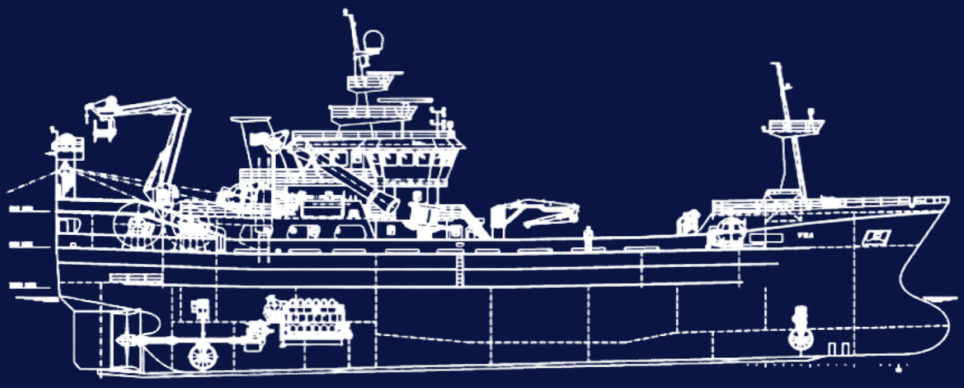


Decarbonizer Premium Report

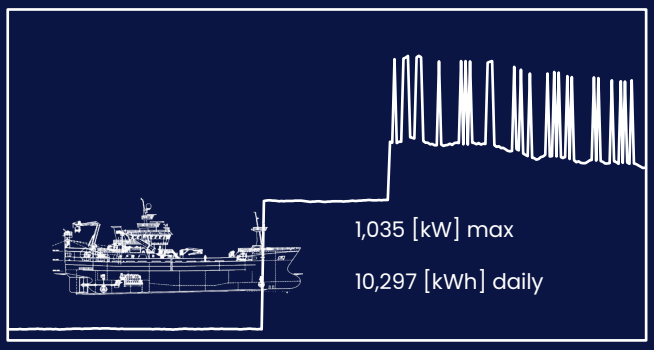
A techno-economic emission reduction guide for Jacobus Maria

Client Name	**vincent**
Date	**2023-08-11**
Source	**Sustainable Ships**

EXECUTIVE SUMMARY

The purpose of this document is to provide vincent with guidance and insights on maritime sustainability of Jacobus Maria. This report elaborates on your operational profile, applicable rules and regulations and on your preferred carbon reduction measures and costs.

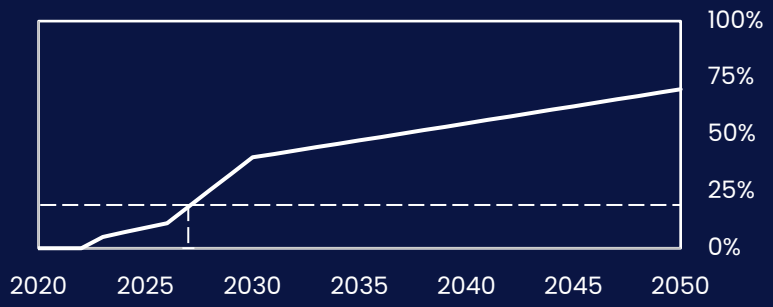
Operational Profile

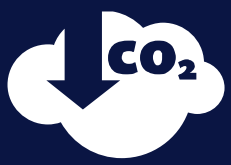


yearly average

Fuel	2,273	[l/day]
CO2	6,486	[kg/day]
ETS	€ 2,140	[€/day]
OPEX	€ 4,480	[€/day]
CII	Not Applicable	
EEXI	Not Applicable	

Rules and Regulations





2027
Year

19%
Reduction

Decarbonization Measures	CO_2 Red.	CAPEX	Dayrate*	Payback [yrs]
Shore Power	4%	€ 29,400	- € 280	**0**
Battery Hybrid	8%	€ 1,122,636	- € 222	**14**
Biofuels	10%	€ 3,000	- € 161	**0**

* The difference in daily costs after implementation of measure. A negative dayrate means your OPEX is reduced and you will save money.

	CO_2 Red.	CAPEX	OPEX [daily]	Payback [yrs]
Current situation	0%	€ 0	€ 4,480	-
Future Jacobus Maria	**23%**	**€ 1,155,036**	**€ 3,817**	**5**

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About Report

Legislation is uncertain

Legislation, rules and regulations or politics in general are vague by nature. In contrast to the engineer's worldview, there is and will always remain uncertainty over upcoming rules and regulations due to 'the political process'. Additionally, the engineering performed for retrofitting is uncertain as well, as it is subject to significantly varying parameters and assumptions.

Our solution to this conundrum is twofold. First, we provide you with a free to use helpdesk, that can help you clarify and answer questions even after this report has been delivered. You can ask any question related to maritime sustainability by clicking on the 'contact helpdesk' button on the top of the page.

Secondly, we provide you with a model, not a solution. Our tools are fully customizable to your vessel and provide you with the option to easily change input parameters when new information is provided. In other words, you can use the Decarbonizer tool as a sensitivity analysis for your vessel, in which you can easily determine what works for you and what does not.

Class is exempt

Class rules and regulations from either DNV, Lloyds or other classification bureaus are excluded in the upcoming rules and regulations section because these are technical of nature. They are included in the cost breakdowns as lump-sum estimates that you can easily customize.

Liability Disclaimer

Sustainable Ships will not be held responsible for any damages that could arise from using the information provided in this report or on its platform. View all terms and conditions here.

1.0 OPERATIONAL PROFILE JACOBUS MARIA

1.1 Vessel and operational properties

Property	Value	Unit
Ship name	Jacobus Maria	
Ship type	Trawler	
Fuel type main	MDO	
Main engine name	Main Engine	
Installed power kw	1000	[kW]
Main engine type	4-Stroke	196 [g/kWh]
Main engine speed	Medium	
Aux engine name	Aux Engine	
Aux power kw	100	[kW]
Aux engine type	4-Stroke	
Aux engine speed	High	[kW]
Year built	2020	[years]
Lifetime from today	25	[years]
GT	4300	[-]
Deadweight	5000	[mT]
Cargo capacity	5000	[m3]
Propulsion type	Direct Drive	
Cruising speed	9	[knts]
Fuel tank capacity main	1000	[m3]
Length	88.1	[m]
Beam	18.3	[m]
Hull roughness	Smooth	
Draught	10	[m]
Displacement	5000	[mT]

Operational profile		
Idle / Moored	40%	145 days per year
Sailing	20%	72 days per year
Working	41%	148 days per year

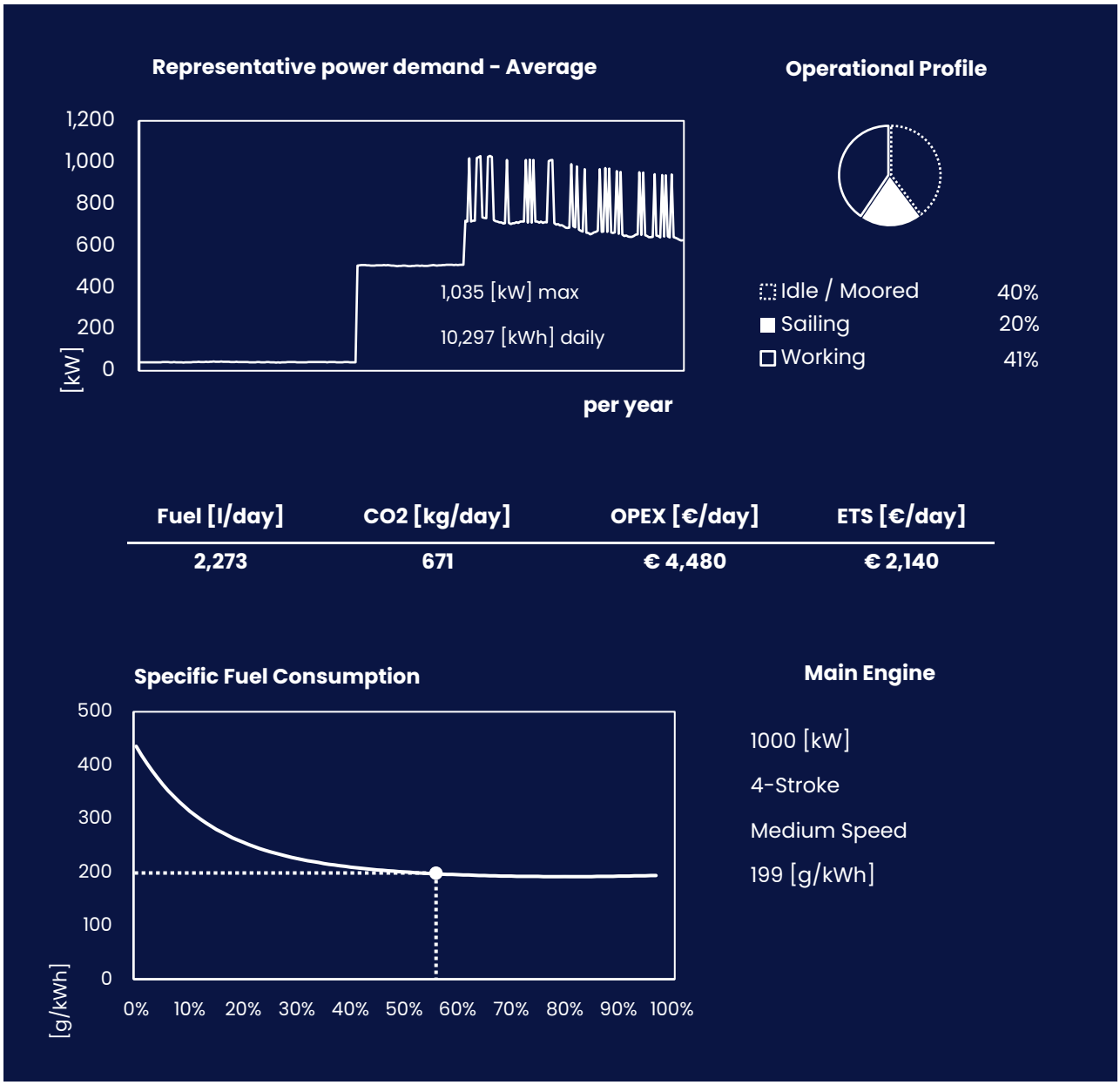
1.2 Current OPEX per operational profile

		Idle / Moored 145 [days/year]	Sailing 72 [days/year]	Working 148 [days/year]	Average per [day]
Max Power	[kW]	44	510	1,035	1,035
Average Power	[kW]	41	502	774	429
Energy Required	[kWh]	983	12,058	18,565	10,297
Fuel Consumption	[liter]	235	2,750	4,038	2,273
Engine Hours	[hrs]	24	24	24	24

CO2 Emissions	[kg]	671	7,847	11,521	6,486
NOx Emissions	[kg]	€ 11.49	€ 134.32	€ 197.22	€ 111.03
SOx Emissions	[kg]	€ 0.45	€ 5.26	€ 7.73	€ 4.35
PM Emissions	[kg]	€ 0.20	€ 2.33	€ 3.41	€ 1.92
CH4 Emissions	[kg]	€ 0.01	€ 0.12	€ 0.18	€ 0.10

Fuel	[€]	€ 183.44	€ 2,145.02	€ 3,149.47	€ 1,773.05
Lease / Rental	[€]	€ 0.00	€ 0.00	€ 0.00	€ 0.00
Engine Maintenance	[€]	€ 480.00	€ 480.00	€ 480.00	€ 480.00
Spares / Consumables	[€]	€ 48.00	€ 48.00	€ 48.00	€ 48.00
ETS Costs	[€]	€ 221.45	€ 2,589.43	€ 3,801.99	€ 2,140.39
Coating	[€]	€ 38.69	€ 38.69	€ 38.69	€ 38.69
OPEX	**daily**	**€ 972**	**€ 5,301**	**€ 7,518**	**€ 4,480**
	yearly	**€ 354,630**	**€ 1,934,918**	**€ 2,744,127**	**€ 1,635,250**

1.3 Average – Yearly



Fuel [l/day]	CO2 [kg/day]	OPEX [€/day]	ETS [€/day]
2,273	671	€ 4,480	€ 2,140

Main Engine

1000 [kW]

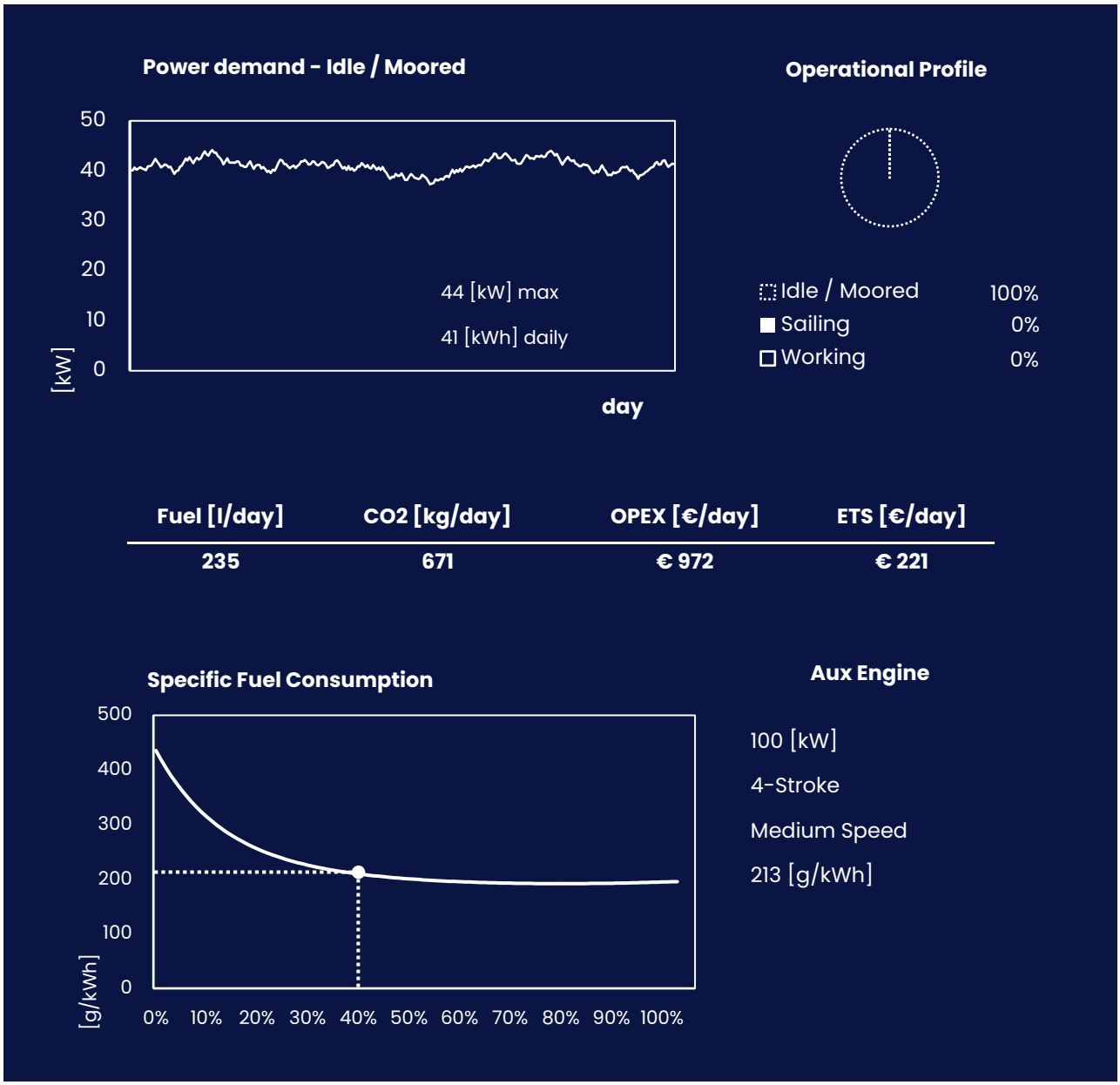
4-Stroke

Medium Speed

199 [g/kWh]

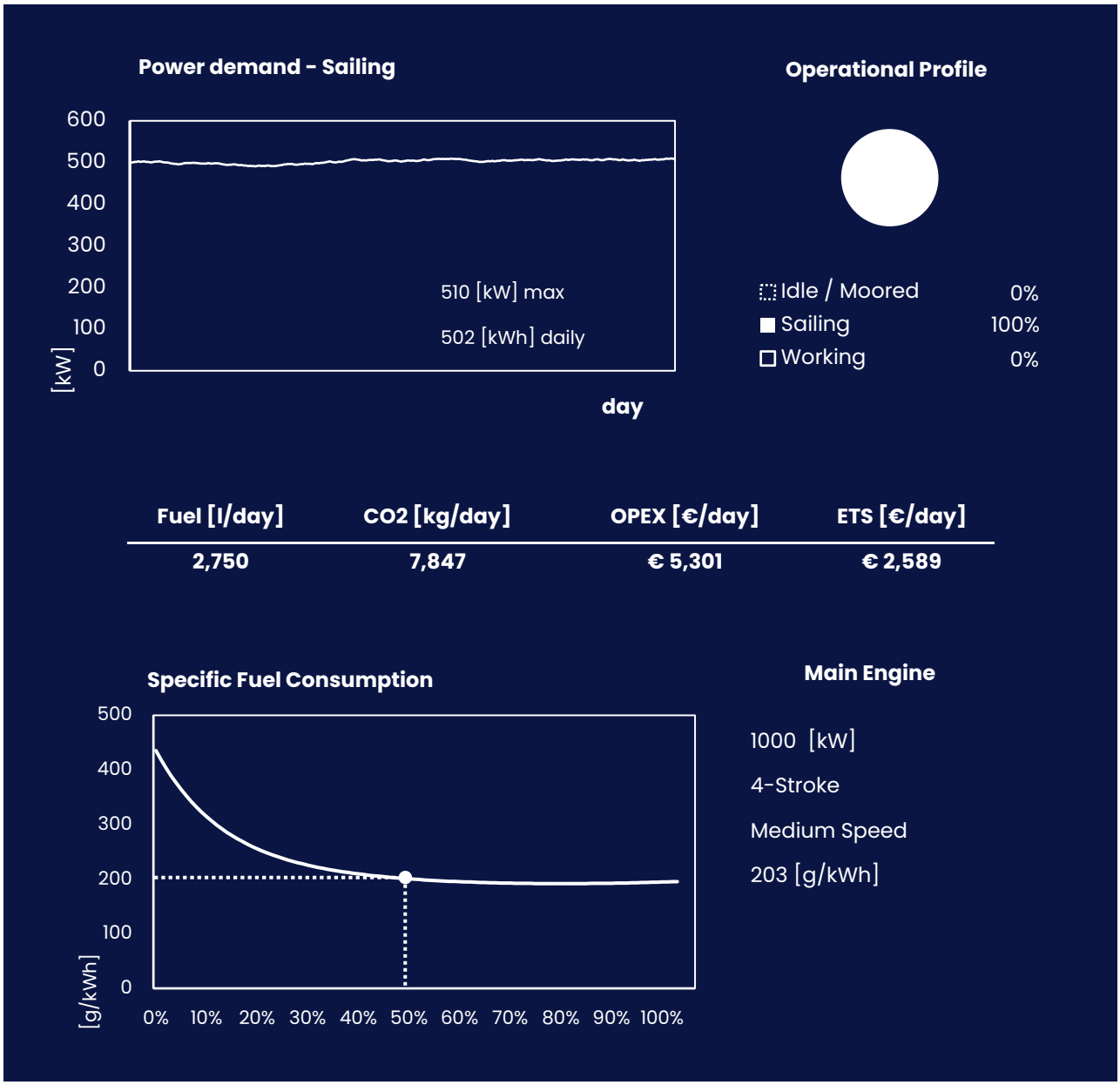
The estimated operational profile of Jacobus Mariawhen operational modes are combined (i.e. idle/moored, sailing and working). For example, a vessel can be moored for 25% of the year and sailing for 75% of the year, which results in a combined power demand representing vessel operations. This can be viewed as 'yearly combined profile". OPEX includes ETS, the ETS component is shown for additional reference.

1.4 Idle/Moored – Daily



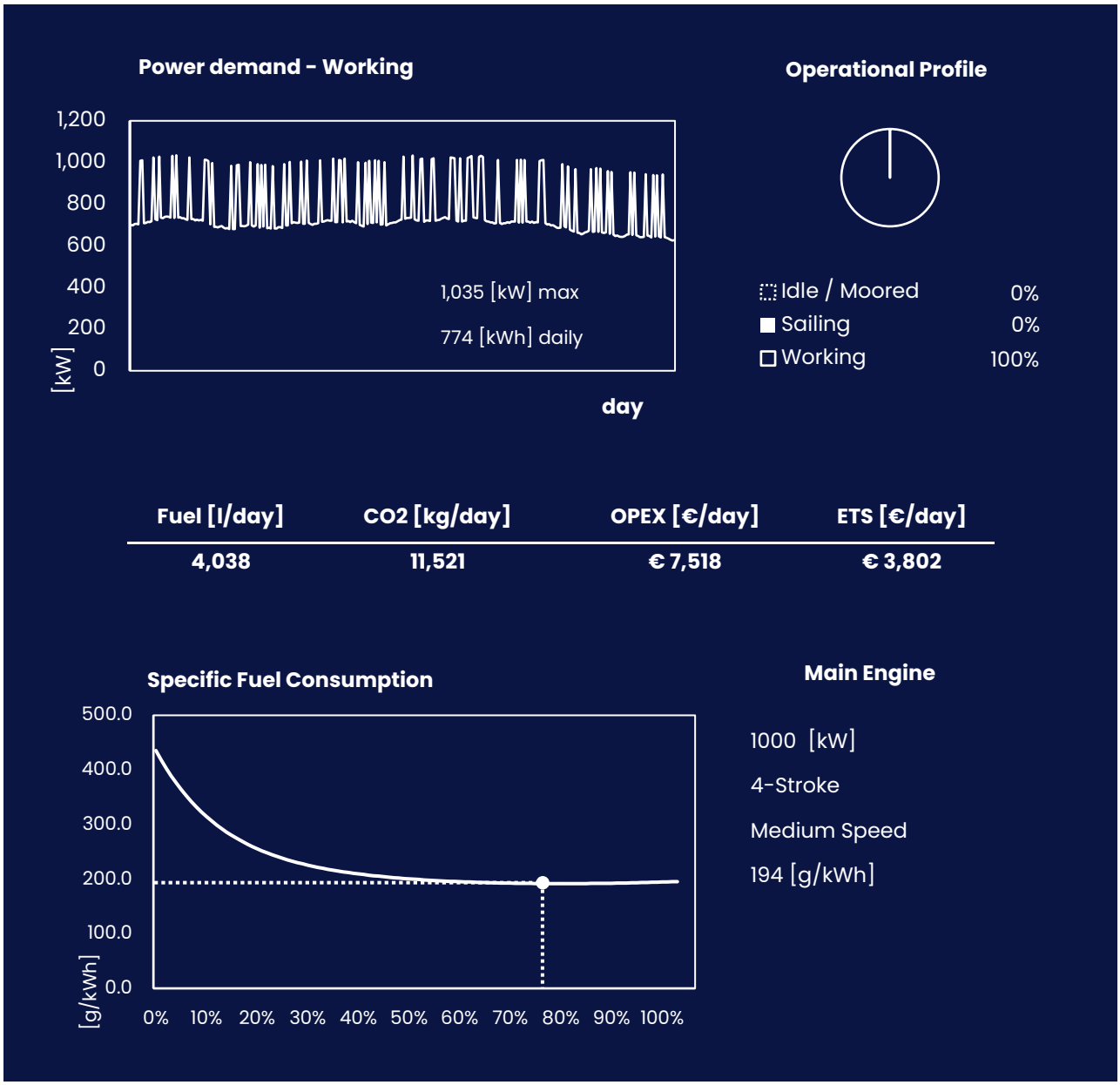
The estimated idle / moored power profile, main fuel and cost parameters for Jacobus Maria. OPEX includes ETS, the ETS component is shown for additional reference.

1.5 Sailing – Daily



The estimated sailing power profile, main fuel and cost parameters for Jacobus Maria. OPEX includes ETS, the ETS component is shown for additional reference.

1.6 Working – Daily



'Working' is defined as an operational mode in which the vessel operates on its main engines and experiences peaks in power demand. This can be the case for offshore working vessels when on DP or operating cranes.. OPEX includes ETS, the ETS component is shown for additional reference.

2.0 KEY UPCOMING RULES AND REGULATIONS FOR JACOBUS MARIA

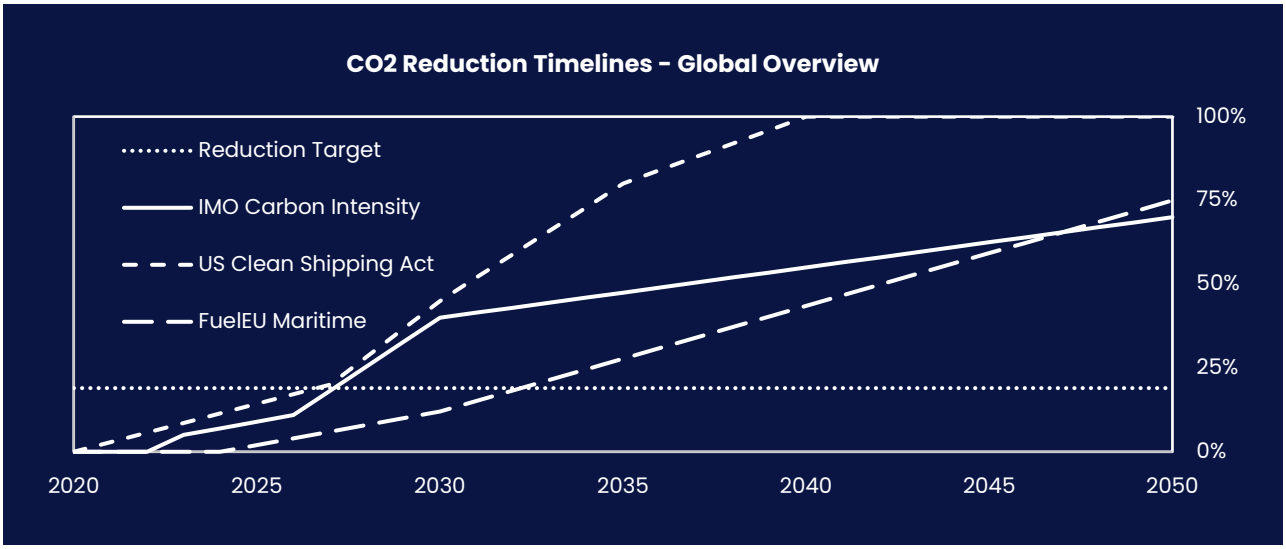


Figure 5. CO2 reduction timelines for key organizations around the world.

Key takeaways	
For 2027 a CO2 reduction of 19% is required	Key regulatory frameworks for maritime sustainability include IMO and EU, of which IMO is more stringent at the moment and EU probably after 2030. In addition, the US Clean Shipping Act requires all vessels to be fully zero emission by 2040. Client requirements have not yet been incorporated.
Electrification is excluded	Electric vessels 'pass' all rules and regulations that have been identified. It is therefore highly recommended to pursue a course of electrification of your vessel where possible to ensure smooth sailing in the future.
Shore power is mandatory	Shore power will become fully mandatory in EU and US by 2030, as per FuelEU and US clean shipping act and this trend in expected to be tightened while at berth. Shore power in the Netherlands is more attractive for operators due to HBE.
Carbon tax & fossil is expensive	Shipping industry will be incorporated into EU ETS from 2025 onwards. With the current price of €330 per mT CO2, that would equate to a surtax of roughly €990 per mT of fuel.

Key rules and regulations for Jacobus Maria		
Regulation	**Organization**	**Impact / Restraint**
Port of Hamburg	Germany	-100% CO2 2040
Port of Rotterdam	Netherlands	-100% CO2 2050
Port of Antwerp-Bruges	Belgium	-100% CO2 2050
Port of Marseille	France	-100% CO2 2050
Port of Dunquerque	France	-100% CO2 2050
Port of HAROPA	France	-100% CO2 2060
Port of Amsterdam	Netherlands	-100% CO2 2025

CII / EEXI / EU ETS		
CII	**EEXI**	**EU ETS [year]**
Not Applicable	Not Applicable	€ 781,244

Purchase the **premium Rules and Regulations report** for an overview on all rules and regulations on sustainability. This includes regulations imposed by energy majors, shipping companies and ports around the world that might affect your operations. It is accompanied by a one-hour consult to clarify all your questions. Click below fore more information.

Learn more

3.0 CARBON REDUCTION MEASURES & COSTS

3.1 All carbon reduction measures

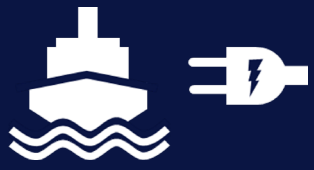
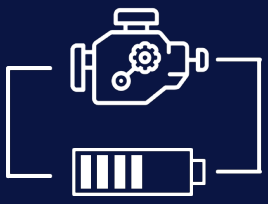
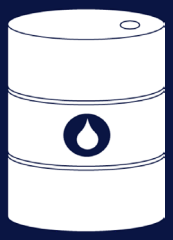
Below is an overview of several key carbon reduction measures. Δ-OPEX represent the difference between current OPEX and OPEX when measures is implement. OPEX of carbon reduction measures include fuel, ETS and maintenance costs. All costs are indicative. No rights or claims can be made based on this analysis.

Measure	CO_2 Reduction	CAPEX	Payback [days]	Dayrate
Shore Power	**4%**	**€ 29,400**	**- € 280**	**105**
Shore Battery	4%	€ 403,621	- € 280	1,441
Solar PV	8%	€ 205,559	- € 310	663
Wind Power	8%	€ 810,000	- € 274	2,952
Hull Coating	7%	€ 125,754	- € 186	677
Battery Hybrid	**8%**	**€ 1,122,636**	**- € 222**	**5,055**
Biofuels	**10%**	**€ 3,000**	**- € 161**	**19**
Ammonia	96%	€ 732,578	- € 1,028	713
Methanol	89%	€ 472,705	- € 1,082	437
Hydrogen	96%	€ 6,995,660	+ € 3,294	-
Full Electric	96%	€ 7,613,462	- € 3,128	2,434

Current situation	**0%**	**€ 0**	**€ 4,480**	**-**
After measures	**23%**	**€ 1,155,036**	**€ 3,817**	**1,741**
Target reduction	**19%**			

3.2 Selected measures for Jacobus Maria

The below carbon reduction measures have been applied to Jacobus Maria. Click on the links below the figures to learn more, or contact the helpdesk to clarify any questions.

Selected carbon reduction measures		
Shore Power	Prevent Measure	Change Measure
		
Shore Power	Battery Hybrid	Biofuels

3.3 CII / EEXI / EU ETS

Below is an overview of current and future CII, EEXI and EU ETS. Future means after implementation of carbon reduction measures. More details and calculations are provided in Appendix I.

CII / EEXI / EU ETS			
	CII	**EEXI**	**EU ETS**
Current	Not Applicable	Not Applicable	€ 781,244
Future	Not Applicable	Not Applicable	€ 603,300

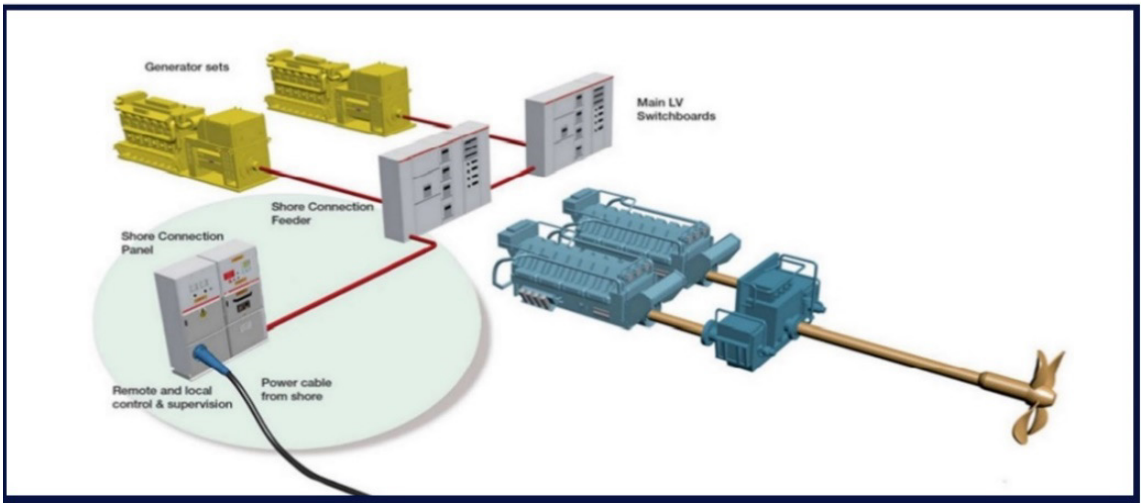
3.4 Technical Details Shore Power

Shore power is the use of electricity from the grid to power your vessel while moored. It is also called 'cold ironing' or 'onshore power supply', OPS. Shore power is a special prevention technology, as it not only mitigates the combustion of fuel completely (generators are assumed to be turned off) it also changes the operational profile for the vessel. Total CAPEX of your shore power system with current input is estimated at €29400. It is assumed that the vessel is moored 39.7% per year, of which shore power is available for 100%. Generally speaking, Sustainable Ships assumed all onshore infrastructure including cable management system is available. Contact the helpdesk for help on this if needed.

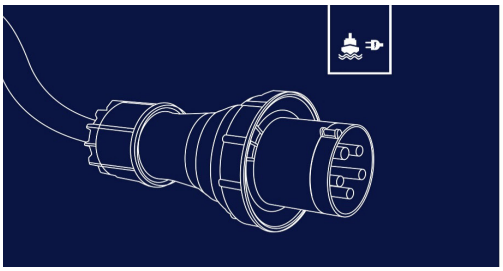
Parameter	Value	Unit
Electricity consumption	836	[kWh/day]
Average power Idle/Moored	35	[kW]
Rated power	100	[kW]
Shorepower availability w.r.t. idle/moored time	100%	-
Operating voltage	440	[V]
Rated Frequency	60	[Hz]
Number of phases	3	-
Number of connections required	1	-
Distance connection panel to engine room	50	[m]
Shore-side operating voltage	440	[V]
Shore-side operating frequency	50	[Hz]
Shore-side number of phases	3	-
Switchboard modifications required?	FALSE	-
Transformer required?	FALSE	-
Converter required?	FALSE	-
Shore Power kWh price	€ 0.27	[€/kWh]
Switchboard equipment purchase price	€ 200	[€/kW]
Power equipment purchase price	€ 200	[€/kW]
Switch-over philosophy	Blackout	-

Learn more about Shore Power

Shore connection panel (left) and connecting cables (right)
These connectors can be ship specific, learn more below



Schematic for incoming power connected to vessel switchboard
This is a direct-drive with separate generator sets, your setup may be different



Overview of sockets and plugs

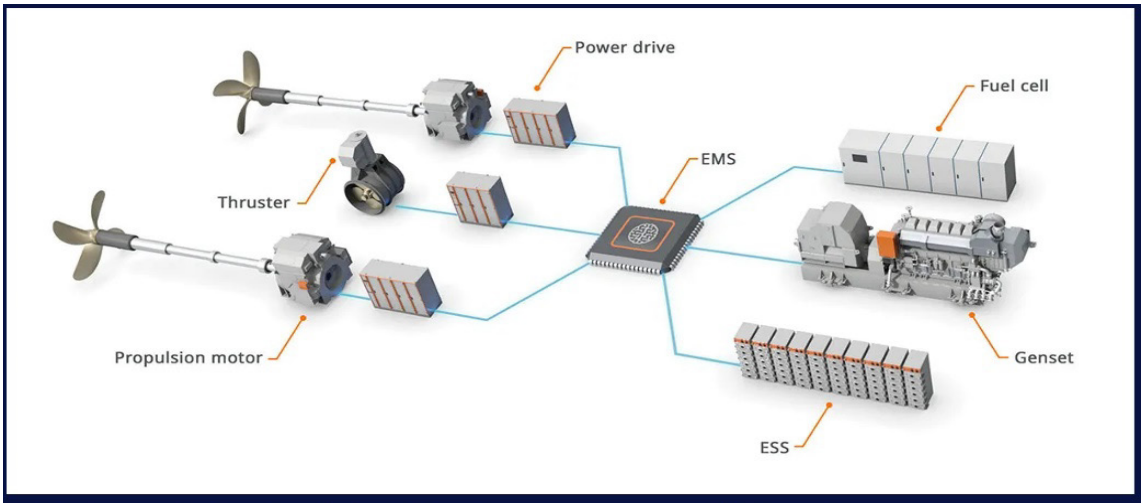
Shore power by Heerema

3.5 Technical Details Prevent Measure Battery Hybrid

In a battery hybrid setup, a marine battery is used for spinning reserve, peakshaving, as boost function, load smoothing or load leveling. More information will be available soon.

Parameter	Value	Unit
Battery Hybrid Design mode	Working	-
Battery application	Spinning reserve	-
Average power in design mode	774	[kW]
Rated Power	1,000	[kW]
Estimated battery capacity	2,000	[kWh]
Energy density battery	2	[MWh/20ft]
Volume of required battery pack	33.2	[m3]
Operating Voltage	440	[V]
Operating frequency	50	[Hz]
Number of phases	3	-
Distance battery to engine room	50	[m]
Converter Required?	No	-
Transformer Required?	Yes	-
Switchboard spare breaker available?	Yes	-
Battery placed on deck or built-in?	Deck	-
Battery/cell purchase price	€ 400	[€/kWh]
Switchboard equipment purchase price	€ 100	[€/kW]
Power equipment purchase price	€ 150	[€/kW]
Fire suppression system price	€ 50	[€/kW]
Battery Hybrid continuous engine load	100%	

Learn more about Battery Hybrid



A schematic of a diesel electric battery system, controlled by an Energy Management System (EMS). This setup's main advantage is that energy supply can be 'swapped'

An example of a 20ft battery container by Corvus
This container is not plug and play but requires integration with on-board systems

The Big Friendly hybrid Giant

Hurtigruten's new hybrid ships

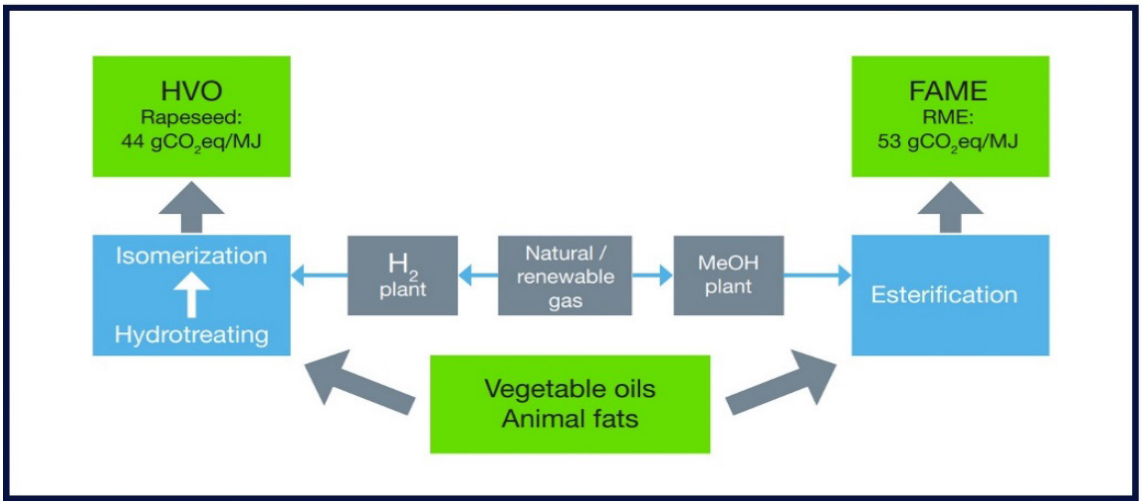
3.6 Technical Details Change Measure Biofuels

Biofuel options and availability are limited from a technical and sustainability viewpoint. The best alternative for MDO is Hydrogenated Vegetable Oil (HVO), as there are virtually no operation distinction in use between HVO and MDO. HVO is a drop-in fuel and can be blended with MDO, one of the biggest benefits. The main drawback is the higher prices – usually between 20-100% premium – and its availability. Contact the helpdesk for suppliers' guides on biofuels.

Parameter	Value	Unit
Biofuel chosen	HVO	
Premium cost for HVO	80%	[%]
HVO price	€ 1.40	[€/liter]
CO2 Reduction Biofuels	15%	[%]
CO2 reduction required after prevention	10%	[%]
O2 Reduction on IPCC Certificate of Biofuel Batch	75%	[%]
Required HVO percentage of fuel mix	14%	[%]
Resulting HVO percentage of fuel mix	14%	[%]
Fuel Density of Mix	0.873	[kg/liter]
Resulting CO2 Emission Factor	2.873	[kg/kg]
Resulting Mix Price	0.866	[€/liter]
SFC Improvement	2%	[%]
Biofuels "CAPEX" Costs	€ 10	[€/kW]

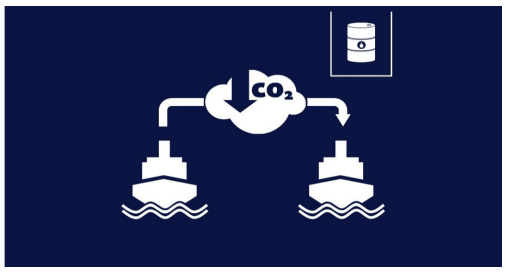
Learn more about Biofuels

Hydrotreated Vegetable Oil (HVO) from Neste is one of the best and most widely available biofuels, complying to EN 15940 standards and the ability to be blended with fossil diesel



HVO and Fatty Acid Methyl Esters (FAME) are the most commonly biofuels used
They can be derived from multiple types of different feedstocks

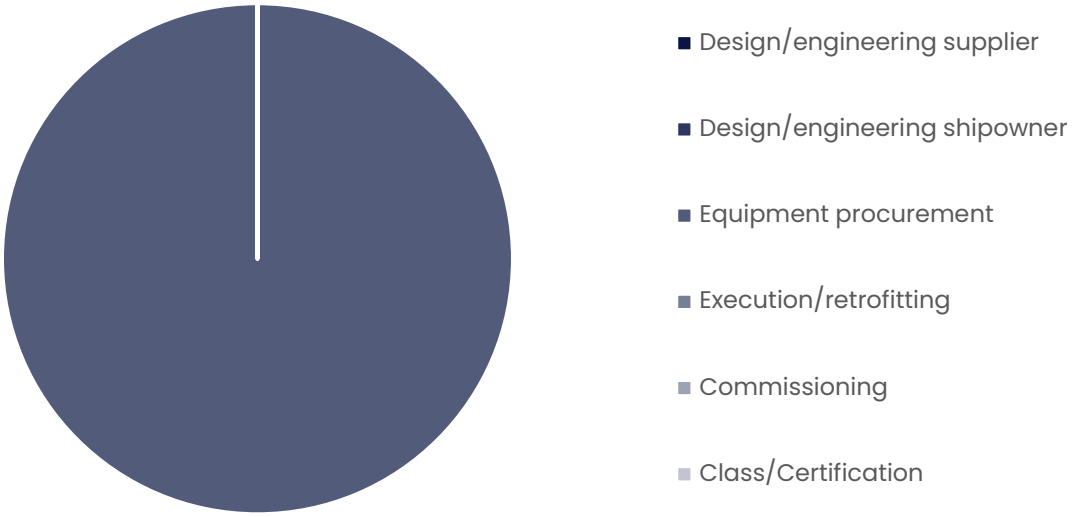
Neste renewable diesel handbook



What is carbon insetting?

3.7 CAPEX Breakdown Shore Power

	Time [hours]	Costs
Design/engineering supplier	140	€ 0
Design/engineering shipowner	160	€ 0
Equipment procurement	-	€ 29,400
Execution/retrofitting	560	€ 0
Commissioning	280	€ 0
Class/Certification	160	€ 0
Total	**33 fte weeks**	**€ 29,400**



Total Time [hrs]*	Total Cost
1300	Total Estimated for Project € 29,400

Shore Power Costs

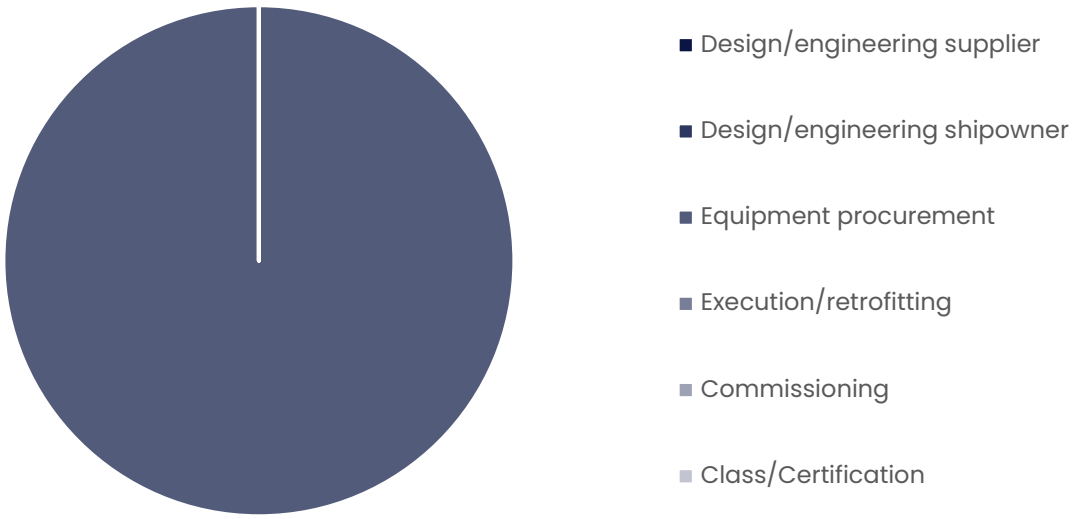
	Time [hrs]	Units	Parameter	Price per hour/unit	Total Cost
Design/Engineering Supplier	**140**				**€ 0**
Electrical engineering for switchboard and breaker modifications	40		EUR/hr	€ 0	€ 0
Electrical engineering for shore connection panels	20		EUR/hr	€ 0	€ 0
Electrical engineering for PMS modifications	40		EUR/hr	€ 0	€ 0
Short circuit and selectivity study for shore connections	40		EUR/hr	€ 0	€ 0
Design/Engineering Shipowner	**160**				**€ 0**
Misscalenous engineering	40		EUR/hr	€ 0	€ 0
Engineering for cable routing at location	40		EUR/hr	€ 0	€ 0
Mechanical engineering for shore connection locations	80		EUR/hr	€ 0	€ 0
Equipment procurement	**0**	**1**			**€ 29,400**
Switchboard modifications*		0	EUR	€ 20,000	€ 0
(HV) Breakers Set		0	EUR	€ 800	€ 0
Converter (if needed)		0	EUR	€ 20,000	€ 0
Transformer (if needed)		0	EUR	€ 20,000	€ 0
Harmonic filters		1	EUR	€ 1,000	€ 1,000
Foundation for shore connection panel		1	EUR	€ 200	€ 200
Shore connection panel/housing		1	EUR	€ 200	€ 200
Cable management system		1	EUR	€ 1,000	€ 1,000
(HV) Cabling [meters]		50	per [m]	€ 150	€ 7,500
Cable trays		50	per [m]	€ 30	€ 1,500
FAT testing of equipment (Factory Acceptance Test)		1	lot	€ 4,000	€ 4,000
Power management system modifications		1	lot	€ 2,000	€ 2,000
Spare parts		1	lot	€ 4,000	€ 4,000
Consumables used on-board, general supplies, paint, electrodes etc.		1	lot	€ 4,000	€ 4,000
Rental tools		1	lot	€ 4,000	€ 4,000
Execution/Retrofitting	**560**				**€ 0**
Creating means of access for safe working location	40		EUR/hr	€ 0	€ 0
Cleaning/removing obstructions from working locations	40		EUR/hr	€ 0	€ 0
Installation/removal of scaffolding on working locations	40		EUR/hr	€ 0	€ 0
Installation/Implementation of switchboard and breaker modifications	40		EUR/hr	€ 0	€ 0
Implementation of power management modifications	80		EUR/hr	€ 0	€ 0
Installation of bulkhead penetrations for cable routing	40		EUR/hr	€ 0	€ 0
Installation of cable trays to complete routing	40		EUR/hr	€ 0	€ 0
Installation of foundations for connection panels	40		EUR/hr	€ 0	€ 0
Installation of connection panels	40		EUR/hr	€ 0	€ 0
Pulling, fastening and terminating of cables	80		EUR/hr	€ 0	€ 0
Painting/coating of equipment	40		EUR/hr	€ 0	€ 0
Non-destructive testing of structures (if installed)	40		EUR/hr	€ 0	€ 0
Commissioning	**280**				**€ 0**
Testing of cable from switchboard to the shore connection panels	40		EUR/hr	€ 0	€ 0
Testing of shore connection in switchboard	40		EUR/hr	€ 0	€ 0
Testing of power management system modifications	40		EUR/hr	€ 0	€ 0
Testing of change over from vessel to shore power and back	40		EUR/hr	€ 0	€ 0
Training and familiarising of crew	120		EUR/hr	€ 0	€ 0
Class/Certification	**160**				**€ 0**
Class approval costs of drawings/calculations	130		EUR/hr	€ 0	€ 0
Surveyor attendence during fabrication/installation incl. travelling expenses	80		EUR/hr	€ 0	€ 0
Permitting for E-house, cabling etc. (if needed)	0		EUR/hr	€ 0	€ 0
(Writing) Operational manuals and procedures	80		EUR/hr	€ 0	€ 0

All numbers are indicative. Ask your supplier for fixed numbers.

It is assumed transportation costs for all equipment is included in the pricing.

3.8 CAPEX Breakdown Prevent Measure Battery Hybrid

	Time [hours]	Costs
Design/engineering supplier	160	€ 0
Design/engineering shipowner	160	€ 0
Equipment procurement	-	€ 1,122,636
Execution/retrofitting	500	€ 0
Commissioning	280	€ 0
Class/Certification	160	€ 0
Total	**32 fte weeks**	**€ 1,122,636**



	Total Time [hrs]*			Total Cost
	1260		Total Estimated for Project	€ 1,122,636

Shore Battery Costs

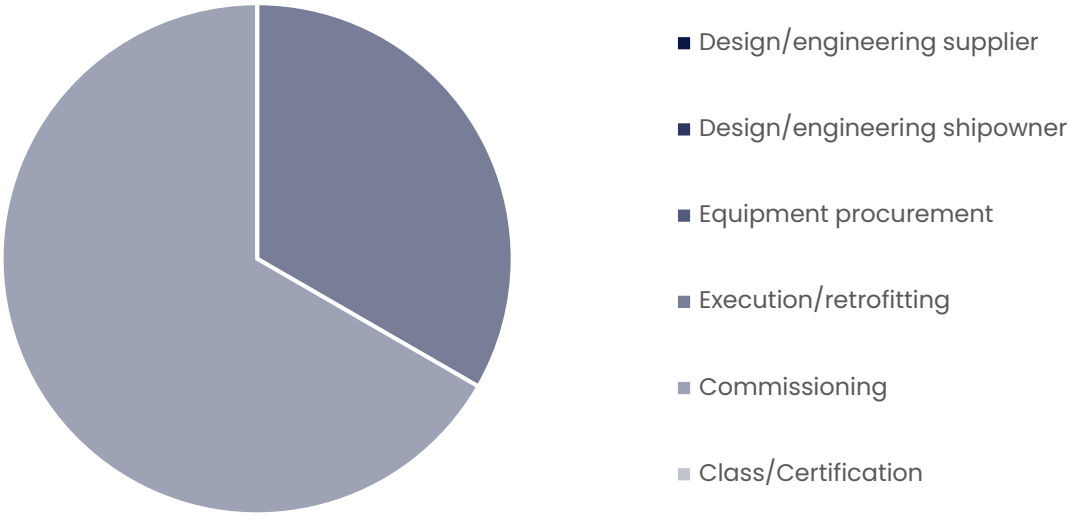
	Time [hrs]	Units	Parameter	Price per hour/unit	Total Cost
Design/engineering supplier	**160**				**€ 0**
Electrical engineering for switchboard and breaker modifications	60		EUR/hr	€ 0	€ 0
Electrical engineering for shore connection panels	20		EUR/hr	€ 0	€ 0
Electrical engineering for PMS modifications	40		EUR/hr	€ 0	€ 0
Short circuit and selectivity study for shore connections	40		EUR/hr	€ 0	€ 0
Design/engineering shipowner	**160**				**€ 0**
Misscalenous engineering	40		EUR/hr	€ 0	€ 0
Engineering for cable routing at location	40		EUR/hr	€ 0	€ 0
Mechanical engineering for shore connection changes	80		EUR/hr	€ 0	€ 0
Equipment procurement	**0**				**€ 1,122,636**
Battery system		1	EUR	€ 800,000	€ 800,000
Switchboard modifications*		0	EUR	€ 100,000	€ 0
(HV) Breakers Set		0	EUR	€ 10,000	€ 0
Converter (if needed)		0	EUR	€ 150,000	€ 0
Transformer (if needed)		1	EUR	€ 150,000	€ 150,000
Harmonic filters		1	EUR	€ 10,000	€ 10,000
Foundation/containment for battery system		1	EUR	€ 4,000	€ 4,000
Fire suppresion system		1	EUR	€ 50,000	€ 50,000
Shore connection panel/housing		1	EUR	€ 4,000	€ 4,000
(HV) Cabling [meters]		50	per [m]	€ 150	€ 7,500
Cable trays		50	per [m]	€ 30	€ 1,500
FAT testing of equipment (Factory Acceptance Test)		1	lot	€ 11,955	€ 11,955
Power management system modifications		1	lot	€ 11,955	€ 11,955
Spare parts		1	lot	€ 23,909	€ 23,909
Consumables on-board, general supplies, paint, electrodes etc.		1	lot	€ 23,909	€ 23,909
Rental tools		1	lot	€ 23,909	€ 23,909
Execution/retrofitting	**500**				**€ 0**
Creating means of access for safe working location	40		EUR/hr	€ 0	€ 0
Cleaning/removing obstructions from working locations	40		EUR/hr	€ 0	€ 0
Installation/removal of scaffolding on working locations	40		EUR/hr	€ 0	€ 0
Installation/Implementation of switchboard/breaker modifications	40		EUR/hr	€ 0	€ 0
Implementation of power management modifications	20		EUR/hr	€ 0	€ 0
Installation of bulkhead penetrations for cable routing	40		EUR/hr	€ 0	€ 0
Installation of cable trays to complete routing	40		EUR/hr	€ 0	€ 0
Installation of foundations for battery	40		EUR/hr	€ 0	€ 0
Installation of connection panels	40		EUR/hr	€ 0	€ 0
Pulling, fastening and terminating of cables	80		EUR/hr	€ 0	€ 0
Painting/coating of equipment	40		EUR/hr	€ 0	€ 0
Non-destructive testing of structures (if installed)	40		EUR/hr	€ 0	€ 0
Commissioning	**280**				**€ 0**
Testing of cable from switchboard to the shore connection panels	40		EUR/hr	€ 0	€ 0
Testing of shore connection in switchboard	40		EUR/hr	€ 0	€ 0
Testing of power management system modifications	40		EUR/hr	€ 0	€ 0
Testing of change over from vessel to shore power and back	40		EUR/hr	€ 0	€ 0
Training and familiarising of crew	120		EUR/hr	€ 0	€ 0
Class/Certification	**160**				**€ 0**
Approval costs of drawings/calculations	126		EUR/hr	€ 0	€ 0
Surveyor attendence for fabrication/installation incl. travel expense	80		EUR/hr	€ 0	€ 0
Permitting for E-house, cabling etc. (if needed)	0		EUR/hr	€ 0	€ 0
(Writing) Operational manuals and procedures	80		EUR/hr	€ 0	€ 0

All numbers are indicative. Ask your supplier for fixed numbers.

It is assumed transportation costs for all equipment is included in the pricing.

3.9 CAPEX Breakdown Change Fuel Biofuels

	Time [hours]	Costs
Design/engineering supplier	0	€ 0
Design/engineering shipowner	0	€ 0
Equipment procurement	0	€ 0
Execution/retrofitting	24	€ 1,000
Commissioning	24	€ 2,000
Class/Certification	0	€ 0
Total	**1 fte weeks**	**€ 3,000**



No detailed CAPEX table for biofuels is provided

3.10 Future OPEX Breakdown Jacobus Maria

The below table shows the current and future OPEX breakdown for Jacobus Maria, based on the representative daily operational profile. Depreciation of equipment has not been taken into account (neither for existing or newly purchased equipment).

		Current	Future
Max Power	[kW]	1,035	1,035
Average Power	[kW]	429	427
Energy Required	[kWh]	10,297	10,238
Fuel Consumption	[liter]	2,273	2,214
Engine Hours	[hrs]	24	14

Fuel	[€]	€ 1,773	€ 2,008
Lease / Rental	[€]	€ 0	€ 0
Engine Maintenance	[€]	€ 480	€ 302
Spares / Consumables	[€]	€ 48	€ 66
ETS Costs	[€]	€ 2,140	€ 1,834
Coating	[€]	€ 39	€ 62

OPEX	**daily**	**€ 4,480**	**€ 4,271**
	yearly	**€ 1,635,250**	**€ 1,558,890**

3.11 Potential suppliers

The below partners can assist in implementing the proposed measures on-board your vessel. You can contact them directly, or contact the helpdesk for further guidance. In case you prefer to work with (local) partners on your own, feel free to use this report as a guideline for their input.

Preferred Suppliers		
Technology	**Supplier**	**Contact**
Shore_Power	Shorelink	**levan@shore-link.eu**
Battery_Hybrid	Available soon	
Biofuels	Goodfuels	**bernard@goodfuels.com**

Other Suppliers		
Technology	**Supplier**	**Contact**
Shore_Power	ABB	
Shore_Power	Siemens	
Battery_Hybrid	Available soon	
Biofuels	Varo	

4.0 APPENDIX I – ASSUMPTIONS AND CALCULATIONS

4.1 Input values and assumptions

Parameter	Value	Unit
Fuel Price	€ 0.78	[€/l]
ETS	€ 330	[€/mT]
Engine Maintenance Costs	€ 20	[€/hr]
Spares / Consumables Costs	€ 2	[€/hr]
Parasitic Load Engine	15%	[-]
(Engineering) Hour External	€ 0	[€]
(Engineering) Hour Internal	€ 0	[€]
Depreciation Time	10	[years]
Annual (Fuel) Price Increase	1.03	[-]

MDO density	0.89	[kg/l]
CO2 Emission Factor MDO	3.206	[kg/kg]
NOx Emission Factor MDO	0.05488	[kg/kg]
SOx Emission Factor MDO	0.00215	[kg/kg]
PM Emission Factor MDO	0.00095	[kg/kg]
CH4 Emission Factor MDO	0.00005	[kg/kg]

Fuel after change	€ 0.00	[-]
Fuel density after change measures	0.873376265	[kg/liter]
Fuel price after change measure	€ 0.87	[€/l]
Shore-side kWh price	€ 0.27	[€/kWh]
CO2 Emission Factor	2.872901916	[kg/kg]
Nox Emission Factor	0.053739612	[kg/kg]
Sox Emission Factor	0.001881942	[kg/kg]
PM Emission Factor	0.000838136	[kg/kg]
CH4 Emission Factor	0.00005	[kg/kg]

4.2 CII Calculation

Jacobus Maria CII Scores	2023	2024	2025	2026
Baseline	n.a.	n.a.	n.a.	n.a.
After reduction measures	n.a.	n.a.	n.a.	n.a.

CII Input Values		
Operational Mode	Yearly average	
CO2 Emissions	2,367,405,660	[g/year]
Capacity	n.a.	[mT]
Distance Sailed	15,552	[nm/year]
a		for Reference line
c		for Reference line
CII ref	n.a.	Reference line
Required CII 2023	n.a.	5% reduction
Required CII 2024	n.a.	7% reduction
Required CII 2025	n.a.	9% reduction
Required CII 2026	n.a.	11% reduction
Attained Current CII	n.a.	Baseline
Attained CII	n.a.	After modifications

Learn more about CII

CII Scores per Technology	2023	2024	2025	2026
Shore Power	**n.a.**	**n.a.**	**n.a.**	**n.a.**
Shore Battery	n.a.	n.a.	n.a.	n.a.
Solar PV	n.a.	n.a.	n.a.	n.a.
Wind Power	n.a.	n.a.	n.a.	n.a.
Hull Coating	n.a.	n.a.	n.a.	n.a.
Battery Hybrid	**n.a.**	**n.a.**	**n.a.**	**n.a.**
Biofuels	**n.a.**	**n.a.**	**n.a.**	**n.a.**
Ammonia	n.a.	n.a.	n.a.	n.a.
Methanol	n.a.	n.a.	n.a.	n.a.
Hydrogen	n.a.	n.a.	n.a.	n.a.
Full Electric	n.a.	n.a.	n.a.	n.a.

4.3 EEXI Calculation

$$EEXI = \frac{CO2\ emissions}{Transportation\ work}$$

$$EEXI = \frac{Main\ engine\ emissions + Auxiliary\ engine\ emissions + (PTI - Innovative\ electrical\ energy\ technologies) - Innovative\ propulsion\ energy\ technologies}{Capacity * Reference\ speed * Reduction\ factors}$$

$$EEXI = \frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} C_{ME(i)} SFC_{ME(i)}\right) + \left(P_{AE} C_{AE} SFC_{AE}\right) + \left(\left(\prod_{j=1}^{n} f_j \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} P_{AEeff(i)}\right) C_{FAE} SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} P_{eff(i)} C_{FME} SFC_{ME}\right)}{Capacity\ V_{ref} f_i f_c f_l f_w f_m}$$

EEXI Input values		
Ship Type	Trawler	
Operational Mode	Sailing	
CO2 Emissions	326,948	[gram/hour]
Capacity	5,000	[mT]
Reference Speed	9	[knts]
fi	n.a.	
fc	n.a.	
fl	n.a.	
fw	n.a.	
fm	n.a.	
Reduction factor	n.a.	

EEXI	**Not Applicable**	**[gram/mT mile]**
EEXI After	**Not Applicable**	**[gram/mT mile]**
EEXI Required	**Not Applicable**	**[gram/mT mile]**

Learn more about EEXI

4.4 EU ETS Calculation

Yearly ETS Costs	2024	2025	2026	2027
Current	€ 0	€ 312,498	€ 546,871	€ 781,244
Shore Power	**€ 0**	**€ 299,653**	**€ 524,393**	**€ 749,133**
Shore Battery	€ 0	€ 299,653	€ 524,393	€ 749,133
Solar PV	€ 0	€ 287,184	€ 502,572	€ 717,961
Wind Power	€ 0	€ 288,982	€ 505,718	€ 722,454
Hull Coating	€ 0	€ 290,394	€ 508,189	€ 725,985
Battery Hybrid	**€ 0**	**€ 286,122**	**€ 500,713**	**€ 715,304**
Biofuels	**€ 0**	**€ 267,696**	**€ 468,468**	**€ 669,240**
Ammonia	€ 0	€ 0	€ 0	€ 0
Methanol	€ 0	€ 21,325	€ 37,318	€ 53,312
Hydrogen	€ 0	€ 0	€ 0	€ 0
Full Electric	€ 0	€ 0	€ 0	€ 0
Yearly Gains	**€ 0**	**-€ 71,178**	**-€ 124,561**	**-€ 177,944**

Year	% Phase-in
2024	0%
2025	40%
2026	70%
2027	100%

Learn more about EU ETS

5.0 APPENDIX II - CASE STUDIES SIMILAR TO JACOBUS MARIA

Here are several case studies similar to your vessel type, as well as more references on potentially interesting technologies and regulations from the Sustainable Ships site. Click on the stories' title to learn more.

Large fishing trawler

Damen's electric tug Sparky

Methanol as marine fuel

Regulations for maritime sustainability