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Energy Saving in Fisheries – EU project ESIF

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***Abstract*— Project "Energy Saving in Fisheries" (ESIF) aimed at investigating potential technical and operational methods to address the need to reduce energy consumption and associated costs in European fisheries. Participants came from: Denmark, Netherlands, Belgium, France, United Kingdom, Ireland and Italy. The team consisted of biologists, fishing gear technologists, naval architects, and economists. The project consisted of an inventory of potential technical solutions and ongoing projects, followed by economic data collection and appraisal of the identified solutions under various scenarios of fuel price. A large number of technical and operational measures were studied, among which: redesigned fishing gears including all their components to reduce drag (e.g. light material warps, more efficient otterboards, reduction in netting twine area, use of thinner twines, use of T90 meshes, hydro-dynamically shaped beams in beam trawls), changing from twin to single rigs, converting from trawling to seining or from beam trawls to outrigger trawls, applying alternative stimulation of fish in gears to become susceptible to capture (electric pulses of manipulation of the water flow inside the net) to replace heavy bottom chafing material, optimizing propeller design (e.g. using a propeller nozzle, enlarging propeller diameter where possible), improving hull shape, adding a bulbous bow if not fitted, but also of operational nature such as: use of fuel meters, reducing steaming and towing speeds, maintaining engines properly, and cleaning hulls more frequently. For some of these quite substantial reductions in energy consumptions were found. However, at the current high fuel prices most adaptations did not result in net gains.**

Keywords-component; fisheries; energy saving; economy

I. INTRODUCTION

With the recent sharp rise in fuel costs energy consumption in fisheries became an issue after having been forgotten since 1985 when fuel prices dropped, after the energy crises of 1973 and 1979. Apart from shortage in resources climate change has emerged as a major problem to address, and emissions of greenhouse gases are strongly linked with the use of fossil fuels. Thus there is an economic and environmental drive to cut fuel consumption. In fisheries problems arose for those sectors operating high fuel intensive gears, such as beam and otter trawls. A European study was carried out in 2007-2008 in which the technical and economic evaluation of new technologies and operational adaptations was investigated for major gear types in a variety of European fishing fleets "(Van Marlen et al., 2008)". This paper deals explains the outline and major conclusions of this study.

II. METHODS

The study started with an inventory of potential technical solutions and ongoing projects in the participating nations. Examples are described of current research projects on reducing the drag of towed fishing gears, potential changes in gear design, components and fish stimulation, as well as replacement by alternative gear types, including static gears.

Collection of new data and information on detailed breakdown of energy consumption has been carried out by new fuel measurement devices on board commercial vessels in some of the nations involved, e.g. in Italy. The collection of data included the measurement of energy consumption during vessel operations in different working conditions (sailing to and from the fishing ground, fishing operations or fish processing).

A s-called 'integrated energy systems' (in Dutch GES) model was adapted for fishing vessels and data collected for input from a total of 10 reference vessels cases in the participating nations. A total of 65 technical and operational adaptations were selected for these vessels and analysed using this model. These technical and operational adaptations featured: redesigned fishing gears including all their components to reduce drag (e.g. light material warps, more

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efficient otterboards, reduction in netting twine area, use of thinner twines, use of T90 meshes, hydro-dynamically shaped beams in beam trawls), changing from twin to single rigs, converting from trawling to seining or from beam trawls to outrigger trawls, applying alternative stimulation of fish in gears to become susceptible to capture (electric pulses of manipulation of the water flow inside the net) to replace heavy bottom chafing material, optimising propeller design (e.g. using a propeller nozzle, enlarging propeller diameter where possible), improving hull shape, adding a bulbous bow if not fitted, but also of operational nature such as: use of fuel meters, reducing steaming and towing speeds, maintaining engines properly, cleaning hulls more frequently.

The percentage change in energy consumption found, estimates of additional investments needed, and effects on catches and earnings were derived as inputs for an economic evaluation.

TABLE I. OVERVIEW OF REFERENCE VESSEL CASES STUDIED IN THE ESIF-PROJECT

Country	FR	NL	BE	IT	UK	IRL
# vessels	1	1	1	2	2	3
# cases	3	8	6	9	11	28

Then the economic performance of a number of selected fleet segments was analysed. For the economic evaluation, the role of fuel use and costs is presented for the participating European member states in this project for a number of relevant fleet segments, using active as well as passive gears. The following aspects were taken into account: the role of energy for individual fleet segments, break-even analysis, factors determining energy efficiency, economic potential for technological improvement, scenarios for future fuel prices, as well as the economic consequences of technical adaptations.

III. RESULTS

The results can be read of the tables below, in spite of potentially considerable savings in fuel consumption, in many cases economic losses can not be eliminated.

TABLE II. SUMMARY OF ENERGY EFFICIENCY AND ROLE OF POTENTIAL SAVINGS

MS / gear	**Length (m)**	**Fuel price (€/tonne)**			**Range of potential savings (%)**	**Break-even fuel price at estimated investment (€/tonne)**
		2004-6	**Break-even 2004-6**	**2008**		
Belgium						
Beam trawl	12-24	407	333	650	n/a	n/a
Beam trawl	24-40	407	271	650	5-50%	125-300
Denmark						
Gillnet	<12	450	0	711	n/a	
Demersal trawl	12-24	409	0	646	5-30%	
Demersal trawl	24-40	388	129	613	5-30%	124-162
France						
Passive gears	<12	310	2816	547	n/a	n/a
Demersal trawl	12-24	310	437	547	15%	489
Ireland						
All inshore		362	514	594		
Demersal trawl	12-24	362	202	594	8-21%	219-256
Demersal trawl	24-40	362	476	594	5-20%	498-595
Pelagic trawl	>40	362	291	594		
Pelagic trawl	24-40	362	1584	594	5-25%	1760-2120
Italy						
Bottom trawl	24-40	478	273	739	8.5%	515
Pelagic trawl	24-40	417	1444	739		
Beam trawl	12-24	446	415	739		
Passive gears	<12	481	2500	739		
Netherlands						
Beam trawl	12-24	344	119	695	n/a	
Beam trawl	24-40	338	263	683	7-40%	0-327
Beam trawl	>40	337	292	680	n/a	
United K.						
Beam trawl	24-40	372	331	650		
Demersal trawl/seine	12-24	372	240	650	5-15%	205-256
Demersal trawl/seine	24-40	372	398	650	10%	442
Demersal trawl/seine	>40	372	105	650	n/a	
Pelagic trawl	>40	443	3896	650	n/a	

TABLE III. EVALUATION OF THE PERFORMANCE AT 2004-6 AND 2008 FUEL PRICE

State	**Gear**	**Length (m)**	**Break-even Fuel price / price 2004-6**	**Perform-ance 2004-6**	**Break-even fuel price / price 2008**	**Perform-ance 2008**
DK	Gillnet	<12	0.00	Loss	0.00	Loss
DK	Demersal trawl	12-24	0.00	Loss	0.00	Loss
UK	Demersal trawl seine	>40	0.28	Loss	0.16	Loss
DK	Demersal trawl	24-40	0.33	Loss	0.21	Loss

State	Gear	Length (m)	Break-even Fuel price / price 2004-6	Perform-ance 2004-6	Break-even fuel price / price 2008	Perform-ance 2008
NL	Beam trawl	12-24	0.35	Loss	0.17	Loss
IE	Demersal trawl	12-24	0.56	Loss	0.34	Loss
IT	Bottom trawl	24-40	0.57	Loss	0.37	Loss
UK	Demersal trawl seine	12-24	0.65	Loss	0.37	Loss
BE	Beam trawl	24-40	0.67	Loss	0.42	Loss
NL	Beam trawl	24-40	0.78	Loss	0.39	Loss
IE	Pelagic trawl	>40	0.80	Loss	0.49	Loss
BE	Beam trawl	12-24	0.82	Loss	0.51	Loss
NL	Beam trawl	>40	0.87	Loss	0.43	Loss
UK	Beam trawl	24-40	0.89	Loss	0.51	Loss
IT	Beam trawl	12-24	0.93	B-E	0.56	Loss
UK	Demersal trawl seine	24-40	1.07	B-E	0.61	Loss
IE	Demersal trawl	24-40	1.31	Profit	0.80	Loss
FR	Demersal trawl	12-24	1.41	Profit	0.80	Loss
IE	All inshore		1.42	Profit	0.87	Loss
IT	Pelagic trawl	24-40	3.46	Profit	1.95	Profit
IE	Pelagic trawl	24-40	4.38	Profit	2.67	Profit
IT	Passive gears	<12	5.20	Profit	3.38	Profit
UK	Pelagic trawl	>40	8.79	Profit	5.99	Profit
FR	Passive gears	<12	9.08	Profit	5.15	Profit

Note: Loss / profit is assumed at ± 10% of the break-even price from the real fuel price. Break-even is within this range.

TABLE IV. IMPACT OF TECHNOLOGICAL IMPROVEMENTS IN THE MOST OPTIMISTIC SCENARIO

State	Gear	Length (m)	Perfor mance 2004-6	Perfor mance 2008	Highest break-even fuel price (€/tonne)	Performance at best technological improvement
DK	Demersal trawl	12-24	Loss	Loss	0	Losses remain for 2004-6
DK	Demersal trawl	24-40	Loss	Loss	162	Losses remain for 2004-6
UK	Demersal trawl	12-24	Loss	Loss	256	Losses remain for 2004-6
IE	Demersal trawl	12-24	Loss	Loss	256	Losses remain for 2004-6
BE	Beam trawl	24-40	Loss	Loss	300	Losses remain for 2004-6
NL	Beam trawl	24-40	Loss	Loss	327	Break-even in 2004-6, loss in 2008
Italy	Bottom trawl	24-40	Loss	Loss	515	Break-even in 2004-6, loss in 2008
UK	Demersal trawl	24-40	Break-even	Loss	442	Profit in 2004-6, loss in 2008
FR	Demersal trawl	12-24	Profit	Loss	489	Profit in 2004-6, Break-even in 2008
IE	Demersal trawl	24-40	Profit	Loss	595	Profit in 2004-6, Break-even in 2008
IE	Pelagic trawl	24-40	Profit	Profit	2120	Overall profit, even without adaptations

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

If is assumed that 2004-6 break-even price within ±10% of the realized price would mean that the segment was operating at approximately break-even level, than 14 out of 24 segments were operating at a loss, while 8 were making profit. The level of performance does not seem to be related to gear type or vessel length.

The situation in 2004-6 shows that there was need for improvement of performance among many different types of vessels and gears, many of them requiring an energy efficiency improvement by at least 25-50%.

The increase of fuel price in the first 8 months of 2008 has produced further deterioration of economic performance. It is estimated that 19 out of the 24 segments were making (significant) losses under those conditions. For many of those segments, an energy improvement by at least 50% would be required to allow them to deal with the extremely high fuel price.

The extent of possible improvements of the energy efficiency by technological and/or operational improvements ranged between 5% and 50%.

In case of five segments (demersal trawlers 12-24m in Denmark, UK and IE, 24-40m in Denmark and beam trawlers in Belgium) the proposed technical adaptations are not even sufficient to eliminate the losses which these segments faced in 2004-6, not to speak of the much higher fuel price in 2008.

For two segments (Dutch beam trawlers 24-40m and Italian bottom trawlers 24-40m) the technical improvements could be introduced to eliminate the losses of 2004-6. However, these improvements are still not sufficient to off-set the high fuel price of 2008.

Finally, three segments of demersal trawlers (UK 24-40m, Italy 24-40m and France 12-24m) could improve their performance and reach approximately break-even level under the 2008 conditions. These segments showed already quite good performance in 2004-6.

The Irish pelagic trawlers 24-40m are very profitable, even under the 2008 conditions, so that the need for further technological improvement is not essential for their survival.

Ranking technological and/or operational improvements in terms of energy savings is barely possible on the basis of this study, if at all. A large overlap was found when ranking was tried according to criteria such as: litres of fuel/kg-fish, fuel costs as % of income, or litres/kW-day.

B. Recommendations

The techno-economic analysis shows that for many fleets, which are highly fuel dependent, improvement of economic performance can be only achieved by a mix of technical and operational adaptations aimed at reduction of fuel intensity and adaptations aimed at increasing earnings from catches (Catch Per Unit of Effort, CPUE). The latter adaptations imply evidently that the length of the fleets would have to be reduced proportionately so that the effective pressure of stocks does not increase.

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