects specifically for processing, trading, logistics, and circular-economy applications.
- Strengthen cooperation with academia, research bodies, and the ETP Assistance Mechanism to advance technology readiness and support knowledge transfer.
- Compile and share best practices and successful models from EU and global experience to guide operators toward viable solutions.
- Enhance financial tools (grants, guarantees, and incentives) to de-risk investments and ensure regional and economic feasibility.

Ports Working Group main recommendations – ***see here the full document***

- Machinery and equipment unloading fish catches, transporting catches inside the port or loading the catches for further transport leads to high amounts of emissions related to fishing and aquaculture. The ETP should establish an EU co-financing program to replace diesel-powered equipment (forklifts, trucks, cranes, etc) with electric or hybrid alternatives, complemented by a joint European procurement mechanism to reduce costs for small ports. Include in the programs the obligation to measure and monitor carbon emissions.
- The lack of Onshore Power Supply (OPS) in fishing ports is due to a combination of factors including implementation costs, inconsistent grid capacity, lack of standardised equipment, and a mismatch between vessel and port infrastructure. The ETP should financially and technically support the implementation and deployment of OPS in all EU fishing ports by 2030 through:
  - Creating specific EU funding lines to co-finance the implementation of OPS infrastructure and/or the placement of new substations and electrical infrastructure in small (<5.000 t/year) and medium ports (5.000 – 20.000 t/year).
  - Co-designing incentive schemes such as reduced port fees or preferential electricity tariffs for connected vessels.
  - Supporting harmonisation and standardisation of OPS technologies at EU level to ensure interoperability across ports and fleets.
- Excessive dependence on traditional energy sources like fossil fuels leads to environmental issues such as air and water pollution and climate change, while also creating geopolitical vulnerabilities and economic instability due to fluctuating prices and supply chain risks. In this sense, Ports are significant energy consumers, primarily relying on non-renewable sources like diesel and fossil fuel-generated electricity for operations such as container movement, cranes, and lighting. The ETP should facilitate/encourage EU-financially supported pilot projects (through calls) and/or co-financed investments (i.e. EIB, CEF) to support the integration of renewable sources of energy (i.e. solar, wind, etc.), battery storage systems into port operations, prioritizing refrigeration and ice plants.
- The roadmap should promote a participatory and inclusive approach by integrating social engagement plans and supporting pilot projects that combine technological and social innovation, to reduce conflicts and align renewable energy deployment with local community's needs.

Research and Academia Working Group main recommendations – ***see here the full document***

- Conduct a baseline study about the EU fleets reality (structure, fuel use, profitability) and explore feasible energy transition solutions to generate mutual trust (research, industry, sector).
- Detailed study on fuel use and emissions regulations and incentives within the EU fisheries and aquaculture sectors. Determine which regulations could be uniformly applied or tailored to fishing and aquaculture sectors, considering promotion of the efficient energy use and associated emission reductions.
- Encourage and support demonstration sites for testing solutions for decarbonising the fisheries and aquaculture sectors; identify sites where a holistic solution is possible, involving all the actors, from the vessel to the port and create a Living lab or demonstrator site to test solutions in real environment, with active involvement of the operators.
- Support and enhance capacity building of the fisheries and aquaculture workforce to new alternative fuels and solutions. Support specialised workforce trainings, help streamlining certifications and credentials within EU (adaptation of curriculum and allowing credentials to be used all along EU), and even promoting a micro-credentials system as a potential solution for training new workforce or re-skilling existing one.