KEY CHALLENGES TO PROMOTE THE ENERGY EFFICIENCY IN FISHERIES FROM A RESEARCH AND INNOVATION PERSPECTIVE

REPORT FROM THE WORKSHOP ABOUT ENERGY EFFICIENCY ORGANIZED BY THE EUROPEAN FISHERIES TECHNOLOGY PLATFORM. Secretaría General de Pesca, Madrid, Spain. September 12th 2012.

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1. BACKGROUND

The European Fisheries Technology Platform aims to identify the key challenges for the future of fisheries and fishing research and technology and, based on them, to formulate the sector's strategy and action plan that will strengthen its capacity to grow smart, sustainable and inclusive in the forthcoming years, thus keeping a prominent role within the European Marine Economy.

The EFTP, through its Board of Directors and Secretariat, is promoting a number of workshops aimed to discus and agree on a series of issues that are of paramount relevance in the above mentioned process:

1. Fishing Vessel Technologies
2. Discards.
3. Energy Efficiency.

The aim of the Energy Efficiency workshop has been to make progress on the above mentioned process by putting together the inputs yielded by a panel of stakeholders and experts from different European regions, developing different activities and representing different particular interests. Discussion addressed the key challenges and how efforts should be oriented in the forthcoming years with regard to them.

The workshop took place on the 12th September 2012 at the premises of Secretaría General de Pesca, in Madrid. Participants from different countries and with different background disciplines and professional profiles attended.

2. METHODOLOGY

The workshop started with a set of welcome and introductory presentations, aiming to give attendants a broad overview of the current marine context scenario. Mrs. Aurora de Blas, Deputy Director of General Secretary of Fisheries from the Ministry of Agriculture, Food and Environment of Spain, and Mr. Javier Garat, president of the European Fisheries Technology Platform, presented this workshop highlighting the importance of energy efficiency in the fisheries sector.

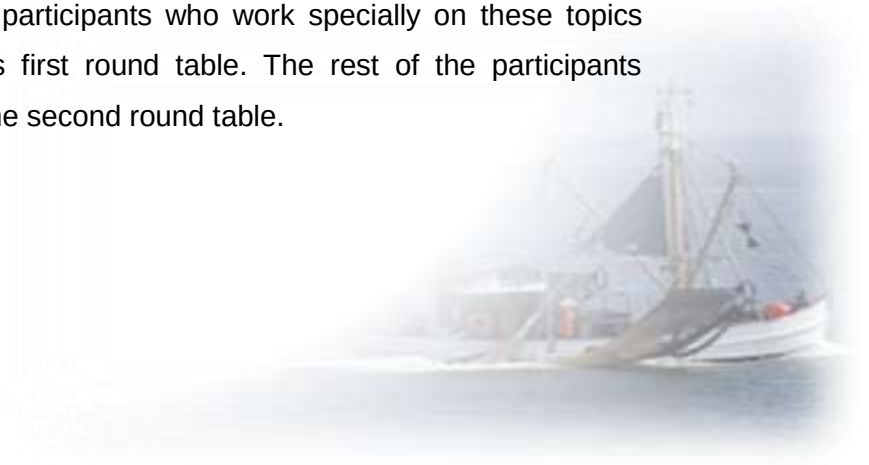
Then Mr. Miguel Pena – Castellot, from DG MARE at European Commission, analyzed the importance of rising fuel costs in fisheries, the reaction by the sector and the reaction by European Commission.

Finally, before the working session, Mr. Torgeir Edvardsen from SINTEF exposed how the EFTP and other Technology Platforms gain increasing influence on research and innovation issues in Brussels, also mentioning the importance of the strong commitment from the sector.

At this point the prioritization of research and innovation issues commenced. To facilitate this process, a discussion document was drafted in order to introduce the scope of the problem and propose major challenges and core technologies to promote. This document had been circulated to workshop attendants a few days prior to the meeting accomplishment.

After introducing the importance of this process for the achievement of the EFTP goals and explaining the working method, participants took part in two parallel round table discussions.

One of them was focused specifically on two of the topics, which dealt with efficiency during fishing operation and with efficient steering and navigation. These topics where not as developed as the others, so participants who work specially on these topics where selected to participate in this first round table. The rest of the participants discussed about the other topics on the second round table.



The list of main topics is the following:

1. Data acquisition and control systems. Energy audits
2. Propeller train optimization
3. Alternative fuels and complementary energies
4. Modifications in the vessels, and new design approaches
5. Energy for uses other than propulsion
6. Energy efficiency during fishing operation
7. Efficient steering and navigation
8: Other aspects related with energy efficiency in fishing activity

The first aspect addressed was to accept or amend the challenges suggested within each topic. Apart from this, the following questions were proposed for the debate:

- **Core technologies**, required for application to solve the identified challenge.
- **Background**: what has already been done:
    - Are there any available technologies suitable to help solving the problem? If not, what is the reason? If yes, why those technologies have not reached the market yet?
- **Necessary activities**: type of activities, expressed in % from research, demonstration, innovation and market development.
- **Scope**: the most suitable scope for addressing the challenge: National, EU Regions, EU Level or international.
- **Key drivers**: aspects which would facilitate and promote the process: technology, market and/or regulation.
- **Priority**: order the challenges according to the urgency / importance to be solved. Priority was assigned from 1 to 5, corresponding 5 to the higher priority.
- **Horizon**: expectancy for the challenge to be solved. Short (5 years), Medium (10 years) or Long (20 years) term.

3. CONCLUSIONS ACHIEVED

SITUATION

An important element for the sustainability of the fisheries sector is the need to reduce energy consumption and to do so throughout the entire value chain in the fisheries, “from the ship to the shop”.

The increased focus on energy consumption is also a core aspect to improve fishing industries’ corporate strategy to cut down expenditures in its processes and an environmental challenge to fulfil international obligations like the Gothenburg protocol and the Kyoto-agreement to cut down greenhouse gas emissions. The greenhouse effect causes changes in oceanographic conditions of seas and oceans and, therefore, in fishing resources.

Fishing is one of the most energy-intensive food production methods in the world, depending almost entirely on fossil fuels. In 2008, the world’s fishing fleets were responsible for about 1.2% of total global fuel consumption, corresponding to 0.67 liters of fuel per kg of live fish and shellfish landed. In the same year, the EU fleet consumed 3.7 billion liters of fuel, representing 25% of the value of landings. Fuel consumption acts as an indicator of environmental impact with the EU fleet releasing 10,000,000 tons of CO2, or else 1.81 Kg CO2/Kg of fish landed. This represents 0.23% of global greenhouse gas emissions.

Between 1995 and 2002 in the EU-25, fuel prices have increased by an average of 80%, while fisheries production declined by 17%. More recently, between 2002 and 2008, fuel prices increased by 152%, while average fish price increased by 67%, and profitability decreased by 33%. Landings in the same period decreased by 23% and in fact in 2005, imports of fish products surpassed EU-landings for the first time. The ratio landing value/fuel cost demonstrated a clear decreasing trend with the fuel efficiency of fish capture indicator being halved since 2002.

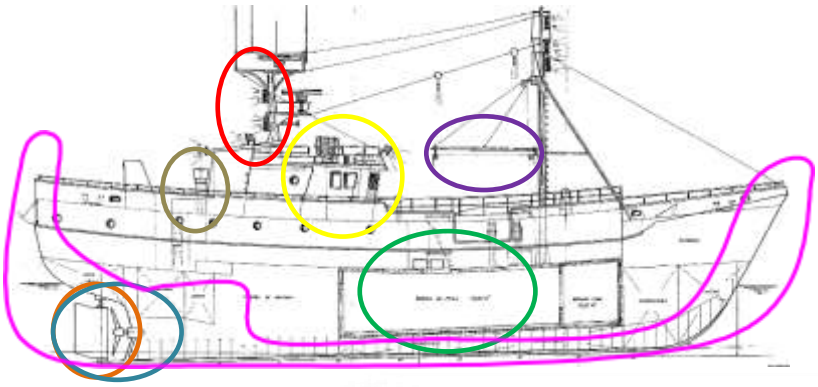
Mostly because fishing capacity is greater than the available fish stocks, many fishing fleets in the EU have been facing economic problems. With added concerns about oil prices since 2005, energy efficiency is the key to profitability and has become both a political and a scientific issue.

It is now acknowledged that EU fishing fleets expend vast quantities of energy and that low overall efficiency is caused not by high oil costs but rather by structural deficiencies.[1]

This workshop had the objective to address technical, economic, and management aspects on how to counteract the difficulties arising from increasing energy costs, including improvements in fishing gear, changes in fishing operations, the use of alternative energy sources, and using alternative fishing methods. Further the workshop will address how the RDTI in implementing fuel related changes in fishing activity and improving fleet dynamics may impact on the profitability of European Fisheries Sector.

MAIN TOPICS AND CHALLENGES TO FOCUS RTD & INNOVATION EFFORTS IN ENERGY EFFICIENCY

The division of topics and challenges are applicable to new or already existing fishing vessels. Different topics correspond to the different parts of the vessel, so this scheme tries to roughly match the topics with them, following the colours code.



[1] 1 Maritime Affairs Unit, FISHREG - Scientific Support to Fisheries, Institute for the Protection and Security of the Citizen (IPSC), European Commission - Joint Research Center, TP 051, I-21027 Ispra (VA), Italy.

Topic 1. Data acquisition and control systems. Energy audits

The aim of this topic is to develop a portable and reusable tool to obtain full information on the generation and use of energy on board.
This requires the implementation of a data collection system, subject to quality control and stored on a Geo-referenced-chronologic way for further analysis.

- **Challenge 1: Tools for energy data acquisition**

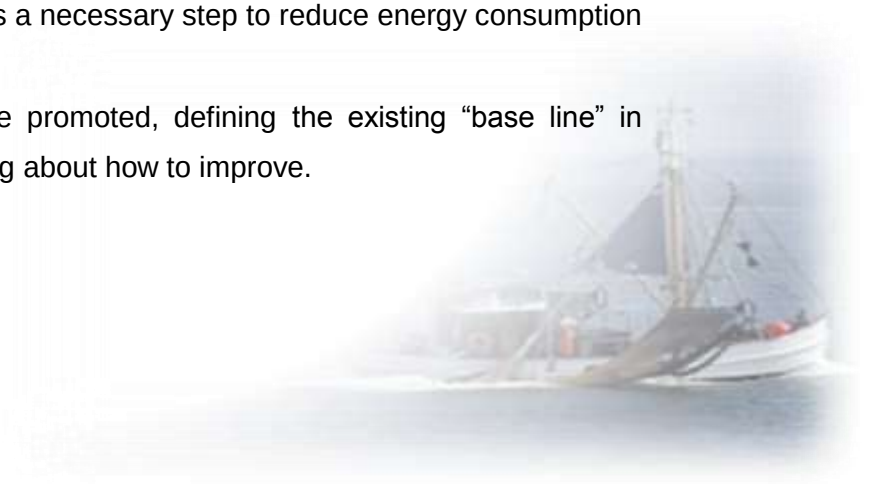
It includes software and hardware (sensors, data loggers, etc.).
Difficult to measure energy flows: one unique input (gasoil) but many different outputs.
Sensors on board are a critical point, in particular the inexpensive and reliable method of measuring fuel consumption.
The data acquisition system should not interfere with normal use of the vessel, but it's good to include navigation data.
Data Acquisition Systems (DAS) and accurate sensors are relatively expensive, so present costs are assumable for large ships but prohibitive for smaller ones.

- **Challenge 2: Energy management and control systems**

The integration of data collection with some settings criteria allows implementing energy management systems that help decision making. The simplest option is to measure fuel consumption and show with the relation speed-consumption specific for a vessel. A more complex system should optimize aspects as the electricity consumption (for example deciding when to connect the cooling).

- **Challenge 3: Energy audits.**

An energy audit, which requires extensive expertise and a good data acquisition, may propose solutions for each vessel. It is a necessary step to reduce energy consumption of existing vessels.
Transparent energy audits should be promoted, defining the existing “base line” in terms of energy efficiency and advising about how to improve.



Efficiency improvements could result in improved catching ability of ships, and this is not acceptable. Proper means should be identified and provided in order to certify this catching ability is not modified (speed/position data loggers, etc.)
In any case, legal aspects should be adapted to technological development, and should not be a barrier.

Topic 2. Propeller train optimization

- **Challenge 1: Propeller selection and new designs**

There are many qualified companies and technology centres in Europe dedicated to propeller design, but fishing boats are often equipped with propellers not matching correctly their needs, despite this is a critical aspect in fuel consumption control.
Interventions frequently focus on engines, but some experts consider this is probably not the best factor to influence on. However, it appears to be no awareness about the importance of a correct propeller selection, and could be really useful a sort of "propeller selection guide" summarizing the main aspects and criteria.

- **Challenge 2: Engines selection and configuration**

The correct choice of the engine is critical for fuel consumption. In particular, engines have poor performance when working under low load. A configuration to consider is the use of two different engines when two different regimes are frequently used.

- **Challenge 3: Transfer case (gear box)**

In addition to possible improvements in design and maintenance, proper selection and modification when necessary are important. In some vessels, the choice of two gear ratios could be a good option.
Despite gear boxes are not much extended (at least within Spanish fleet), recent studies suggest significant savings derived from using two gears instead of just one.

- **Challenge 4: Integrated design.**

Optimized design of the entire drive train is recommended, starting from hull data and the vessel final usage. In particular, hybrid diesel-electric propulsion should be considered.

Topic 3. Alternative fuels and complementary energies

Find alternatives to diesel oil in fishing boats.

In this topic the principal aims are to analyse and assess, through feasibility and techno-economic studies, the potential use of other fuels, and/or alternative energy for fishing vessels.

Main fuels to consider are: LNG, CNG, LPG, hydrogen, biofuels, and syngas.

Main alternative energies to consider, usually as auxiliary energy, are: wind turbines, sails and solar PV.

It is necessary to study the economic and energetic feasibility in order to obtain complete information and offering energy-efficient solutions to the energy consumption of the fishing vessels.

- **Challenge 1: Alternative fuels, as:**

- Natural gas, liquid or compressed
- Biofuel
- Hydrogen
- LPG
- Syngas

- **Challenge 2: Renewable energies, as:**

- Solar
- Wind turbines
- Sails
- Waves

Energy harvesting from waves is a technology in a too early stage to be useful for fishing purposes.

Topic 4. Modifications in the vessels, and new design approaches

The main objective in this topic is to study the vessels shape, and to recommend possible changes, in order to obtain a boat design that minimizes energy consumption, without forgetting stability, safety and functionality for each application.

- **Challenge 1: Shapes and sizes configuration**

Design technologies must optimize energy consumption. Computer simulation methods and testing of models can be improved, but especially should be more widely used in fishing boats.
Merchant sector has implemented an energy efficiency index system for boats to fulfil; this is not the case in fisheries sector.

- **Challenge 2: Use of low friction painting. Maintenance**

Maintenance of the ship painting in contact with water can help reducing friction and therefore reducing fuel consumption.

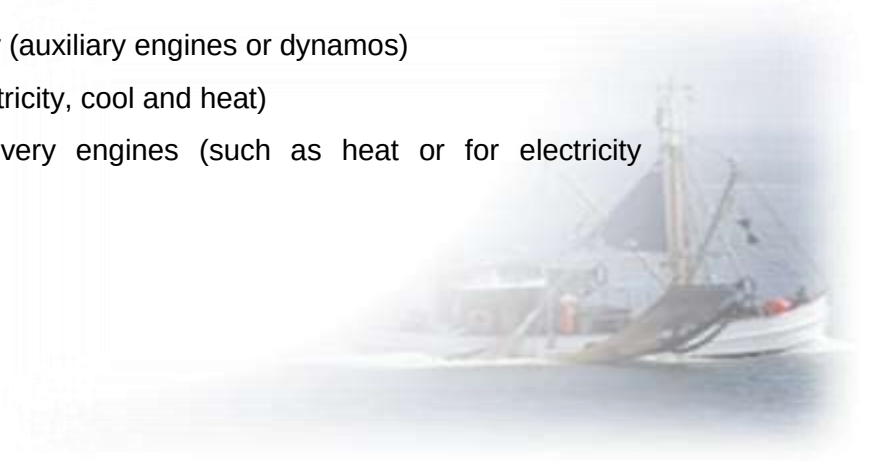
- **Challenge 3: Hydrodynamic modifications: bulbs**

The design of bulbs may be an option on ships already constructed, but changing hull configuration could be the most expensive action, and current regulation is a barrier.
In any case, correct data acquisition would be crucial in order to suggest and assess hull modifications.

Topic 5. Energy for uses other than propulsion

In this topic is included:

- the generation of electricity (auxiliary engines or dynamos)
- consumer equipment (electricity, cool and heat)
- the residual energy recovery engines (such as heat or for electricity generation)



- **Challenge 1: Auxiliary engines**

Improvements in electricity consumption management would allow using engines of lower power, at higher load. This greatly reduces consumption.
Generating electricity with a part of the propulsion engine reduces consumption as well.

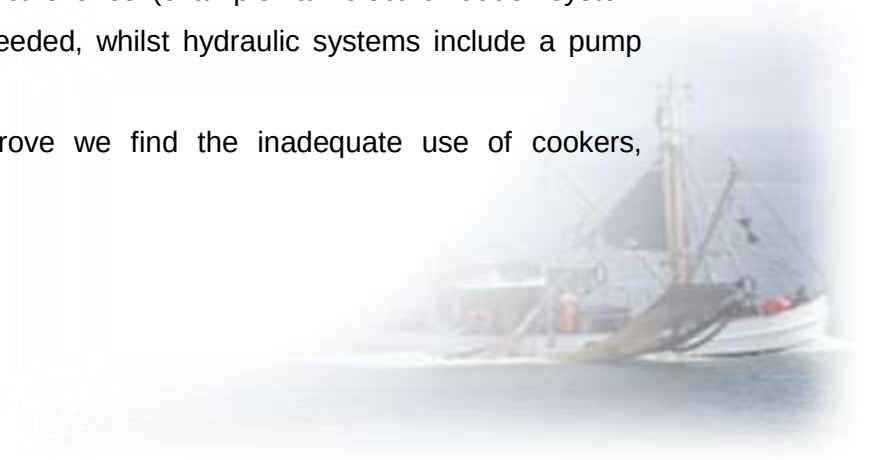
- **Challenge 2: Heat recovery**

The residual heat from the propulsion engines contains more than 60% of the energy of the fuel. This energy is in the exhaust gases, and in the water used for cooling the engines. Some of this energy can be recovered for:

- Heating, if necessary.
- Cooling the refrigeration room. Absorption machines are not suitable for the movement of the vessel, but adsorption systems had an interesting potential.
- ORC machines can generate electricity from surplus heat. Even with hot water used to cool the engine, it is possible recover more than 6% into electricity.
- Desalination of sea water to obtain potable water through evaporation. This would get a big energy savings by eliminating the demand for the traditional purification system through reverse osmosis.

- **Challenge 3: Electricity on board consumers**

The use of electric consumers (such as kitchens, heating and/or cooling systems, desalination systems, lights, deck machinery (hydraulic, electric), pumps, etc.) must be minimised and correctly regulated.
It is recommended to explore possible advantages derived from converting hydraulic actuators, or other systems, into electric ones (example: an electric rudder system works just when the movement is needed, whilst hydraulic systems include a pump working 24 hours a day).
As an example of aspects to improve we find the inadequate use of cookers, permanently switched on for coffee.



Topic 6. Energy efficiency during fishing operation

It is also possible to reduce an important amount of energy at the moment of the fishing operation. There are two main ways of doing this: through applying the innovative and appropriate fishing gears or through the execution of an optimized fishing operation.

- **Challenge 1: Fishing Gears**

Different gears which allow saving energy are already developed, although it is possible to implement new technologies and optimizations of the old ones. They are divided into active gears (trawls and nets), mobile gears (trawl doors) or passive gears. It is also possible to use fishing gears simulations and monitoring of fishing gears, guided by sensors on hook lines.

These technologies already exist but not on the market yet, because there is no request for them. In addition they should be improved and more specific ones should be developed.

Research is the most necessary activity to be done in this challenge, besides innovation, demonstrations and market developments are also important.

Its scope is focused on a European Union level and it is an important issue that the key driver should be the regulation of this new technologies.

Experts assure that this is a really high priority challenge which should be improved in less than five years. They also mention that instrumentation is fundamental, and that it is an error that some of these technologies are considered as an increasing-catch machine, as the eco-sonda, normal sonda and sonar.

- **Challenge 2: Fishing operation**

Fishing operation refers to saving energy through adapting the way of fishing. There are some core technologies already developed on fishing operation, based on discrimination tools, as acoustical and visual ones. These technologies are not yet in the market, but acoustic tools are more developed than visual tools at a research level.

Research is the most necessary activity to be done in this challenge (on a 40%), besides innovation, demonstrations and market developments are also important (20% each).

It is supposed to be developed at an EU level, using regulation and technology as its key drivers. This challenge is less primordial than fishing gears, and should be achieved in a medium horizon (approximately 10 years) as experts considered.

Topic 7. Efficient steering and navigation

The main objective of this topic is to achieve lower fuel consumption by introducing variations on the way of storing, way of processing and of transporting fishes. Besides, routes optimization represents an interesting option. It is necessary to study the economic cost of implementing the different proposed models to assess their actual implementation capacity.

- **Challenge 1: Optimization of routes**

Talking about optimization of routes, there are some oceanographic and meteorological algorithm developments, which some of them are in the market but not really developed or adjusted to specific needs.
Necessary activities to be done on this challenge are research on a 80% and innovation on a 20%, but on an international scope and with technology and market as key drivers. This challenge should have a medium priority and should be developed on a short or medium horizon, between 5 and 10 years.

- **Challenge 2: Fishing effort control by area instead of time.**

This was a proposed challenge for this topic which should be developed specifically on the Mediterranean region.
Core technologies involved are remote data acquisition and management, some of which are on the market and maybe have some problems to be available because of its regulation. Research on a 50% and demonstration on another 50% are the necessary activities for this challenge which should have the regulation as a key driver. It is necessary to develop it in a high priority and in a short horizon (less than 5 years).

Topic 8: Other aspects related with energy efficiency in fishing activity:

- **Challenge 1: Fishing vessel energy consumption at port facilities.**

It is frequent keep running a high power auxiliary engine to supply small consumption in a port. This represents great fuel consumption, plus an inadequate environmental impact. Alternative systems should be considered.
Implementing renewable electricity supply onboard is difficult; nevertheless, implementing it at ports could be relatively easy.

- **Challenge 2: Gas emissions reduction (CO2, NOx…).**

Considering all the elements involved in the fisheries activity, reduction in energy use is linked to a decrease in the emission of harmful gases to the environment. Therefore reducing energy consumption would contribute to environmental improvement.

- **Challenge 3: Social and economic effects of increases in fuel costs.**

Fluctuations in the energy price imported by the European Union causes instability in fisheries management and therefore presents a risk for the stability of employment and the economy involved. Reducing energy consumption will reduce it significance in operating costs, thereby reducing the social and economic risks.

- **Challenge 4: Market approach**

In the fisheries sector, further than improving research and development, it is really necessary facilitate the actual incorporation of the technology to the market. This is quite complicated due to the sector is composed by small companies or individual fishermen.

- **Challenge 5: Regulatory aspects (gas, propeller, engine...)**

Regulatory aspects discourage the change to new fuels, at least in the Spanish and Italian context. In Norway, however, natural gas is already allowed as ship fuel.
It is necessary that competent authorities get involved in the research and development carried out. This would facilitate developing adapted regulation at an early stage, facilitating the implementation of this technology.

SUMMARY OF EFTP PRIORITIES ON ENERGY EFFICIENCY

Core technologies	Background	Necessary activities				Scope	Key drivers	Priority	Horizon
	Available technologies	% Research	% Demonstr.	% Innov.	% Market development	National, EU Level, EU Regions, International	Market / Technology / Regulation	1 – 5 5 = Highest priority	Short, Medium, Long
Topic 1. Data acquisition and control systems. Energy audits									
Challenge 1: Tools for energy data acquisition									
Sensors, DAS	Not enough. Expensive.	70	15	10	5	EU level	Technology	4	Short - Medium
Challenge 2: Energy management and control systems									
Integrated Control Systems	Under development	40	40	10	10	EU level	Regulation	3	Medium
Challenge 3: Energy audits.									
Procedure standardization	Ongoing in some countries	20	40	25	15	International	Regulation	4	Short - Medium
Topic 2. Propeller train optimization									
Challenge 1: Propeller selection and new designs									
Propeller	Very good but not applied	10	20	30	40	EU level	Market	5	Short
Challenge 2: Engines selection and configuration									
Engine selection software / design methodology	Poor	30	20	20	30	EU level	Market	4	Short - Medium
Challenge 3: Transfer case (gear box)									
Adapted to the use	Very good but not applied	10	30	30	30	EU level	Market	3	Medium
Challenge 4: Integrated design.									
	Very good but not applied	10	30	30	30	EU level	Market	4	Short - Medium

Core technologies	Background	Necessary activities				Scope	Key drivers	Priority	Horizon
	Available technologies	% Research	% Demonstr.	% Innov.	% Market development	National, EU Level, EU Regions, International	Market / Technology / Regulation	1 – 5 5 = Highest priority	Short, Medium, Long
Topic 3. Alternative fuels and complementary energies									
Challenge 1: Alternative fuels									
New fuels	Depending on fuel	30	30	20	20	EU + International	Technology + regulation	5	Short
Challenge 2: Renewable energies									
Solar and wind	Expensive yet	10	30	30	30	EU level	Technology + regulation	4	Short
Topic 4. Modifications in the vessels, and new design approaches									
Challenge 1: Shapes and sizes configuration									
Simulation methods	Very good but not applied	10	20	20	50	EU level	Market	4	Short - Medium
Challenge 2: Use of low friction painting. Maintenance									
		10	20	20	50	EU Regions	Market + regulation	4	Short
Challenge 3: Hydrodynamic modifications: bulbs									
Design. Shipyard	Expensive	30	30	25	15	EU level	Market	4	Short
Topic 5. Energy for uses other than propulsion									
Challenge 1: Auxiliary engines									
To increase the % of power used	Yes	5	15	30	50	EU level	Technology + Market	5	Short
Challenge 2: Heat recovery									
ORC, desalination by evaporation		30	30	25	15	EU level + international	Technology	5	Short
Challenge 3: Electric on board consumers (Kitchens, Air heating and/or cooling systems, Desalination Systems, Lights, Deck machinery (hydraulic, electric), Pumps…									
	Not used	15	5	30	50	EU level + regions	Market	5	Short

Core technologies	Background	Necessary activities				Scope	Key drivers	Priority	Horizon
	Available technologies	% Research	% Demonstr.	% Innov.	% Market development	National, EU Level, EU Regions, International	Market / Technology / Regulation	1 – 5 5 = Highest priority	Short, Medium, Long
Topic 6. Energy-efficient during fishing operation									
Challenge 1: Fishing gears									
Active, mobile and passive gears. Fishing gears simulations and monitoring. Sensors on hook lines.	They have to be improved and more specific to be on the market	40	20	20	20	EU Level	Research	5	Short
Challenge 2: Fishing operation									
Discrimination tools (acoustic and visual)	Not in the market but acoustic are more developed than visual	40	20	20	20	EU Level	Research and Technology	2	Medium
Topic 7. Efficient steering and navigation									
Challenge 1: Optimization of routes									
Oceanography and meteorological algorithm development	Some of them are in the market but they are not really developed	80	0	20	0	International	Technology and Market	3	Short - Medium
Challenge 2: Fishing effort control by area instead of time									
Remote data acquisition and management	They are not in the market yet because of regulation	50	50	0	0	EU Region (Mediterranean)	Research	5	Short

Core technologies	Background	Necessary activities				Scope	Key drivers	Priority	Horizon
	Available technologies	% Research	% Demonstr.	% Innov.	% Market development	National, EU Level, EU Regions, International	Market / Technology / Regulation	1 – 5 5 = Highest priority	Short, Medium, Long
Topic 8: Other aspects related with energy efficiency in fishing activity									
Challenge 1: Fishing vessel energy consumption at port facilities									
Reduce emissions	Solar and wind engines	40	30	15	15	EU level	Technology + market	5	Short - Medium
Challenge 2: Gas emissions reduction (CO2, NOx…)									
Engines and global reduction in energy consume		30	30	20	20	EU level + international	Technology + market	5	Short - Medium
Challenge 3: Social and economic effects of increases in fuel costs									
		10	10	10	70	International	Market	4	Short - Medium
Challenge 4: Market approach									
		5	5	5	85	EU level	Market	5	Short
Challenge 5: Regulatory aspects (gas, propeller, engine...)									
		5	40	20	35	Eu level	Regulation	5	Short

4. LIST OF PARTICIPANTS

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