EPSY

Energy Self-sufficient Sailing Yacht

Ekin Ege Altintas, Timon Behrendt, Topi Hartikka & Knuutti Karsikas

Team Members

Knuutti Karsikas
Sailing Yachts and Industrial design
Team Leader

Ekin Altintas
Maritime Engineering

Timon Behrendt
Mechanical Engineering
Product development

Topi Hartikka
Mechanical Engineering

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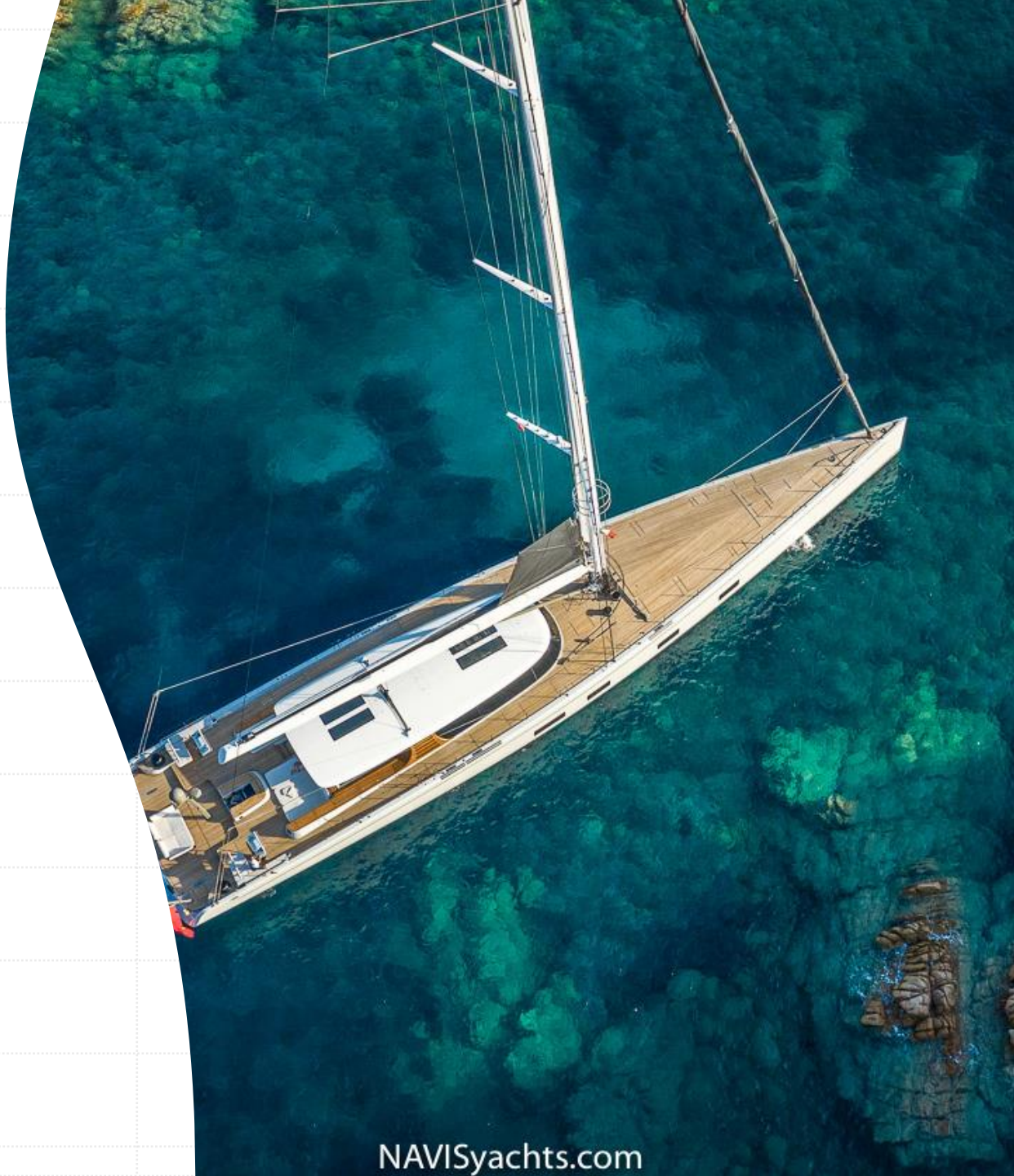
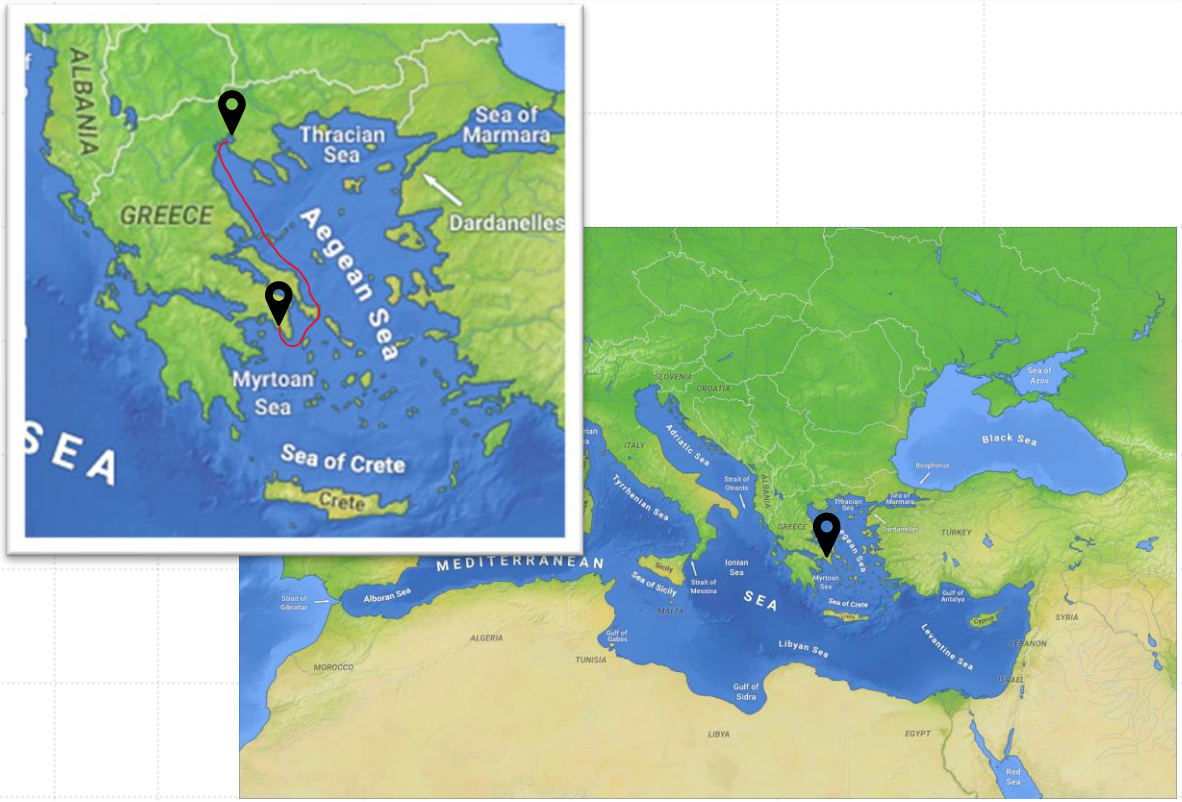


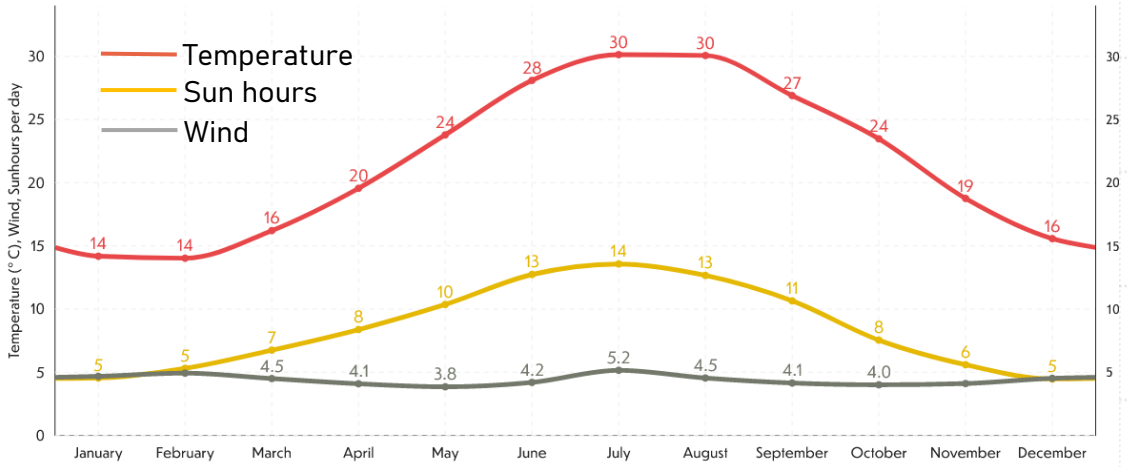
Mission and Objectives

- 45 meters Luxury Sailing Yacht
- Relaxed Sailing Experience, minimized heel angle
- Minimum one week of Energy Self-Sufficiency
- Zero-Emission and Energy Production
- 12 Guest and 7 crew
- Sailing Speed: 6-12+ knots

Operational Area

- Mediterranean Sea
- Main route: Athens - Thessaloniki
- Operational time: April-September





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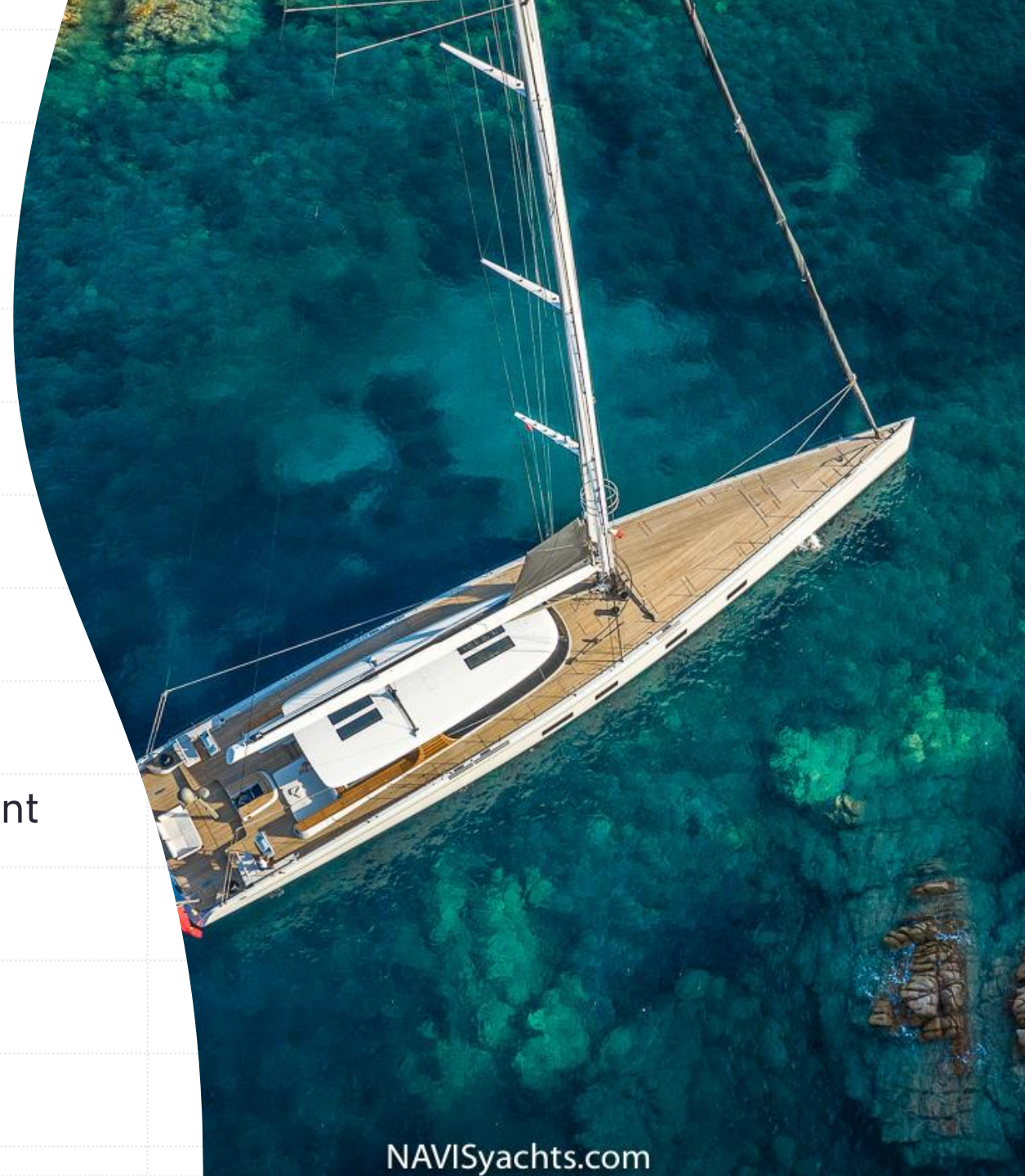
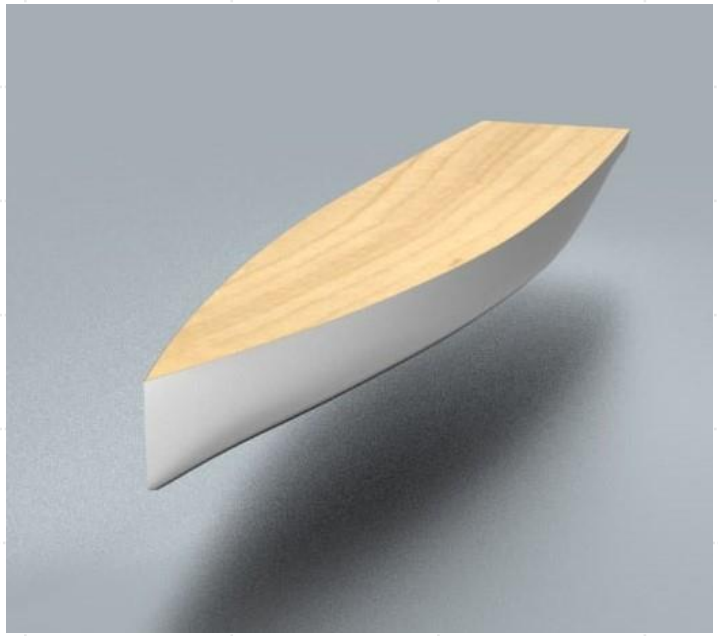
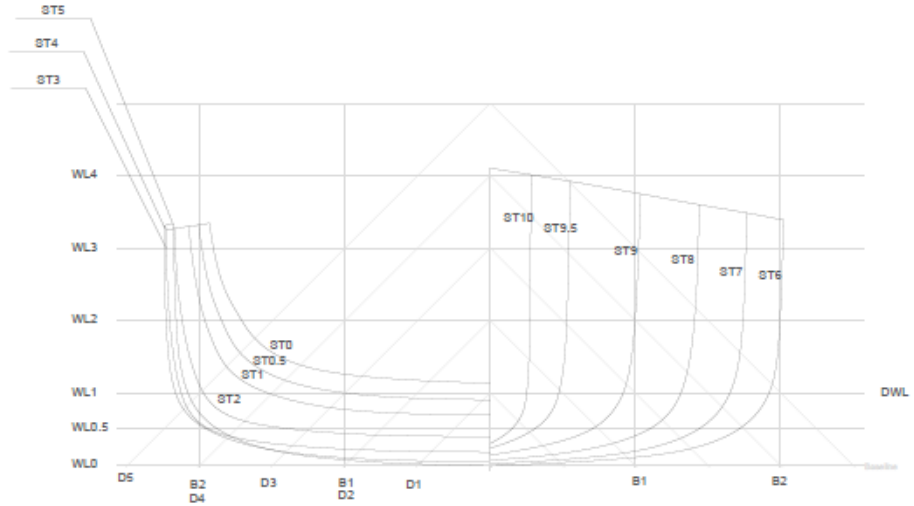
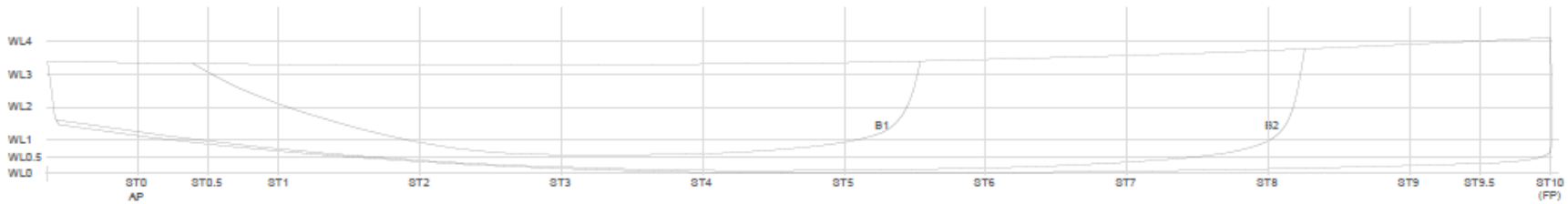


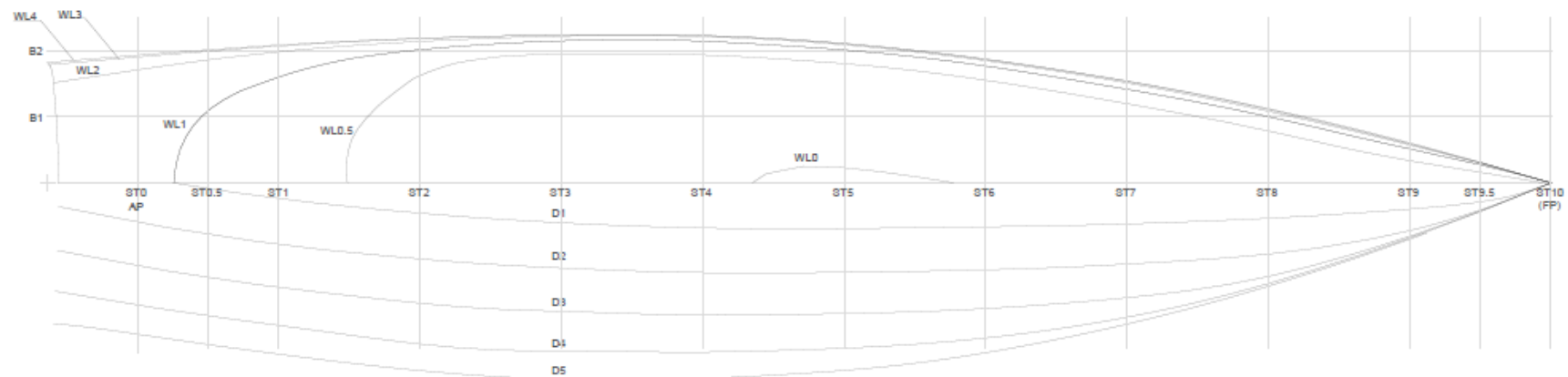
General Characteristics and Hull Lines

EPSY Characteristics		
L_{WL}	41.6	m
B_{WL}	8.6	m
T	4/6.7	m
Sail Area	680	m^2
C_P	0.57	-




ST5
ST4
ST3
WL4
WL3
WL2
WL1
WL0.5
WL0
ST10
ST9.5
ST9
ST8
ST7
ST6
ST0
ST0.5
ST1
ST2
DWL
D5
B2
D4
D3
B1
D2
D1
B1
B2


WL4
WL3
WL2
WL1
WL0.5
WL0
B1
B2
ST0
AP
ST0.5
ST1
ST2
ST3
ST4
ST5
ST6
ST7
ST8
ST9
ST9.5
ST10
(FP)


WL4
WL3
B2
WL2
B1
WL1
WL0.5
WL0
ST0
AP
ST0.5
ST1
ST2
ST3
ST4
ST5
ST6
ST7
ST8
ST9
ST9.5
ST10
(FP)
D1
D2
D3
D4
D5

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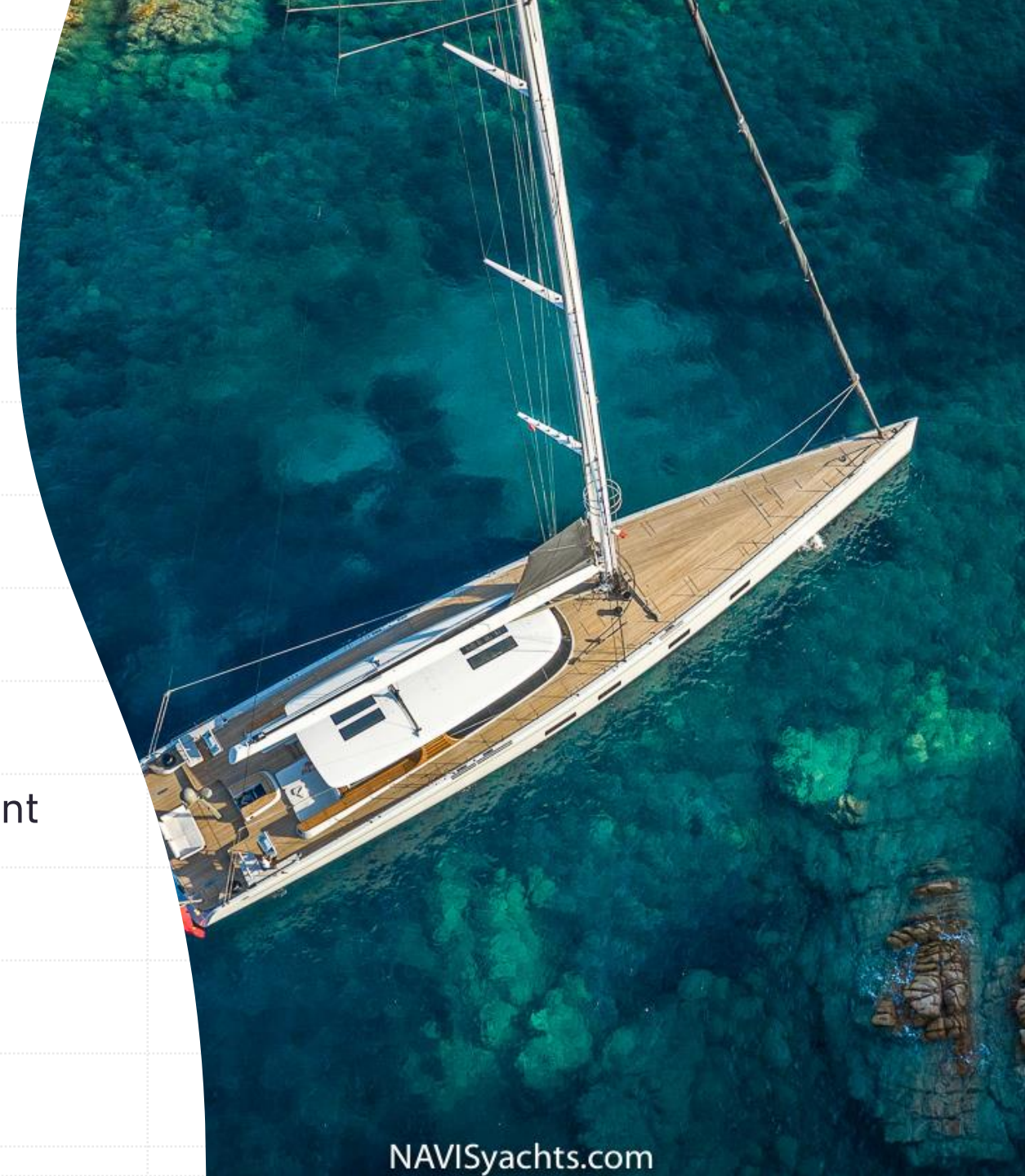
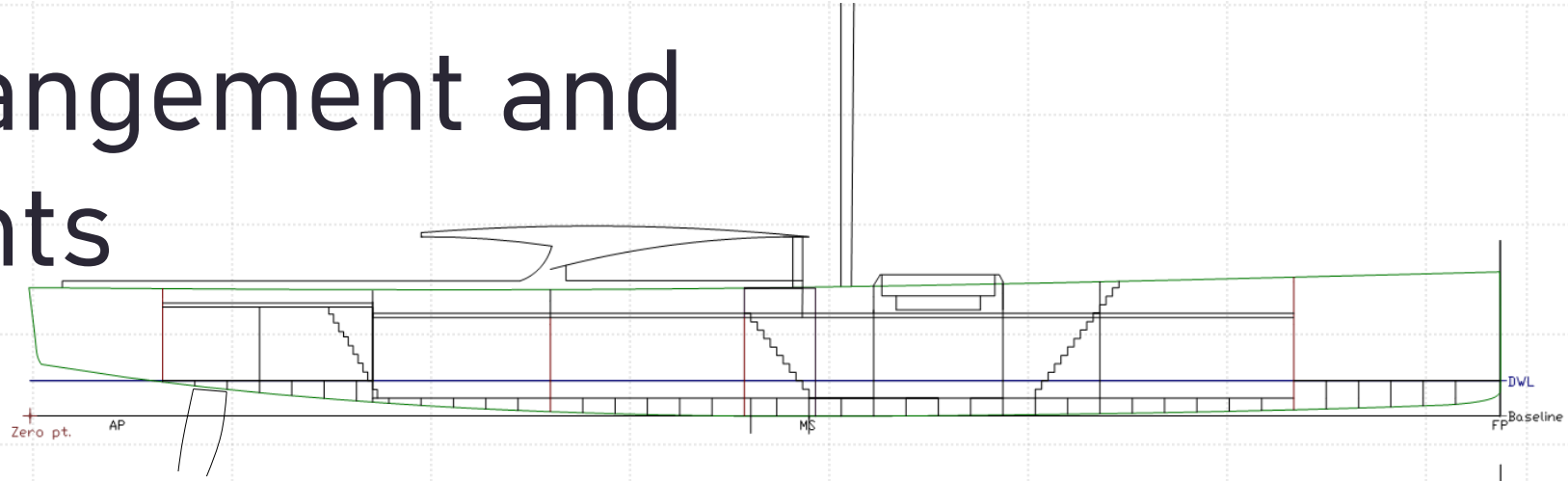
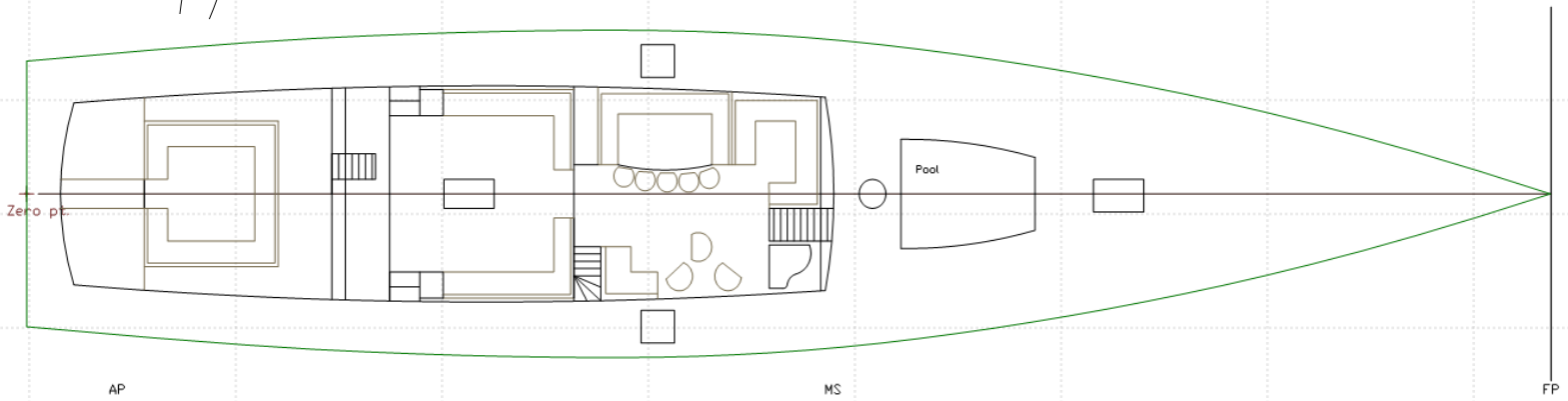
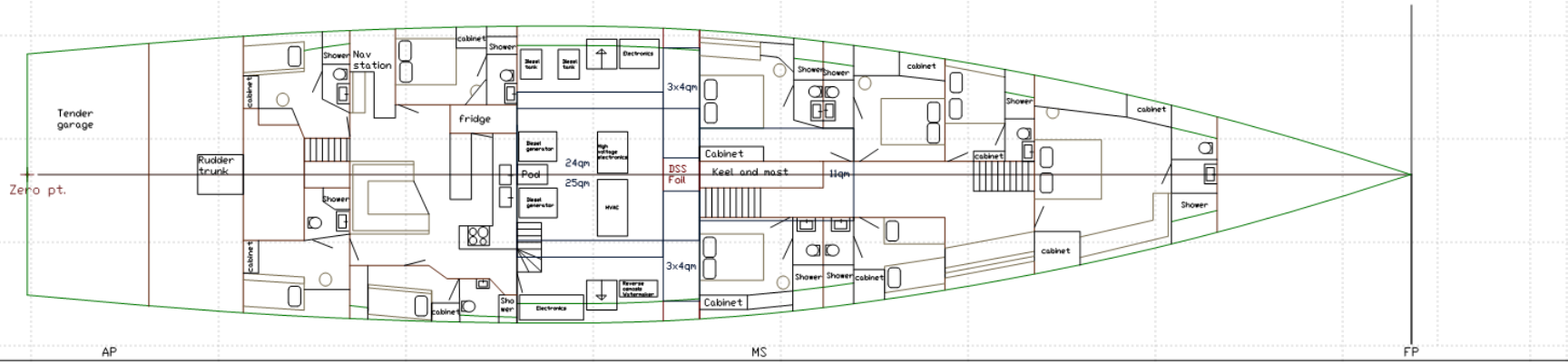


General Arrangement and Compartments

- Lounge areas, saloon and the pool on the upper deck
- Tender garage, crew compartment, machinery compartment, guest compartment and forepeak on the lower deck







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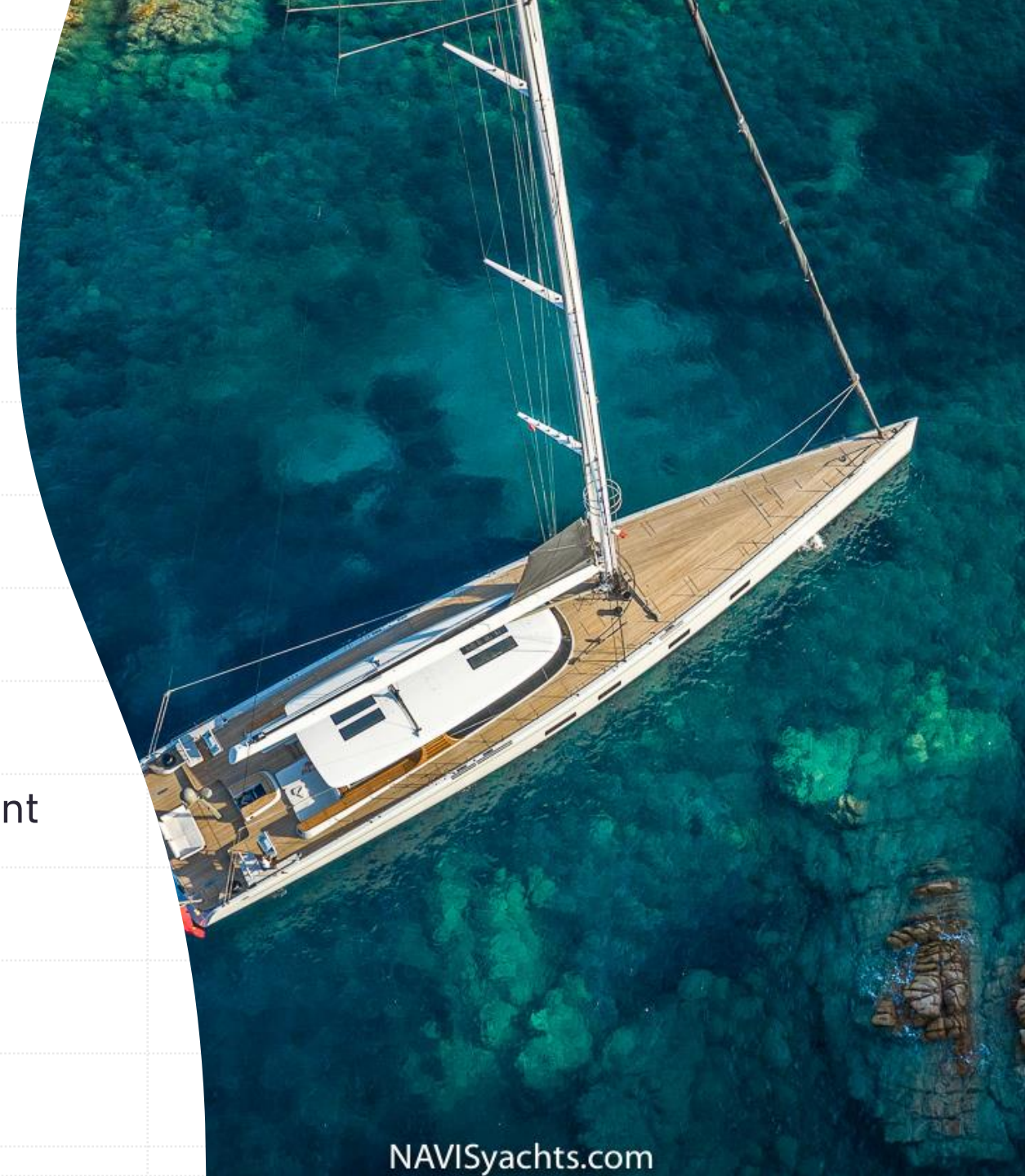
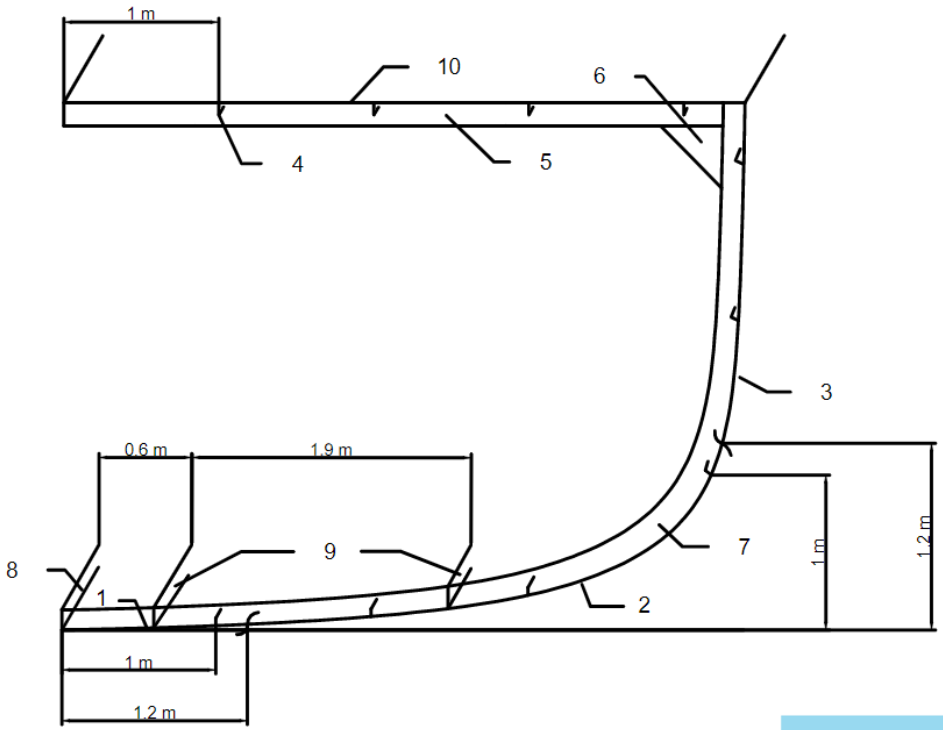


Material Selection and Structural Design

- Selected Material: Aluminum NV 5083 O Temper
  - Good strength to weight ratio
  - 5000 series -> Marine grade
- Mixed Framing System:
  - Distance between Frames= 0.5 m
  - Distance between Web Frames: 2.5 m
- Minimum plate thickness:
  - 8.5 mm in keel plating
  - 6.5 mm in shell plating



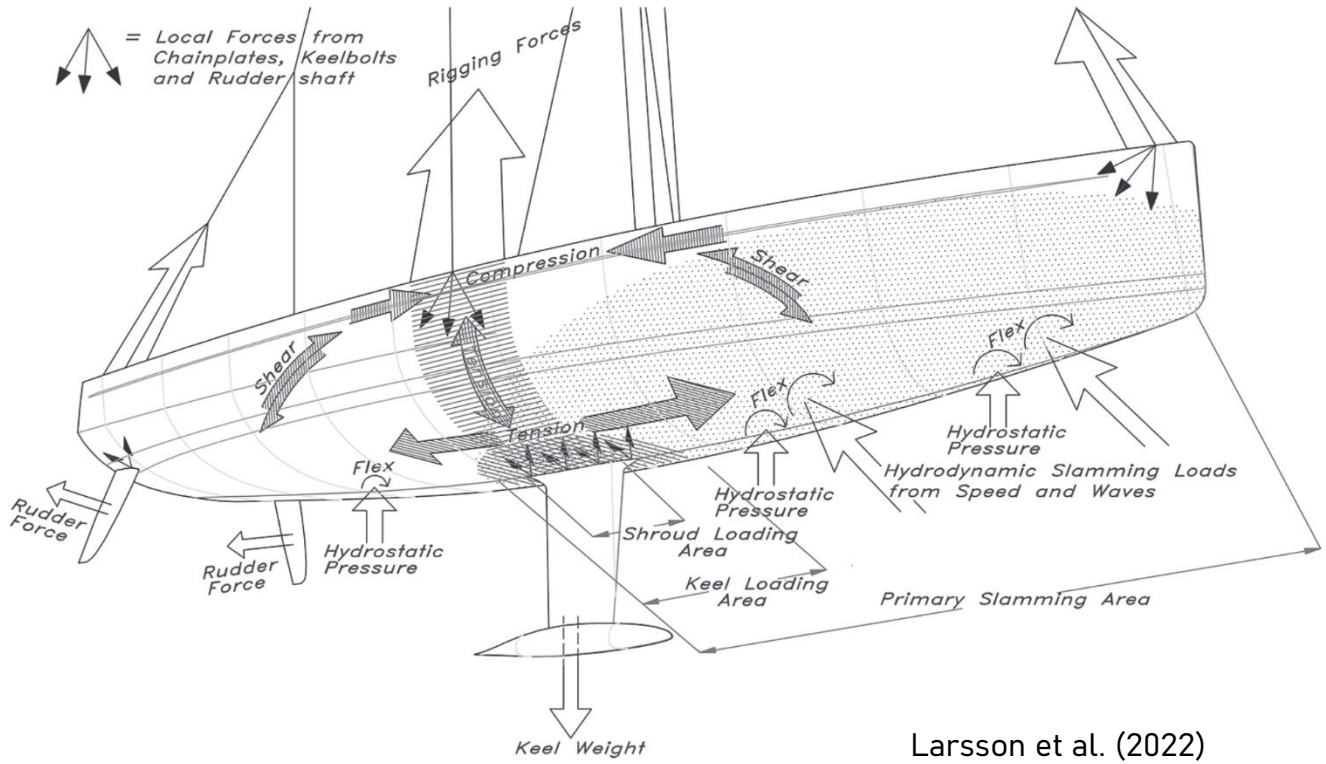
1: Keel Plate
2: Bottom Plate
3: Side Plate
4: Longitudinals (distance 1m)
5: Deck-beam
6: Bracket
7: Webframe
8: Main girder
9: Side girder
10: Deck plate

∫ -> Welding Points of the plates

DNV

Rig and Wave Bending Moments

- Highest global loads from combined wave and rig sagging
- Calculated maximum bending moment 31 MNm
- Important for both structural integrity and sailing performance



Larsson et al. (2022)

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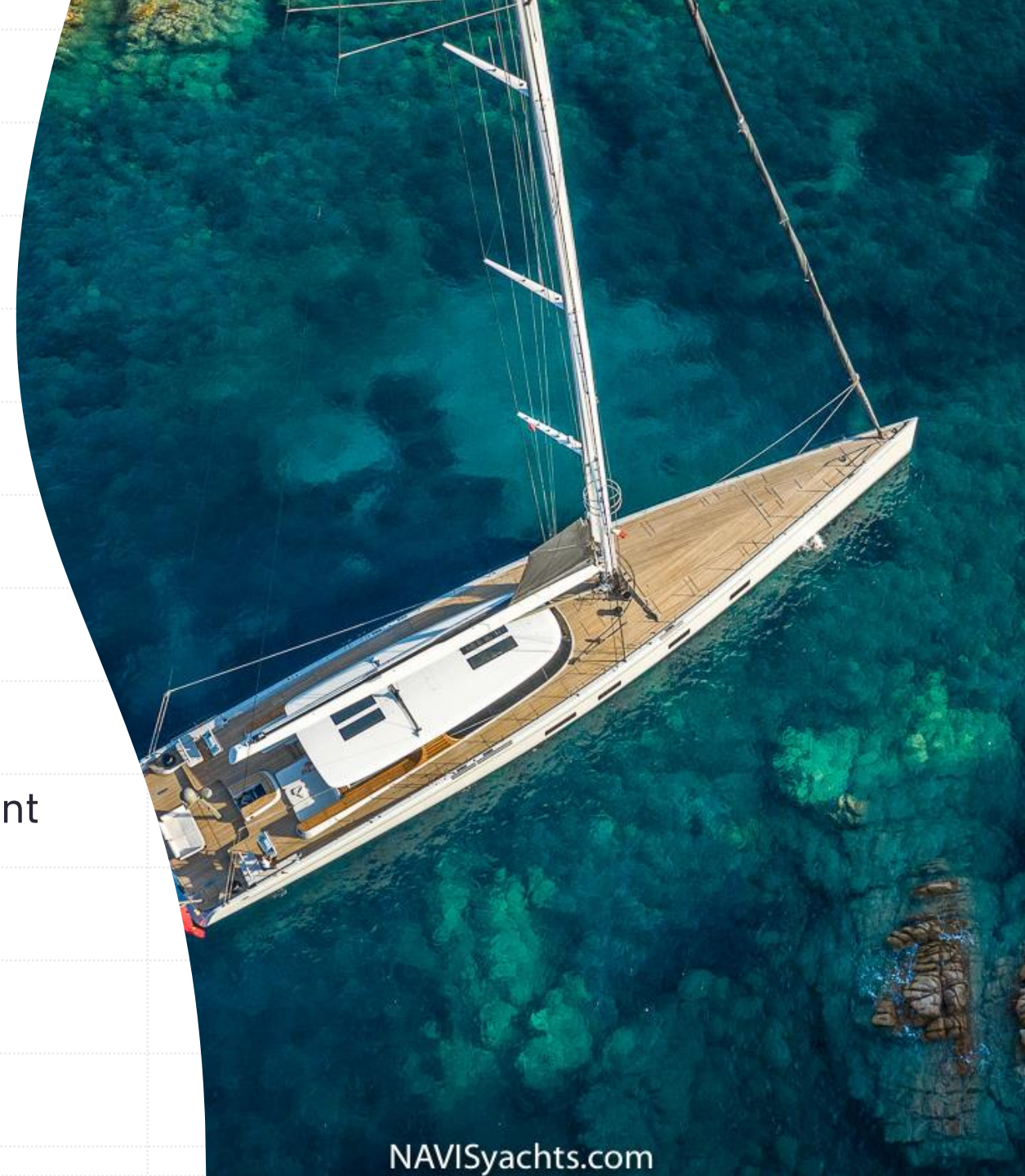
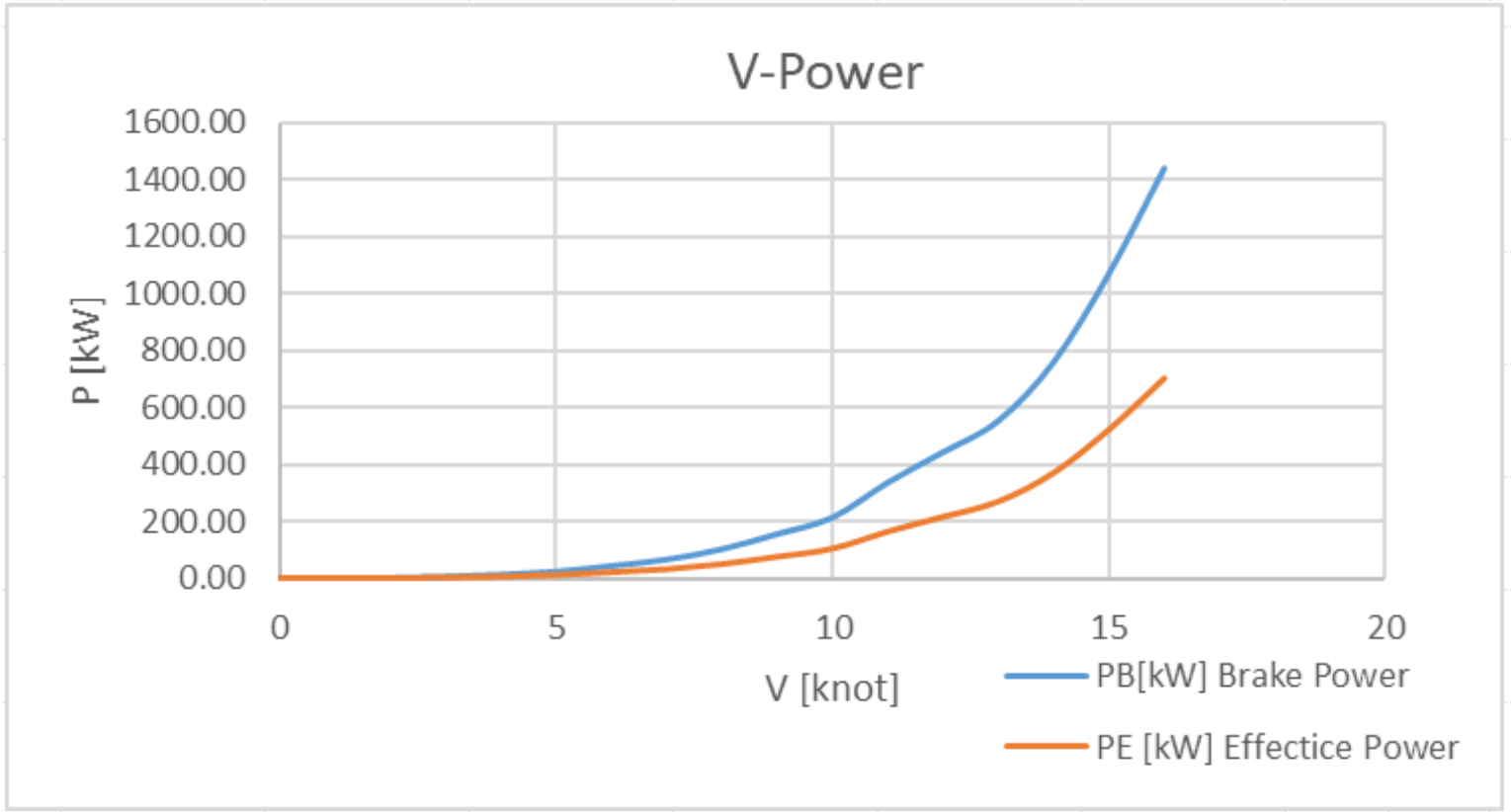


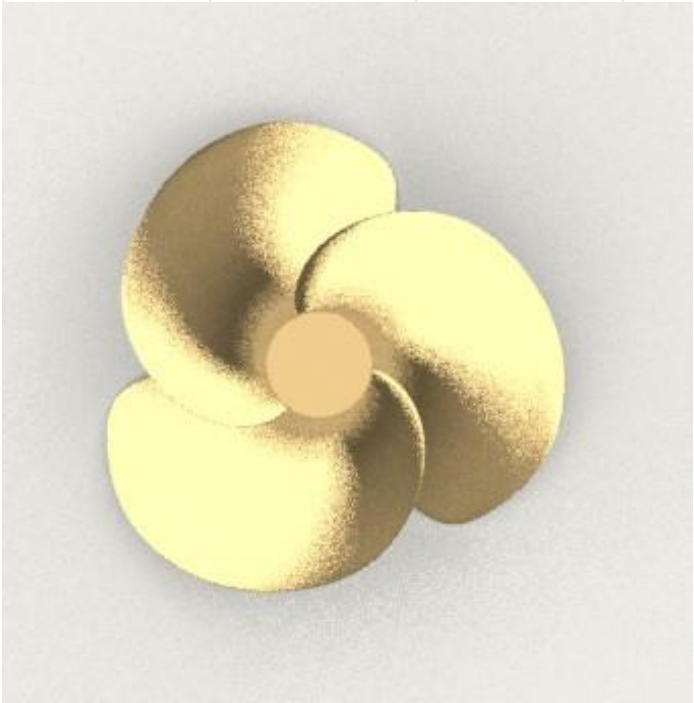
Total Resistance in Upright and No Leeway Angle Condition

Speed [knots]	Resistance [kN]	Break Power [kW]
6	6.86	43.23
12	35.05	441.60



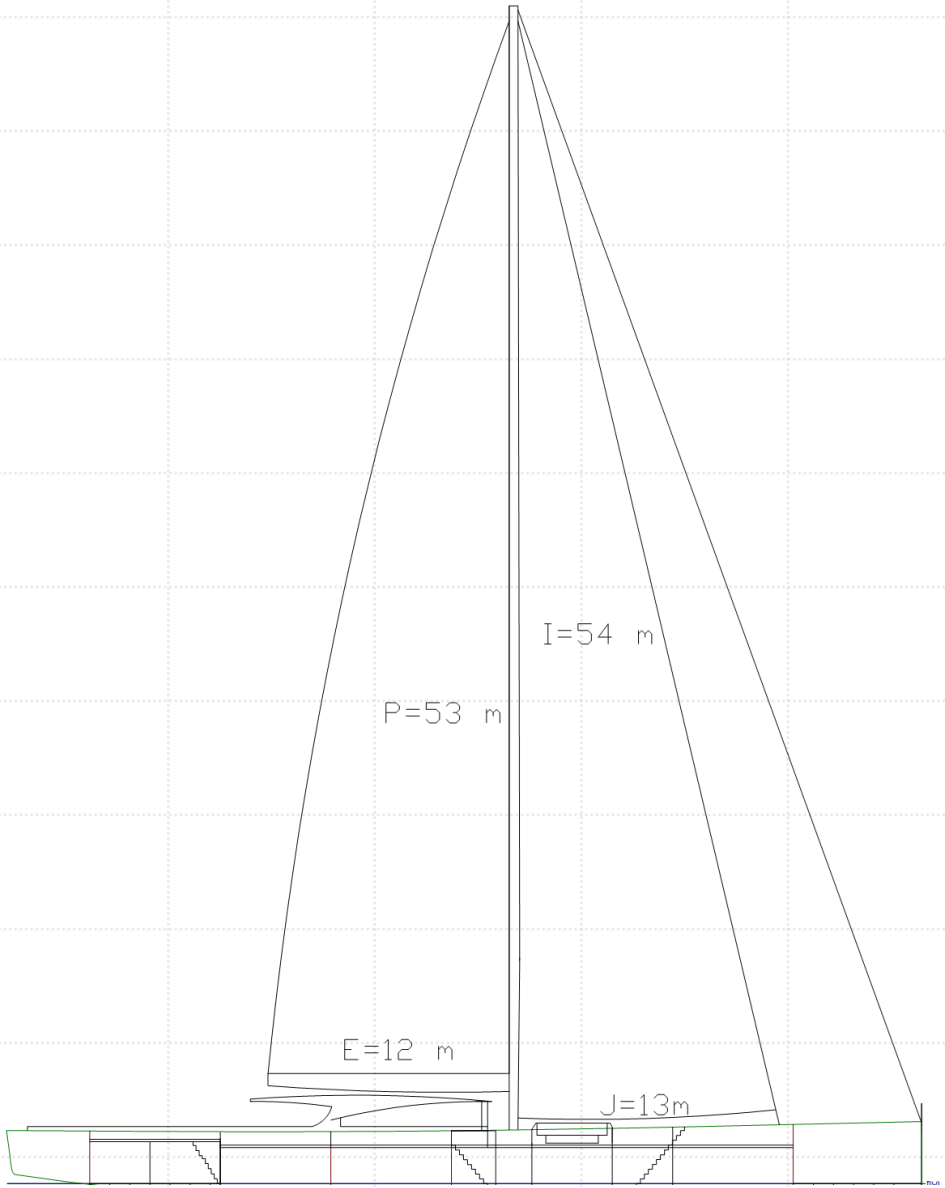
Vessel and Propeller Efficiency

Propeller Characteristics		
Propeller Model	Wageningen B Series	
BAR Area	0.7	-
Diameter	1.15	m
Number of Blades	3	-
Open Water Efficiency	0.50	-
Total Efficiency	0.49	-



Rig and Sails

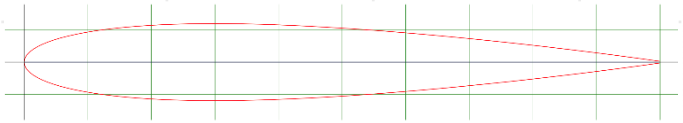
- For upwind conditions:
  - Sail area main + jib 680 m^2
- For downwind conditions
  - Code-0 and gennakers

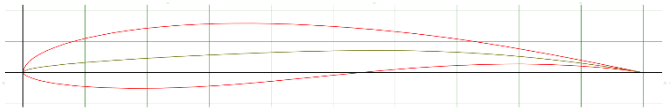


Keel, rudder and DSS-foil

Baltic yachts

- Keel
  - Naca 63-013
  - Ballast 55 tons
- Rudder
  - NACA 0012
- DSS
  - Wortmann FX 60-100





airfoiltools.com

Upwind Sailing Scenario

- AWA 27°
- Windspeed 5 m/s
- Leeway angle 4°
- Rudder angle 5°
- Heel 10°
- Resulting velocity 8 knots

Energy Production

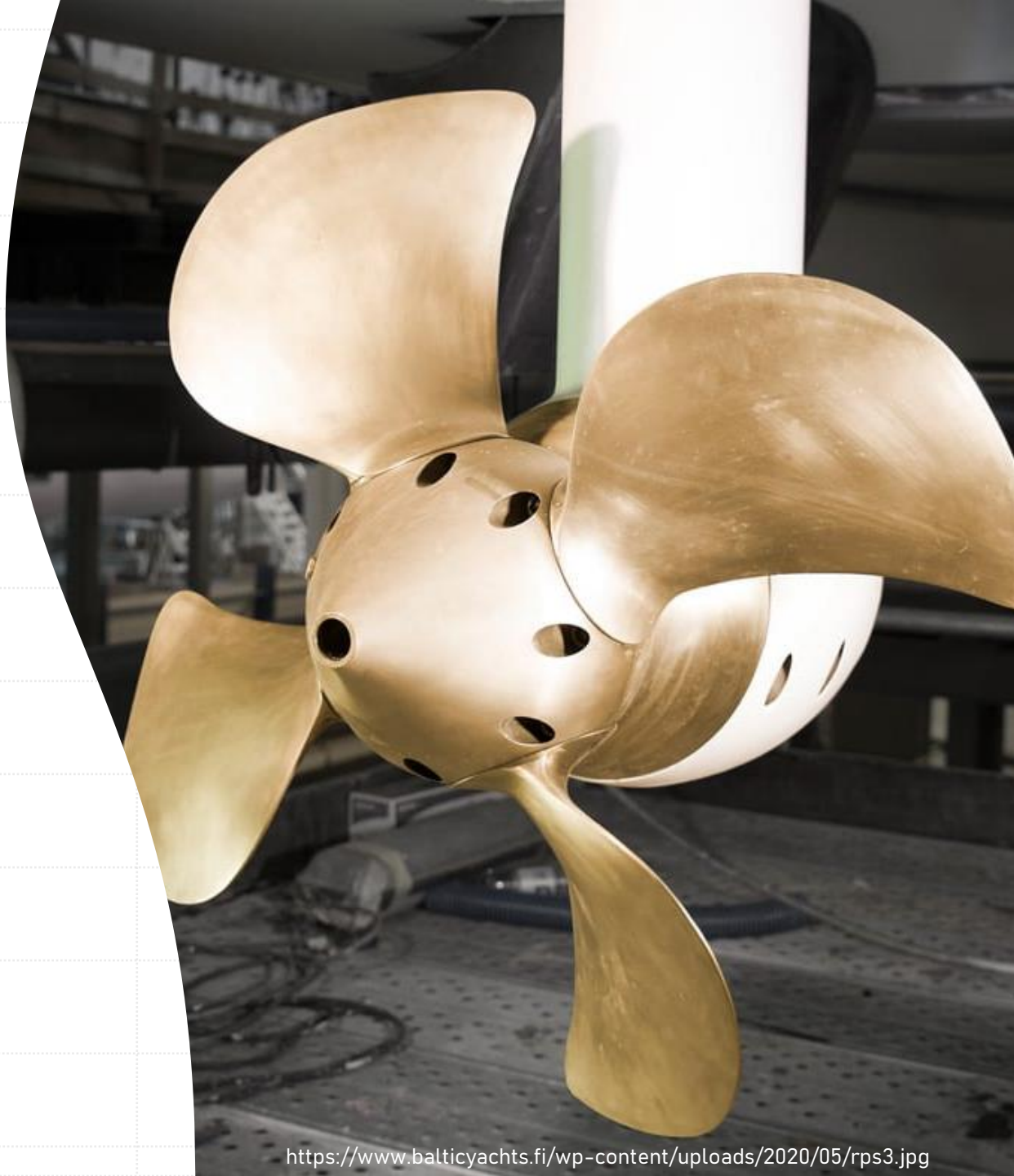
- Solar Panels
  - Roof
  - Sails
  - Total of around 800kWh a day
- Hydrogeneration
  - Total 120 kwh per day with 8 hours sailing
- Average sailing day at sea
  - More energy production than consumption

Batteries

- Depending on the Worst Case
  - Road: Round trip from Athens to Thessaloniki in 14 days, 8 hours motoring with 6 knot per day. 1 night staying in a port in Thessaloniki.
  - Limited sun light based on meteorological data
  - No wind
- Athens -> 7 days, 6knots for 8 hours per day -> 1 night Thessaloniki -> back to Athens
- With safety factor 1.5, up to 470 batteries, 3384kwh, 25t

Machinery

- 400 kW Electric Drive Pod
- Retractable Bow Thruster
- 2 x 100 kw Emergency Diesel Generator with 2 x 1000 liters Biodiesel tank.
- 33 hours of Emergency energy production



https://www.balticyachts.fi/wp-content/uploads/2020/05/rps3.jpg

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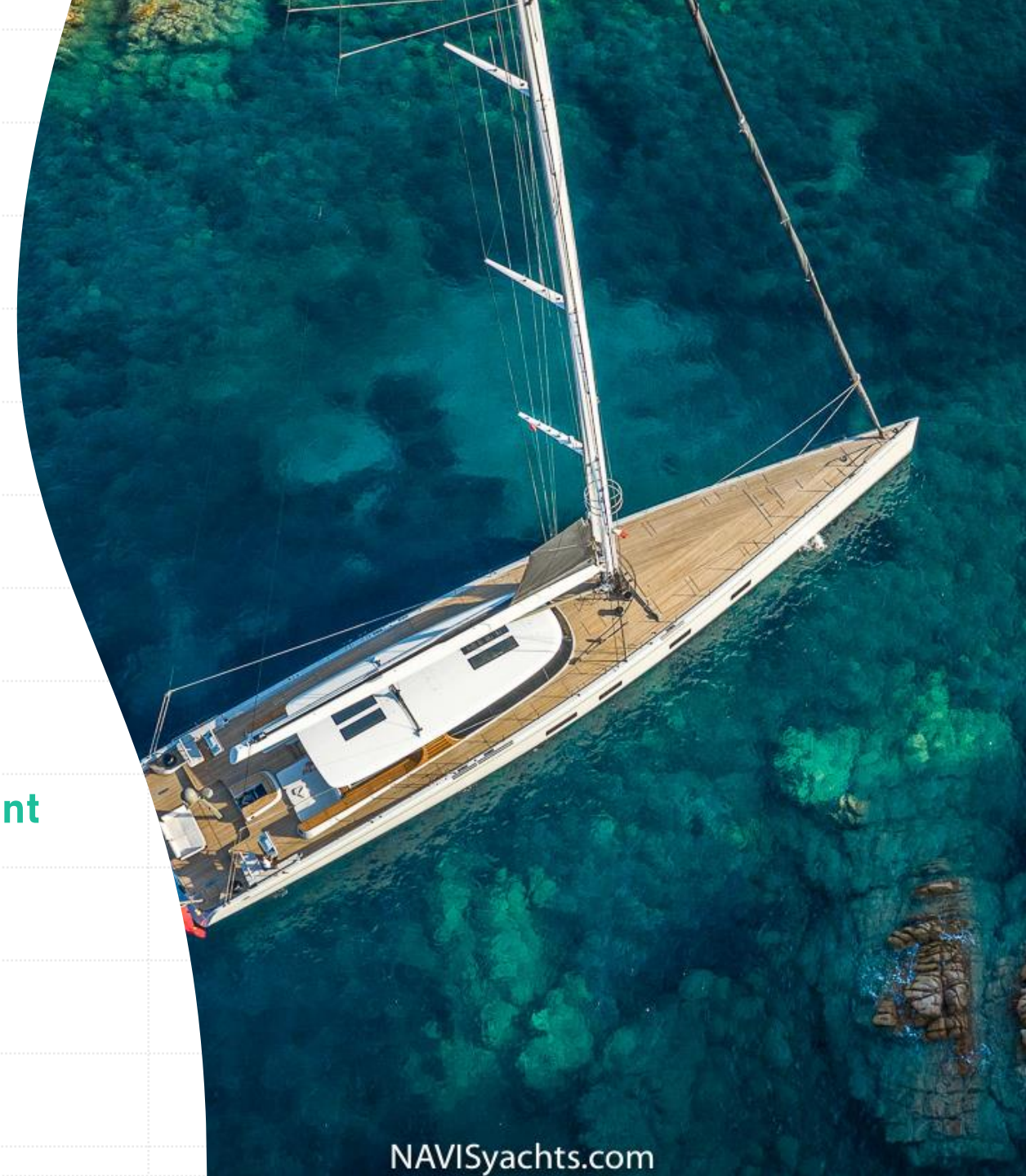
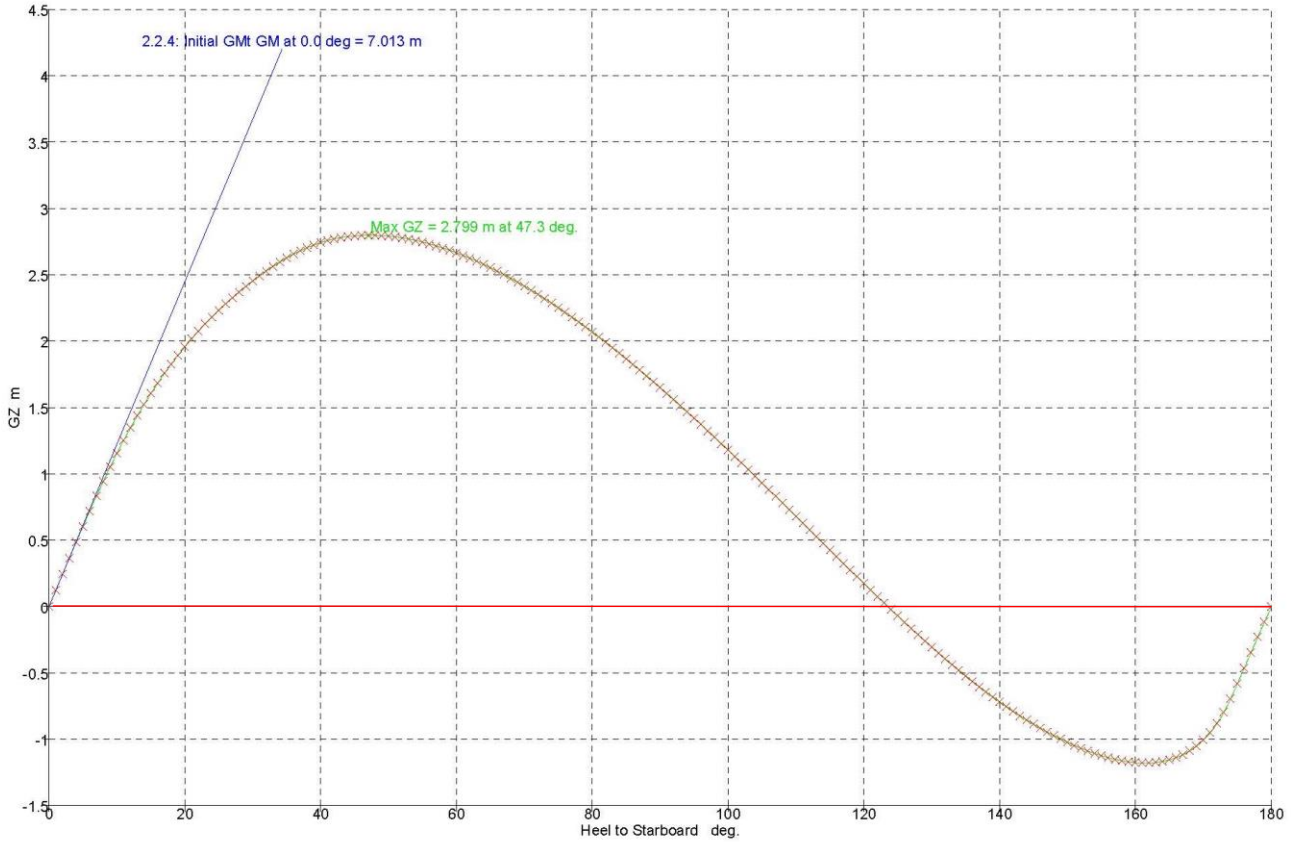


Weight Estimation

- Lightweight 171 tons
  - Hull Weight 54 tons
  - Keel 55 tons
  - Battery 25 tons
- Sailing condition displacement 179 tons
  - Deadweight 8 tons

http://www.futuna-yachts.com/construction/marine-aluminum

GZ Curve and Stability Assessment



- KG = 0.34
- GZ_{MAX} = 2.8 meters
- GM= 7.0 meters
- Positive stability 123°

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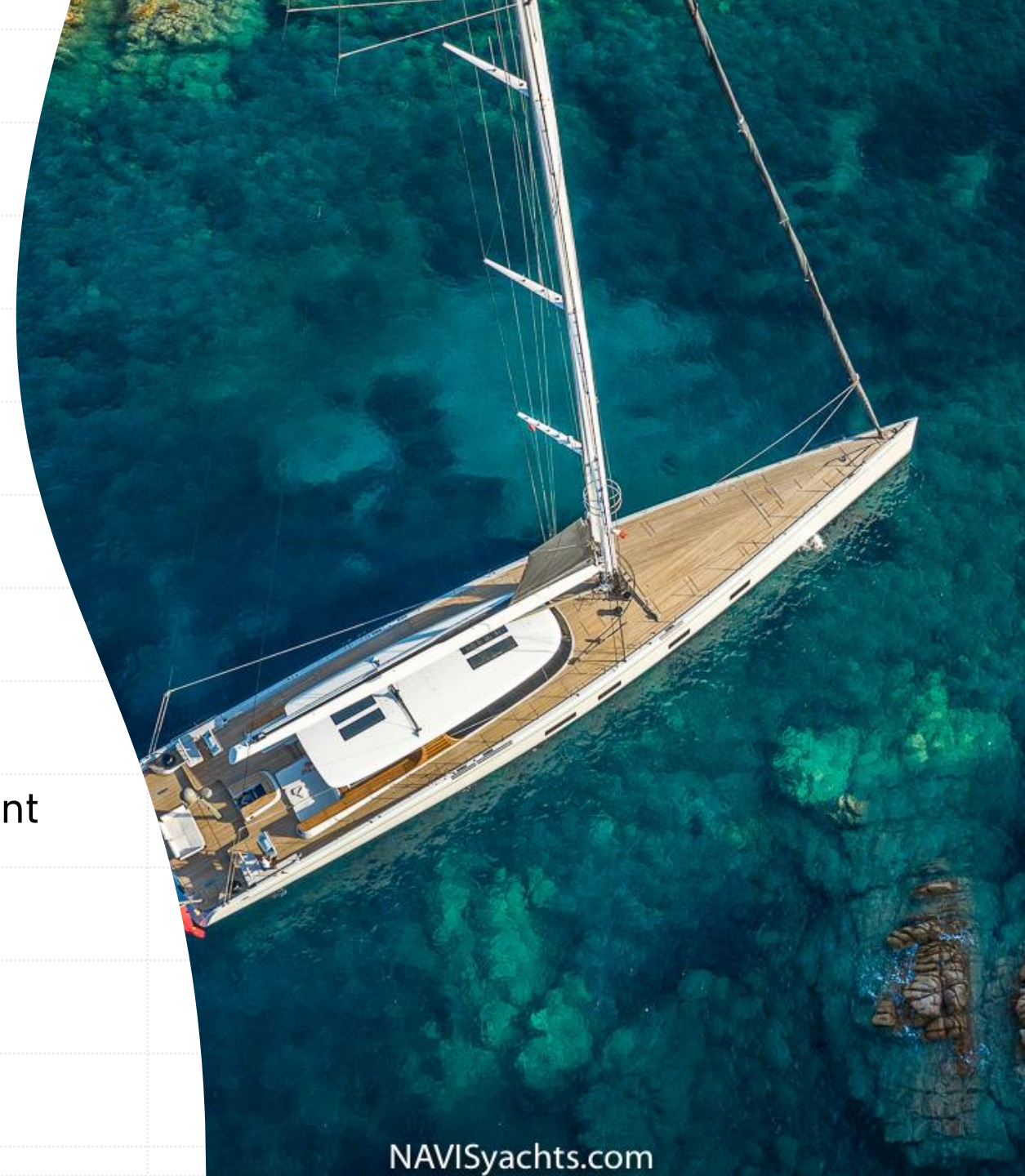


Economic Assessment

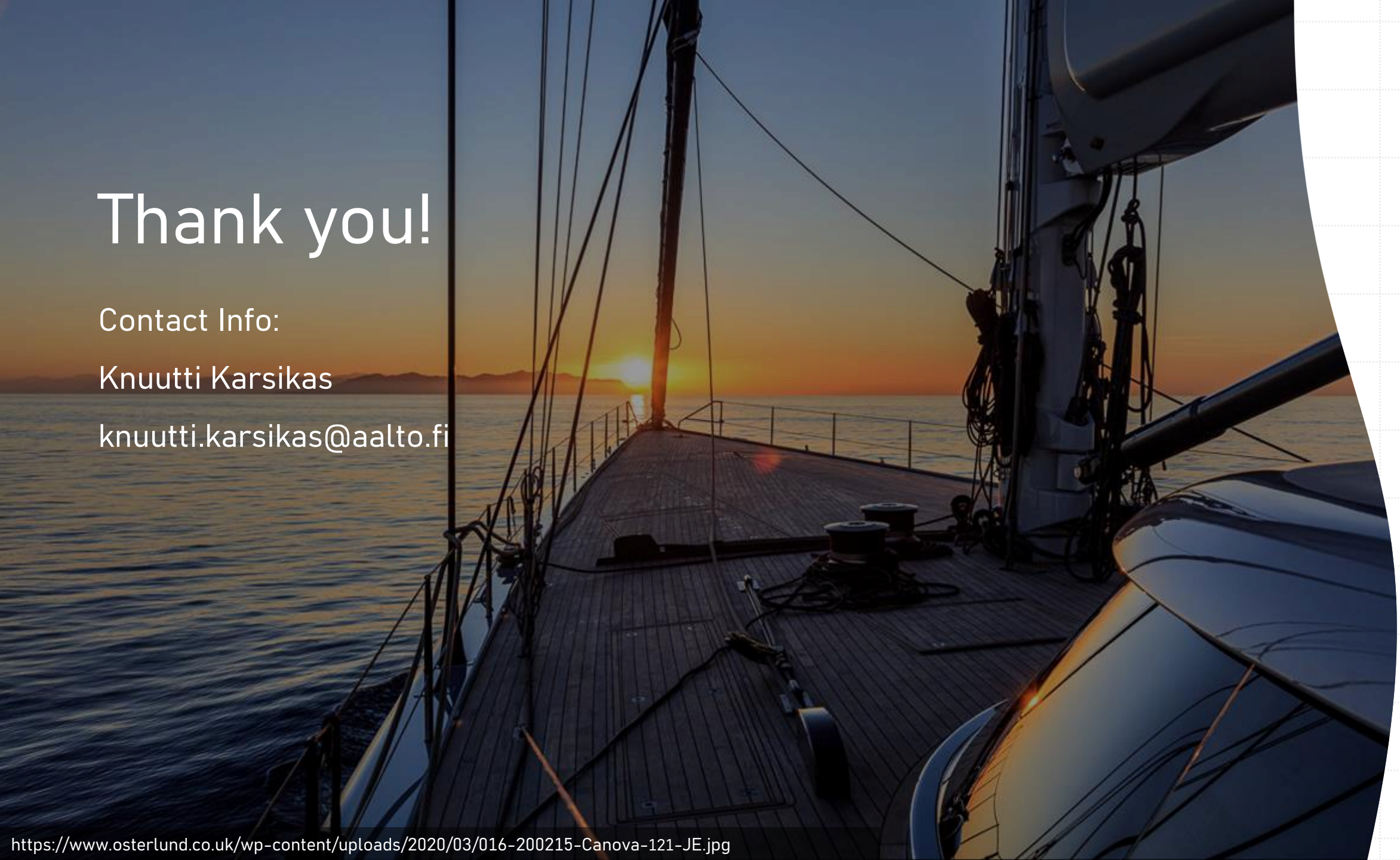
- 40 Million € Initial Investment
- 270 000 € Operational Costs Per Year
- 5.4 Million € Revenue per Year
- 5.1 Million € Profit per Year

Economical Assessment	
Initial Investment	40,000,000.00 €
6 Months Battery Charging Costs	9,240.00 €
Annual Maintenance Cost	100,000.00 €
6 Months Crew Salary	126,000.00 €
Mooring Fees	31,590.00 €
Total Cost Annually	266,830.00 €
Charter Price / Week	225,000.00 €
Operating Time	24 Weeks / Year
Revenue / year	5,400,000.00 €
Profit / year	5,133,170.00 €

EPSY

Energy self-sufficient
zero emission luxury sailing
experience for
12 guests in the Mediterranean Sea

https://www.balticyachts.fi/dynamic-stability-system/



Thank you!

Contact Info:

Knuutti Karsikas

knuutti.karsikas@aalto.fi

https://www.osterlund.co.uk/wp-content/uploads/2020/03/016-200215-Canova-121-JE.jpg