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Comparative Financial Analysis of marine multi-purpose platforms projects: MERMAID and TROPOS projects

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Chapter 3

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Abstract

The Oceans of Tomorrow (FP7-OCEAN) initiative aimed to foster multidisciplinary approaches between different economic and scientific sectors and disciplines, maintaining a common focus on marine and maritime challenges. Under this umbrella, three projects were developed focusing on the development of multi-use offshore platforms: H2Ocean, TROPOS and MERMAID. The development of all these three projects included the design of different concepts in terms of study cases and application of the main findings of the projects. The financial aspect of these design concepts was carried out in all projects, but the assumptions made to perform this analysis were quite different among the projects. Although none of the Oceans of Tomorrow projects had the objective to produce a viable proposal from the economic point of view, it is necessary to analyse the possibilities of the concepts developed. A common methodology and parameters need to be used in order to achieve a constancy and homogeneity that allows comparing the results. This chapter[5] defines a common financial framework that permits to obtain comparable results of the financial performance of the different design concepts proposed in the Oceans of Tomorrow projects.

Key words: H2Ocean, TROPOS, MERMAID, financial framework, multi-use offshore platform

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3.1 Introduction

This chapter presents the results of a comparative financial analysis performed to the three Oceans of Tomorrow projects. Each one of the projects has generated different deliverables where the economic data are reviewed. However, the direct comparative of these outputs presented in project's deliverables, shows diverse weakness. Firstly, different financial indicators were obtained. Secondly, different initial conditions were used. Thirdly, different parameters were used in the analysis. These three problems combined result in the final output not being comparable as it is.

To address this issue and to allow for a clear comparative analysis of the results from the projects, some further actions need to be taken. The methodology, presented in section 2.2, includes two main steps. At a first stage, a normalisation of project's data is performed. This normalisation transforms the main financial outflows and inflows in a relative value using the production size of each project as a normalising parameter. These values are then compared to main figures obtained in the scientific literature and other economic information. This step should help to assess if the cost and revenues structure of each project are included in common range of variation. These results are presented in Section 2.3.

The second stage involves the calculation of a profitability indicator, in this case, the Net Present Value. This calculation is performed with standard and homogeneous parameters (such as horizon time, discount rate, and construction years) for all different projects. The use of these common boundary conditions makes possible to compare the results of the projects under the same framework. This analysis is detailed in Section 2.4. Beyond the data used in the financial analysis, the possibility exists for variability on the values used in the analysis. To assess the impact of the possible variability of the inputs on the financial model, a sensitivity and a risk analysis are also performed. These two are presented in Section 2.5 and Section 2.6 respectively. Finally, some concluding remarks and caveats about the results obtained are included in Section 2.7.

3.2 Methodology

The following methodology has the objective to assess and compare the financial viability of multi-use of space and multi-use platform concepts developed on the Oceans of Tomorrow projects studied in H2Ocean, TROPOS and Mermaid.

The Methodology to apply is divided into five steps:

1. Review available information from projects' plans.
2. Homogenise available information.
3. Perform financial assessment.
4. Perform sensitivity analysis.
5. Perform risk assessment.

The main outputs of this process are obtained from steps 3, 4 and 5.

- From step 3, the Financial Net Present Value (FNPV) are obtained as an indicator of the project profitability. Also, the Financial Rate of Return (FRR) is calculated as a complementary indicator.
- From step 4, the list of the critical parameters of each project is obtained. These parameters are defined as those whose variations, be they positive or negative, have the largest impact on the project's financial performance.
- From step 5, a probabilistic distribution of the FNPV are obtained by assigning a probability distribution to each of the critical variables of the sensitivity analysis.

For the calculation of FNPV and even the sensitivity analysis, Excel is the broadest and commonly tool used. Nevertheless, for the risk assessment the employment of Monte Carlo simulations is recurrent. For this R language programming has used. Furthermore, the use of an open language makes it easy to completely reproduce an analysis (starting from the same data, we can achieve the same results), so that different researchers will obtain the same results and so that analyses can be audited (Hopper, 2016).

The five steps of the methodology are described in detail next.

3.2.1 Review available information from projects' plans.

In this first step, all available information from Ocean of Tomorrow projects is gathered so as to obtain the financial and economic data necessary for the assessment. Public deliverables and scientific publications are reviewed looking for this data. When the financial parameters of interest could not be found, or there is evidence that some necessary information is available from not public deliverables, contact with the person responsible of the project has been made asking for their cooperation and collaboration.

3.2.2 Homogenise available information

This step is necessary due to the different level of detail of information in the different projects. The available information is classified according to the maximum possible detail and it is grouped in a manner that allows performing the later assessment between projects in time. The use of homogeneous classification of costs and incomes allows to use a common methodology and to compare the obtained results for each project.

3.2.3 Financial assessment

According to the EC "Guide to Cost-Benefit Analysis (CBA) of Investment Projects" (Sartori et al., 2015), financial assessment has different objectives. These are identified as follows:

- Assess the project profitability.
- Assess the project profitability for the project owner and some key stakeholders.
- Verify the project financial sustainability.
- Outline the cash flows which underpin the calculation of the socio-economic costs and benefits.

To achieve these aims, there are different categories of cash inflows and outflows that must be considered. The most common are described in Table 3.1.

Table 3.1 Inflows and outflows proposed to be included in the financial analysis (Sartori et al., 2015).

Inflows / Outflows	Examples
Investment costs	Start-up and technical costs Land Buildings Equipment Machinery Replacement costs Residual value
Operating costs	Personnel Energy General expenditure Intermediate services Raw materials
Other outflows	Loan repayments Interests Taxes
Inflows	Revenues Operating subsidies
Sources of financing	Union assistance Public contribution Private equity Private loan

The analysis that the cited guide proposes is based in the use of the Discounted Cash Flow method. This methodology assumes several points:

- Only cash inflows and outflows are considered in the analysis, i.e. depreciation, reserves, price and technical contingencies and other accounting items which do not correspond to actual flows are disregarded.
- Financial analysis should, as a general rule, be carried out from the point of view of the infrastructure owner. If, in the provision of a general interest service, the owner and the operator are not the same entity, a consolidated financial analysis, which excludes the cash flows between the owner and the operator, should be carried out to assess the actual profitability of the investment, independent of the internal payments.
- An appropriate Financial Discount Rate (FDR) is adopted in order to calculate the present value of the future cash flows. The financial discount rate reflects the opportunity cost of capital from the public point of view.
- Project cash-flow forecasts should cover a period appropriate to the project's economically useful life and its likely long term impacts. The number of years for

which forecasts are provided should correspond to the project's time horizon (or reference period). The choice of time horizon affects the appraisal results.
- The financial analysis should usually be carried out in constant (real) prices, i.e. with prices fixed at a base-year.
- The analysis should be carried out net of VAT.

Project profitability and financial viability are measured by two indicators:

- The Financial net present value on investment (FNPV) is defined as the sum that results when the expected investment and operating costs of the project (discounted) are deducted from the discounted value of the expected revenues:
$$\mathrm{FNPV} = \sum_{t=0}^{n} \alpha_t S_t = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + \frac{S_2}{(1+i)^2} + \cdots + \frac{S_n}{(1+i)^n}$$
where: S_t is the balance of cash flow at time t, α_t is the financial discount factor chosen for discounting at time t and i is the financial discount rate.
- The financial rate of return on investment is defined as the discount rate that produces a zero FNPV, i.e. FRR is given by the solution of the following equation:
$$0 = \sum_{t=0}^{n} \frac{S_t}{(1+\mathrm{FRR})^t}$$
The FNPV(C) is expressed in money terms (Euro), and must be related to the scale of the project. The FRR(C) is a pure number, and is scale-invariant. Mainly, the examiner uses the FRR(C) in order to judge the future performance of the investment in comparison to other projects, or to a benchmark required rate of return.

For the purposes of this analysis, several simplifications and assumptions for the generic methodology are carried out. Homogeneous parameters, as to be able to distinguish and compare the different projects, are proposed. The same is done with the simplification of the flows to be considered.

- Only the flows described in Table 3.2 are used for the analysis. These include CAPEX, OPEX, DECEX, loan flows and revenues.

Table 3.2 Financial flows considered in the analysis

Inflows / Outflows	Concept
Investment costs	CAPEX
Operating costs	OPEX
Decommission costs	DECEX
Inflows	Revenues

- An 8.9% is adopted as uniform discount rate for all projects.
- A 4-year construction period is considered, plus 20 years for operation and 1 year for decommission.

Another relevant parameter calculated in addition to NPV and IRR is the levelised cost of production (LCoP). This can be seen as a financial assessment of the average total cost to build and operate an investment over its lifetime distributed over total output produced during the lifetime of the investment considering the discount effect of each unit contribution. The LCoP can also be understood as the minimum cost at which an output must be sold in order to break-even over the lifetime of the project.

$$\mathrm{LCoP} = \frac{\text{Sum of costs over lifetime}}{\text{Sum of outputs produced over lifetime}} = \frac{\sum_{t=1}^{n} \frac{\mathrm{CAPEX_t} + \mathrm{OPEX_t} + \mathrm{DECEX_t}}{(1+i)^t}}{\sum_{t=1}^{n} \frac{\mathrm{Output_t}}{(1+i)^t}}$$

3.3 Sensitivity analysis

Sensitivity analysis enables the identification of the 'critical' variables of the project. Such variables are those whose variations, be they positive or negative, have the largest impact on the project's financial and/or economic performance. The analysis is carried out by varying one variable at a time and determining the effect of that change on the NPV. As a guiding criterion, the recommendation is to consider 'critical' those variables for which a variation of ±1 % of the value adopted in the base case gives rise to a variation of more than 1 % in the value of the NPV (Sartori et al., 2015). The tested variables should be deterministically independent and as disaggregated as possible. Correlated variables would give rise to distortions in the results and double-counting issues.

A particularly relevant component of the sensitivity analysis is the calculation of the switching values. This is the value that the analysed variable would have to take in order for the NPV of the project to become zero, or more generally, for the outcome of the project to fall below the minimum level of acceptability. The use of switching values in sensitivity analysis allows making some judgements on the risk of the project and the opportunity of undertaking risk-preventing actions.

3.4 Risk assessment

This type of analysis assigns a probability distribution to each of the critical variables of the sensitivity analysis, defined in a precise range of values around the best estimate, used as the base case, in order to recalculate the expected values of financial and economic performance indicators. The probability distribution for each variable may be derived from different sources, such as experimental data, distributions found in the literature for similar cases or consultation with experts. Obviously, if the process of generating the distributions is unreliable, the risk assessment is unreliable as well. However, in its simplest design (e.g. triangular distribution) this step is always feasible and represents an important improvement in the understanding of the project's strengths and weaknesses as compared with the base case.

Having established the probability distributions for the critical variables, it is possible to proceed with the calculation of the probability distribution of the FRR or the NPV of the project. For this purpose, the use of the Monte Carlo method is suggested, which requires a simple computation software. The method consists on the repeated random extraction of a set of values for the critical variables, taken within the respective defined intervals, and then the calculation of the performance indices for the project (FRR or NPV) resulting from each set of the extracted values. By repeating this procedure for a large enough number of extractions, one can obtain a pre-defined convergence of the calculation as the probability distribution of the IRR or NPV.

The values obtained enable the analyst to infer significant judgments about the level of risk of the project. The result of the Monte Carlo drawings, expressed in terms of the probability distribution or cumulated probability of the IRR or the NPV in the resulting interval of values, provide more comprehensive information about the risk profile of a project. The cumulated probability curve (or a table of values) assesses the project risk, for example verifying whether the cumulative probability for a given value of NPV or IRR is higher or lower than a reference value that is considered to be critical.

3.5 Normalisation of project's flows

In this section, the information about flows in the projects (CAPEX, OPEX, DECEX and revenues) are presented in a "normalised format". This step should help to assess the flows per unit of production. This new presentation of the data is useful in the way that it allows to compare with other similar projects. This type of analysis is performed by sector. The data per sector are presented in the following subsections.

3.5.1 Aquaculture

The normalised values for the aquaculture sector have been obtained from the available data of the projects. Two designs include aquaculture activities in their proposals: TROPOS Aquaculture and Mermaid North Sea (Table 3.3).

Table 3.3 Normalised financial values for aquaculture sector.

	Parameter	**Normalised value**	**Reference**		**Common value range (ref)**
TROPOS Aquaculture					
European Seabass	Production	152.1 ton/cage year	n.a.	in-project internal data	
	Price	825 €/ton	n.a.	in-project internal data	
Meagre	Production	152.1 ton/cage year	n.a.	in-project internal data	
	Price	1 043 €/ton	n.a.	in-project internal data	
Greater Amberjack	Production	146 ton/cage year	n.a.	in-project internal data	
	Price	1 365 €/ton	n.a.	in-project internal	

				data	
Total	CAPEX	5 094.18 €/ton	n.a.	in-project internal data	1.87 – 9.41 €/kg (*)[3-6]
	OPEX	7 651.71 €/ton year	n.a.	in-project internal data	1.74 – 7.65 €/kg (*)[3-6]
MERMAID North Sea					
Mussel	Production	48 000 ton/year	n.a.	in-project internal data	
	Price	940 €/ton	n.a.	in-project internal data	
	CAPEX	145.83 – 229.17 €/ton	[7]	article data	
	OPEX	177.08 – 1 187.5 €/ton year	[8]	article data	
Seaweed	Production	80 000 ton/year	[9]	article data	
	Price	210 – 600 €/ton	[8, 10]	article data	
	CAPEX	262.50 – 5 000 €/ton	[8, 10, 11]	article data	
	OPEX	587.5 – 850 €/ton year	[8, 10, 11]	article data	

(*) Data for different species.

3.5.2 Energy

Three designs include energy production in their proposals: TROPOS Service hub, Mermaid Atlantic Ocean and Mermaid North Sea. Data are summarized in Table 3.4. In the case of offshore wind OPEX costs, it is important to note that relevant uncertainty that exists about these values, due to the few operating offshore wind parks that exist in the world. In the case of Mermaid Atlantic Ocean design, no common references for values are provided as there is no other known project that combines wind and wave (excepting those research projects, where cost structure is not clearly defined).

Table 3.4 Normalised financial values for energy sector.

	Parameter	**Normalised value**	**Reference**		**Common value range (ref)**
TROPOS Service hub					

Wind	Power Installed	500 MW	n.a.	in-project internal data	
	Production	1 796 000 MWh/year	n.a.	in-project internal data	
	Price		n.a.	in-project internal data	
	LCoE	1 252 €/kWh	n.a.	in-project internal data	100 – 190 €/MWh [12]
	CAPEX	4 173 000 €/MW	[16]	in-project internal data	1 600 000 – 4 000 000 €/MW [12-15]
	OPEX	53 351.66 €/MW/year	[16]	in-project internal data	0.035 CAPEX [15]
MERMAID Atlantic Ocean					
Wind+Wave	Power Installed	616 MW	n.a.	in-project internal data	
	Production	80 000 MWh/year	n.a.	in-project internal data	
	Price (8 first years)	150.0 €/MWh	n.a.	in-project internal data	
	Price (after 8 years)	170.0 €/MWh	n.a.	in-project internal data	
	LCoE	167.00 €/MWh	n.a.	in-project internal data	
	CAPEX (mix)	3 664 683 €/MW	n.a.	in-project internal data	
	OPEX (mix)	46 926 €/MW/year	n.a.	in-project internal data	
MERMAID North Sea					
Wind	Power Installed	600 MW	n.a.	in-project internal data	
	Production	2 600 000 MWh/year	n.a.	in-project internal	

			data	
Price (with subsidies)	170 €/MWh	n.a.	in-project internal data	
Price (without subsidies)	43 €/MWh	n.a.	in-project internal data	
LCoE		n.a.	in-project internal data	100 – 190 €/MWh [12]
CAPEX	4 666 666 €/MW	[18]	real project data	1 600 000 – 4 000 000 €/MW [12-15]
OPEX	100 000 – 2 300 000 €/MW/year	[8, 19-21]	article, report data	0.035 CAPEX [15]

3.5.3 Leisure

Only one design includes leisure activities in their proposals: TROPOS Leisure Data are summarized in

Table 3.5.

Table 3.5 Normalised financial values for leisure sector.

	Parameter	Normalised value	Reference		Common value range (ref)
TROPOS Leisure					
<u>Visitor Centre</u>	Annual visitors	69 277	n.a.	in-project internal data	
	Ticket price	12 – 25 €	n.a.	in-project internal data	
	CAPEX	3.63 €/visitor	[22-24] Other commercial reports	article, reports	
	OPEX	8.54 €/visitor year	[22-24] Other commercial reports	article, reports	
<u>Restaurant</u>	Annual meals	94 133	n.a.	in-project internal data	
	Meal price	15 – 30 €	n.a.	in-project internal data	
	CAPEX	6.11 €/meal	[22-24] Other commercial reports	article, reports	
	OPEX	17.11 €/meal year	[22-24] Other commercial reports	article, reports	
<u>Accommodation</u>	Annual stays	10 220 room nights	n.a.	in-project internal data	
	Stay rate	300 €/night	n.a.	in-project internal data	
	CAPEX	36.68 €/room night	[22-24] Other commercial reports	article, reports	
	OPEX	43.88 €/room night year	[22-24] Other commercial	article, reports	

reports

3.5.4 Container Transport

Only one design includes container transport activity. This is the TROPOS Container terminal (Table 3.6).

Table 3.6 Normalised financial values for container/transport sector.

	Parameter	Normalised value	Reference		Common value range (ref)
TROPOS Container terminal					
Container Terminal	Throughput	1 000 000 TEU/year	[25]	article	
	Transhipment	500 000 TEU/year	[25]	article	
	Price	125 €/TEU	[25]	article	
	Levelized costs				240 – 335 €/TEU [26]
	CAPEX	426.23 €/TEU	[22-24] Other commercial reports	article, reports	135 – 530 €/TEU [25-27]
	OPEX	26.07 €/TEU year	[22-24] Other commercial reports	article, reports	21.8 €/TEU year [27]

3.6 Financial analysis

In this section, as described in the Methodology section, a homogeneous financial analysis of the Ocean of Tomorrow projects is to be developed. This analysis has the objective to test financial performance for all projects under the same assumptions and hypothesis, obtaining indicators that allow comparing the results between projects and comparing them themselves.

The main hypothesis and parameters used in this analysis are:

- CAPEX, OPEX, DECEX and revenues data from previous sections
- An 8.9% is adopted as uniform discount rate for all projects.

- A four-year period for construction is considered, plus 20 years for operation and 1 year for decommission.
- Construction costs (CAPEX) are distributed in the four-year period in 10%, 20%, 40% and 30% percentage.

3.6.1 TROPOS commercial viability

In Table 3.7 the results of the financial analysis for the four TROPOS designs (Aquaculture, Leisure, Service hub and Container) are presented. In those involving different activities, detailed results are also included. Figure 3.1 provides a graphic summary of the NPV TROPOS design contexts.

Table 3.7 Results from the financial analysis of TROPOS concepts designs.

Design	CAPEX (€ million)	OPEX (€ million /year)	Revenues (€ million /year)	NPV (€ million	NPV / CAPEX	Internal Rate of Return
Aquaculture	-102.74	-43.44	48.35	-69.01	-0.6716	-0.90%
European Seabass	-34.25	-14.48	12.54	-55.84	-1.6303	-
Meagre	-34.25	-14.48	15.87	-25.27	-0.7378	-2.41%
Great Amberjack	-34.25	-14.48	19.93	12.11	0.3535	12.54%
Leisure	-40.66	-6.26	7.63	-32.57	-0.8010	-4.08%
Visitors Centre	-13.61	-2.02	1.73	-17.74	-1.3034	-
Restaurant	-13.66	-2.73	2.82	-14.30	-1.0468	-
Hotel	-13.39	-1.51	3.07	-2.02	-0.1508	8.45%
Service hub	-58.95	-36.27	20.33	-211.92	-3.5949	-
Container terminal	-462.23	-26.07	62.50	-178.28	-0.3856	4.04%

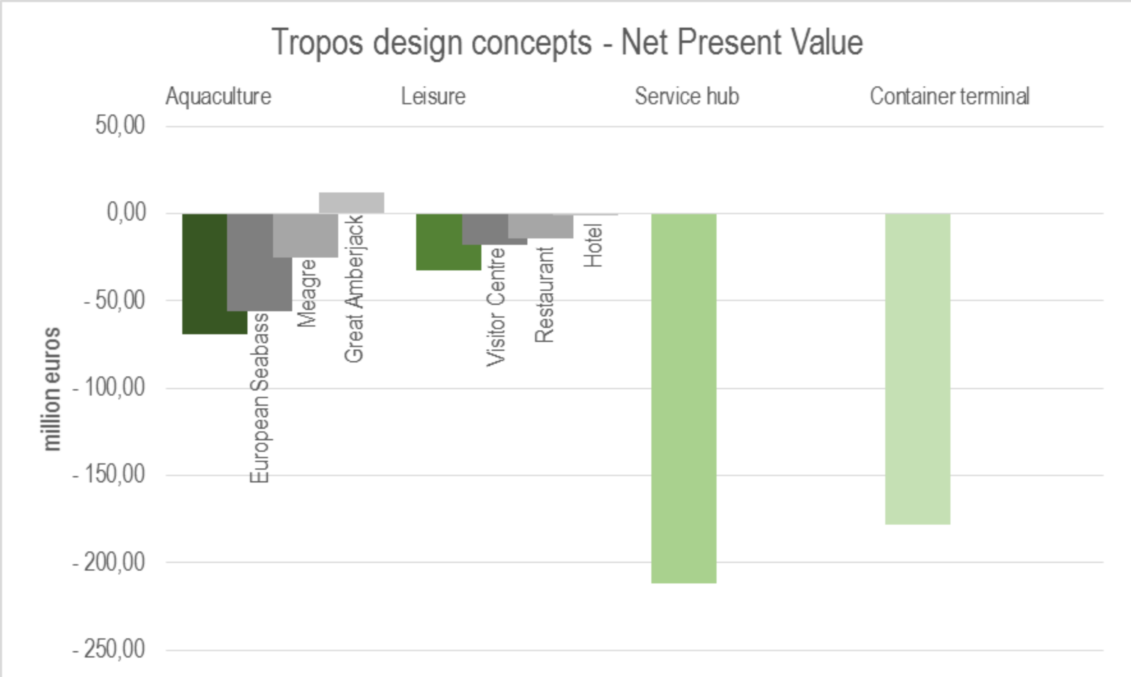


Figure 3.1. TROPOS design concepts Net Present Value comparison.

Several conclusions arise from the results obtained:

- No design offers financial viability according to their Net Present Values, which result all negative. The most promising design could be "Leisure".
- If financial conditions vary and affect the discount rate, the "Container Terminal" design could be profitable if this rate is minimised to 4%. The IRR for the rest of the designs is not reasonable.
- Although no design presents a positive NPV, the production of Greater Amberjack in the "Aquaculture" design is profitable. While negative, the accommodation module in the "Leisure" design could present easily a positive NPV.

Levelized costs of production for each sector are presented in Table 3.8.

Table 3.8 Levelised costs of production for TROPOS design concepts.

Design	unit	Production (units/year)	LCoP (€/unit)
Aquaculture			
European Seabass	ton of fish	1 521	12 240
Meagre	ton of fish	1 521	12 240
Great Amberjack	ton of fish	1 460	12 751

Leisure

Design	unit	Production (units/year)	LCoP (€/unit)
Visitor Centre	visits	69 277	52.85
Restaurant	meals	94 133	46.52
Hotel	night stays	10 220	305.69
Service hub	services	20 334 129	2.13
Container terminal	TEU	500 000	163.78

3.6.2 Mermaid commercial viability

The results of the financial analysis for the two Mermaid designs analysed (Atlantic and North Sea sites) are presented in Table 3.9. Detailed results for each sector included in the combinations are also included. Figure 3.2 illustrates the NPV estimations for the Mermaid designs.

Table 3.9 Results from the financial analysis of Mermaid concepts designs

Design	CAPEX (€ million)	OPEX (€ million /year)	Revenues (€ million /year)	NPV (€ million	NPV / CAPEX	Internal Rate of Return
Atlantic Site	-2 257.45	-53.94	148.14	-1 659.19	- 0.7349	-2.91%
Wind energy	-1 410.90	-33.71	129.75	-695.32	- 0.4928	2.24%
Wave energy	-846.54	-20.23	18.39	-963.87	-1.1385	-
North Sea Site	-3 037.84	-190.25	437.47	-1 129.63	- 0.3718	4.15%
Wind energy	-2 800.50	-100.00	359.50	-746.90	- 0.2667	5.63%
Mussels	-22.58	-32.75	45.00	87.37	3.8693	36.69%
Seaweed	-214.76	-57.50	32.50	-470.10	- 2.1889	-

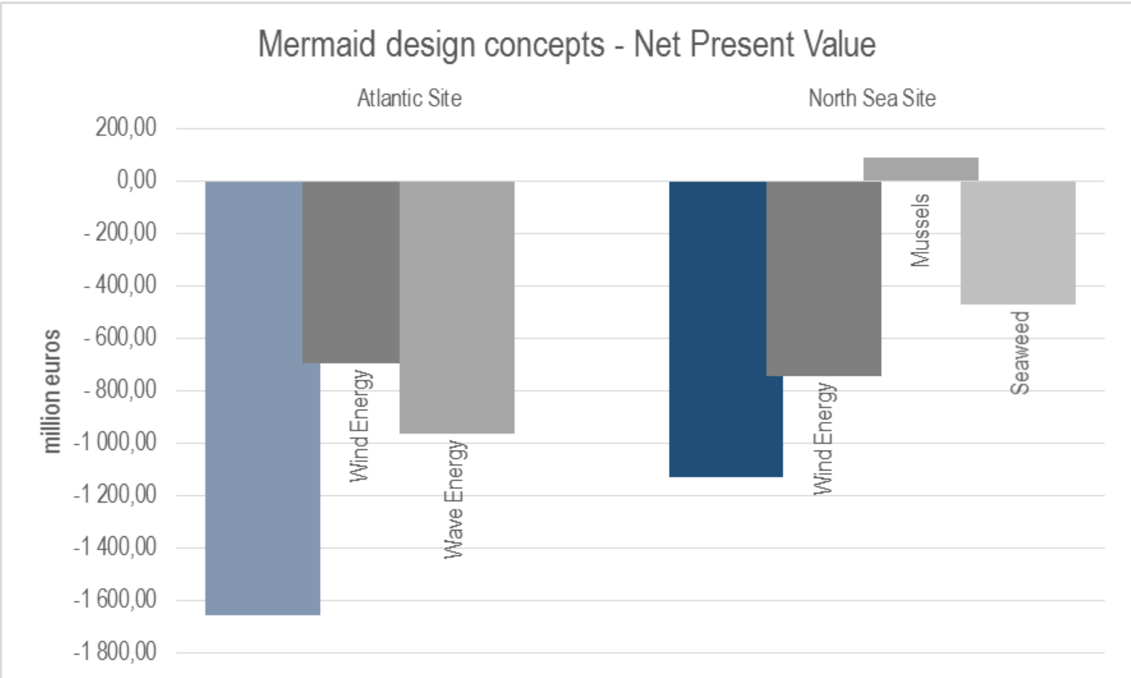


Figure 3.2. Mermaid design concepts Net Present Value comparison.

The results show that:

- None of the design concept shows financial viability according to their NPVs, as all of them result negative.
- Additionally, both designs involve important investments, so their NPVs are negative in a huge dimension, especially when compared with TROPOS designs.
- The results obtained for Mermaid design concepts include in their revenues calculation an important feed-in-tariff added to the price of electricity. When or if this subsidy

disappears, NPV results will be even more negative, In contrast, any change in policy that rises feed-in tariffs may reinforce the project profitability.

The levelised costs of production for each sector are presented in Table 3.10.

Table 3.10 Levelised costs of production for Mermaid design concepts.

Design	unit	Production (units/year)	LCoP (€/unit)
Atlantic Site			
Wind energy	MWh	776 930	264
Wave energy	MWh	110 110	1 119
North Sea Site			
Wind energy	MWh	2 600 000	169.51
Mussels	tons of mussels	48 000	739.51
Seaweed	tons of seaweed	480 000	174.23

3.6.3 H2Ocean commercial viability

For the case of H2Ocean project, a special situation was presented: project deliverables stated the impossible viability of the proposed design. Under their parameter assumptions, the final NPV of the project was 21.6 billion € negative. To allow for a consistent comparison, the results for the joint financial analysis under the proposed values of the parameters are presented here. However, due to the high negative value of the NPV obtained, no further analysis will be performed with this input, nor comparison with the rest of the Oceans of Tomorrow projects.

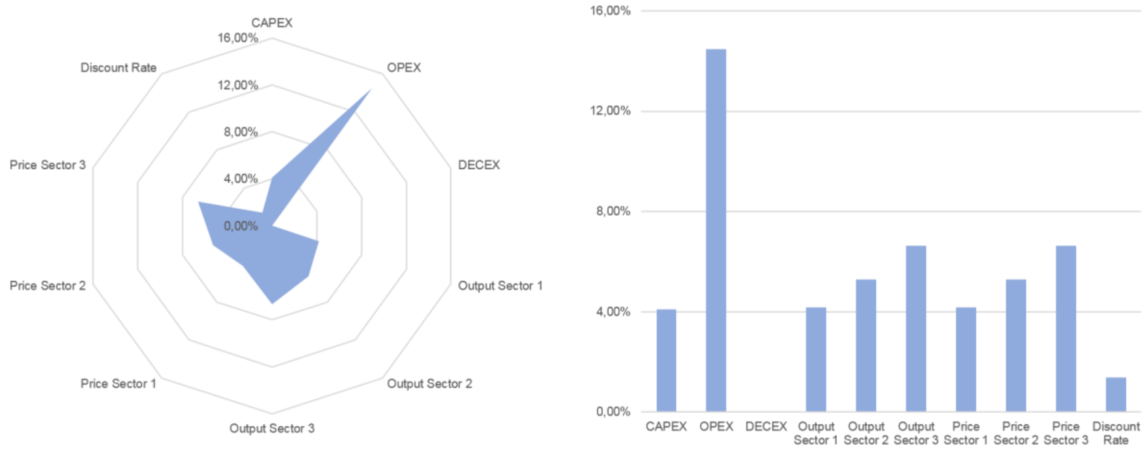
Table 3.11 Results from the financial analysis of H2Ocean concept design.

Design	CAPEX (€ million)	OPEX (€ million /year)	Revenues (€ million /year)	NPV (€ million	Internal Rate of Return
Portugal Site	-11 902.13	-455.56	89.70	-16 558.42	-
Fish	-3 685.38	-166.39	55.85	-5 103.76	-
Water	-3 328.01	-144.59	0.10	-5 022.12	-
Hydrogen / Oxygen	-4 888.74	-144.59	33.75	-6 432.55	-

3.7 Sensitivity analysis

The results of the sensitivity analysis performed in the financial model for each of the design concepts are illustrated in the following figures. The percentage showed is the variation of the NPV of the concept when the associated parameter varies by 2.5%. All parameters showing a variation higher than 2.5% should be considered critical for the financial model. The figures also permit identifying the most critical parameters of each concept.

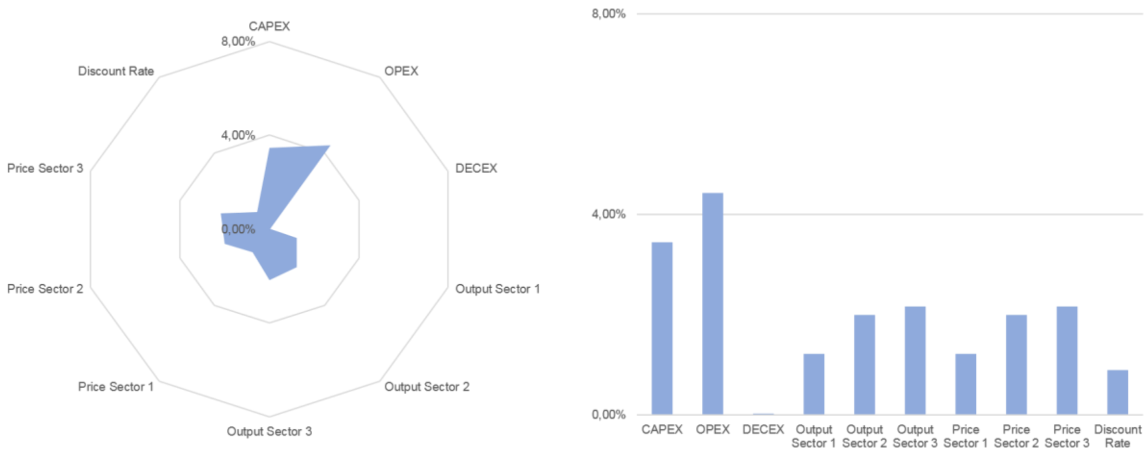
TROPOS Aquaculture



Sector 1 European Seabass
Sector 2 Meagre
Sector 3 Greater Amberjack

Figure 3.3. TROPOS Aquaculture design concept sensitivity analysis.

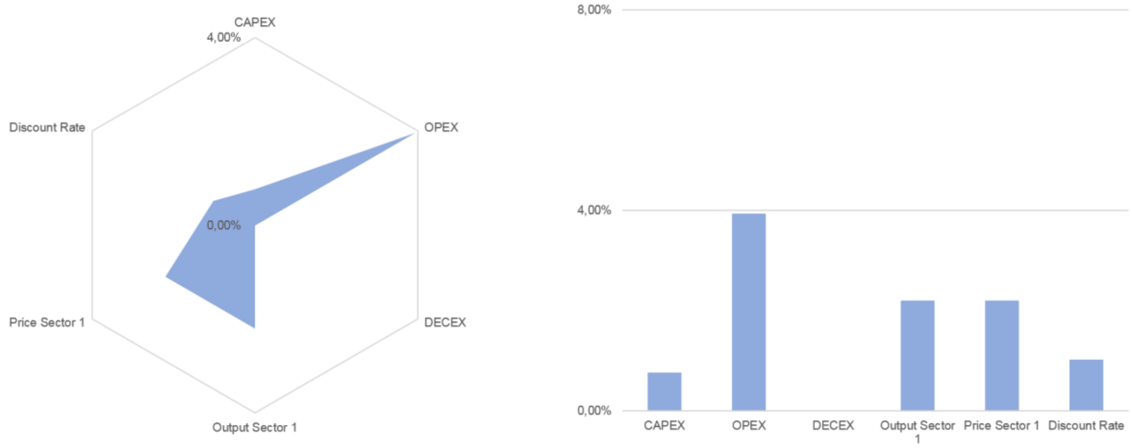
TROPOS Leisure



Sector 1 Visitor Centre
Sector 2 Restaurant
Sector 3 Hotel

Figure 3.4 TROPOS Leisure design concept sensitivity analysis.

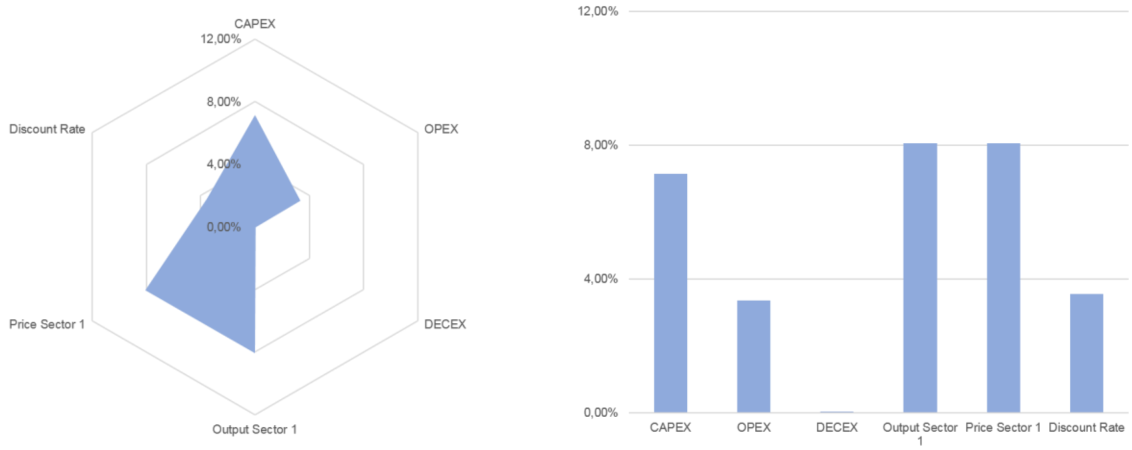
TROPOS Service Hub



Sector 1 Service / Wind Energy

Figure 3.5. TROPOS Service Hub design concept sensitivity analysis.

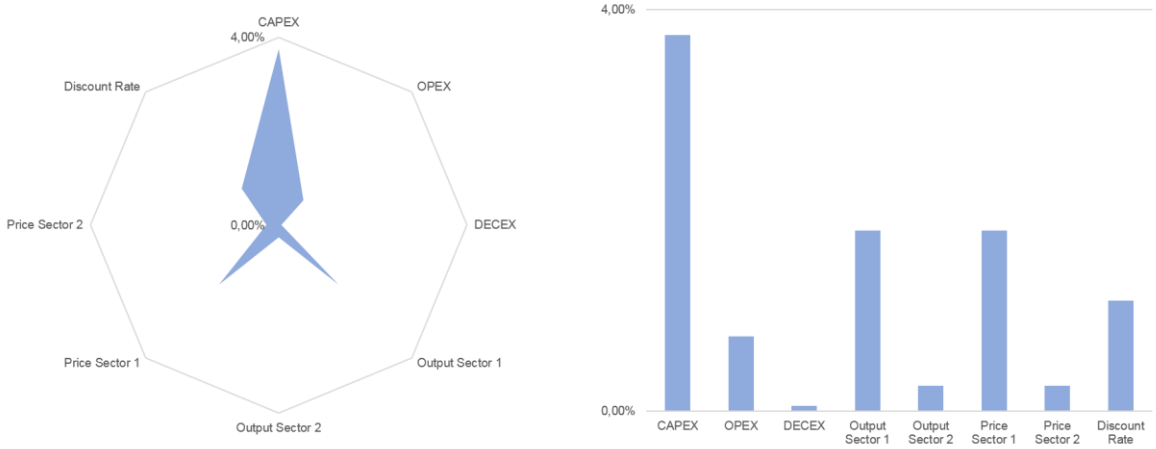
TROPOS Container



Sector 1 Container Transport

Figure 3.6. TROPOS Container design concept sensitivity analysis.

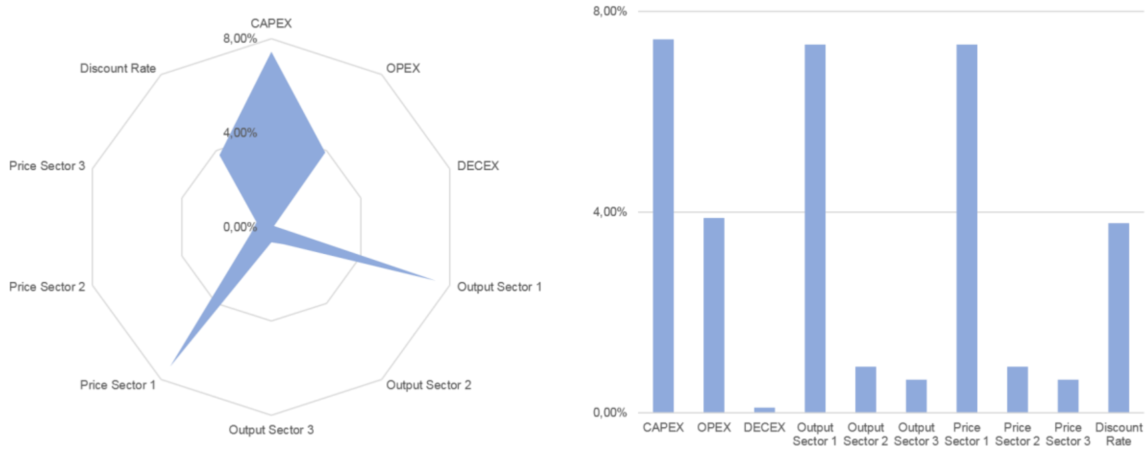
Mermaid Atlantic Site



Sector 1 Wind Energy
Sector 2 Wave Energy

Figure 3.7. Mermaid Atlantic Site design concept sensitivity analysis.

Mermaid North Sea Site



Sector 1 Wind Energy
Sector 2 Mussels
Sector 3 Seaweed

Figure 3.8. Mermaid North Sea Site design concept sensitivity analysis.

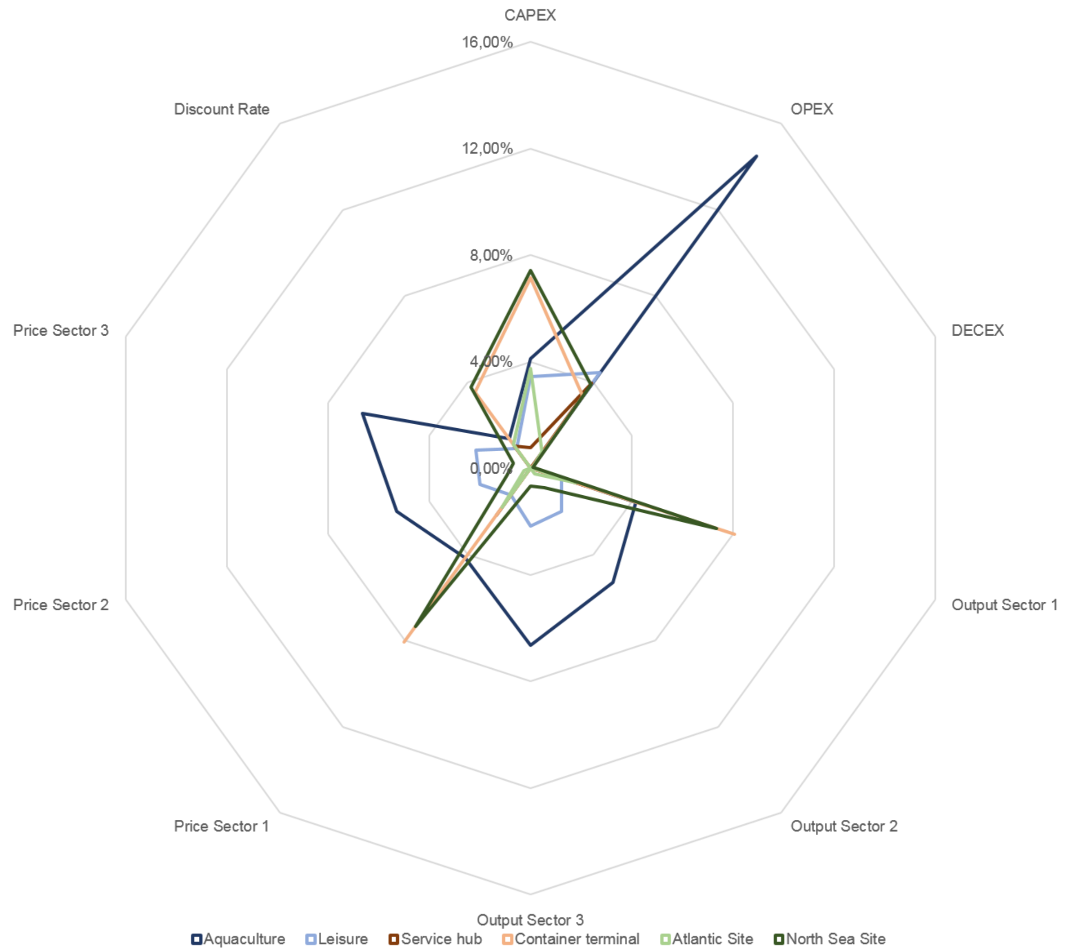


Figure 3.9. Comparative sensitivity analysis for all design concepts.

3.8 Risk assessment

In this section the results of the probabilistic risk analysis of the Oceans of Tomorrow design concepts studied in the previous sections are presented. The methodology applied follows the recommendations of the European Commission. Table 3.12 summarizes the parameters simulated and the probabilistic distributions used. Results are illustrated in Figure 3.10.

Table 3.12 Parameters simulated, and probabilistic distributions used.

Inflow / Outflow	Concept	Distribution
Outflows	Operating costs	Uniform distribution Min: 0.85 base OPEX Max: 1.15 base OPEX
Inflows	Production	Uniform distribution Min: 0.75 production Max: 1.00 production
Inflows	Prices	Uniform distribution Min: 0.85 base price Max: 1.15 base price

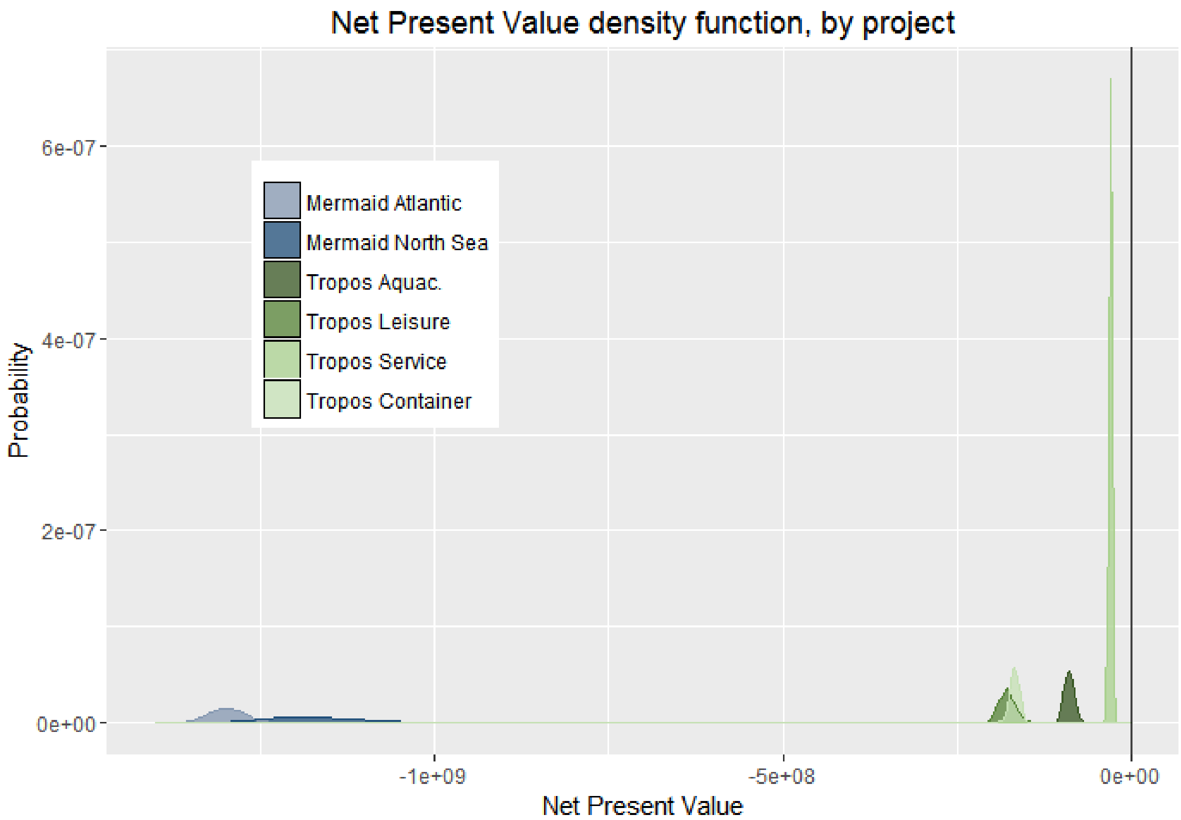


Figure 3.10. Results from risk analysis of all Ocean of Tomorrow design concepts.

Looking at the results the following points emerge as important to note:

- There is a group of concepts with a similar probabilistic distribution. These are “Aquaculture”, “Leisure” and “Container” designs from TROPOS. Although each one varies with respect to NPV values, the maximum-minimum amplitude is similar and so is its maximum probability.
- TROPOS “Service hub” presents a very sharp probabilistic distribution. This can be translated into a minimum sensitivity to the parameters analysed and means that the NPV of the design concept is quite defined.
- On the contrary, Mermaid “North Sea Site” and “Atlantic Site” probabilistic distributions are almost flat. This means that the NPV of both design concepts accept a wide range of variation, so the viability of the projects is mostly unclear (although always negative so with no financial viability).

3.9 Conclusions

The challenge represented by offshore resources for blue growth economy has been addressed with different strategies, but the results obtained up to now show that the timeline for definitive success is still large. Several reasons have been pointed as explanations such as the lack of adequate technology, required time for technology maturity and adequate knowledge of the effective conditions under which the new business will compete. One of the instruments tested through technology issues in the EU has been the possibility of accelerating expansion through the promotion of sharing resources, experience and space. This possibility has been explored through a set of European funded projects with different approaches, different maturity levels and focusing on different sectors.

This chapter has presented a transversal analysis of the outputs generated through different projects, trying to clarify the comparison among the existing alternatives, testing them from a standard economic and financial point of view. The results based on the comparison of different projects summarized in this chapter show a homogeneous ranking on the viability of the different alternatives and their business possibilities. The differences in TRL (Technology Readiness Level) explain the different expectations of the projects. What has been proposed as a mere concept idea test cannot be compared with an industrial test under real environmental conditions.

The leadership in offshore activities at present is clearly located in renewable energy and more specifically on offshore wind, hence the most promising combination proposals should be those where this industry appears. However, these proposals show the lowest profitability through our set of projects. This fact calls can be the result of a lower TRL of the combos explored in our sample, to the preeminent role played by huge electrical companies with broad sources of finance, or just to the high level of regulation in this industry, heavily subsidized through feed in tariffs.

The results presented by aquaculture, seabed, logistics and leisure show more optimistic view in the related projects, but this optimistic analysis does not match with the real investments developed in those sectors in offshore areas, hence the eventual existence of a bias has to be tested in future research. The main sources of uncertainty about the viability of the projects are on one hand the lack of precise knowledge on the operational conditions of the technology under untested conditions, (losses, operational restrictions, and external effects between activities), and on the other hand the intrinsic volatility of revenues to be obtained in the future with uncertainty in market conditions, environmental pressures and policy regulating measures.

Finally, it is important to assume that the initially recognized lack of maturity is still heavily restricting further developments in offshore activities. At the present state of the art it is unclear that the shared approach creates expectations that it will be a successful strategy.

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