
The third-place project of the 12th National Ship and Yacht Design Competition is the ZADA project designed by Yasin Karakuş and Hasan Eroğlu from Yıldız Technical University, Department of Naval Architecture and Marine Engineering.


**Concept Design**

The 'Zada' project was designed in accordance with the concept of the 12th Ship and Yacht Design Competition organized by the Turkish Ship and Yacht Exporters Association, which called for a 24- meter catamaran excursion boat.

In Turkish mythology, Zada is depicted as the god who rules over the winds and storms. He rides his horse above the winds and embarks on journeys. His horse is depicted as brown-colored with hawk wings. This mythological motif forms the foundation of our concept. In the design process of the hull form, inspiration was drawn from the aerodynamic structure of the hawk.

**Design Features**

This project embraces harnessing the power of nature while also committing to preserving it. Therefore, its main principle is zero emissions. Consequently, the primary propulsion of the boat consists of sails and lithium-ion batteries. In the design process, imaginary systems that stray from feasibility were avoided to ensure manufacturability.

The main material of the boat is composite, with a preference for carbon fiber, and production will be executed using the vacuum infusion technique to ensure durability. Hydrofoil technology has been employed to reduce resistance, increase cruising speed, and extend the range.

**Certification**

Under the guidance of Turkish Lloyd regulations, boats under 24 meters obtain their qualifications by adhering to ISO standards. As a result of this qualification, they receive the CE (European Conformity) certification. There are various modules of the CE certification, which are categorized based on the capacity and capabilities of the boat. These modules are labeled as A, B, C, and D. The table provided byTurkish Lloyd, which explains these modules, is as follows:

Table 1. Modules of the Recreational Boats Regulations Prepared by Turk Loydu

| | **Design Categories** | **2.5 < Lh <12 (m)** | **12 < Lh <24 (m)** |
|---|---|---|---|
| Design and Structure | A Ocean | Module A1, B+C, B+F, G | B+C, B+F, G |
| | B Offshore | | |
| | C Coast | Where compliance with te harmonized standards regarding article 3.2 of annex-1.A of the 2013/53/EU regulation is ensured. Module A, A1, B+C, B+F, G | |
| | D Sheltered Water | Module A, A1, B+C, B+F, G | |
| | Personal Watercraft | A, A1, B+C, B+F, G | |
| | Ingredients | B+C, B+F, G | |

The following regulations have been followed in the design and production of Zada. As a result of adhering to these regulations, it falls into the category of Class A module, which allows for ocean crossings. In this module, the boat is expected to withstand up to 8 Beaufort (40 knots of wind) resistance.

Table 2. ISO regulations followed

| | |
|---|---|
| Selection of materials used in body and construction | ISO 12215-1 / ISO 12215-2 |
| Following hull manufactruing rules | ISO 12215-4 |
| Calculating pressure and tension | ISO 12215-5 |
| Determination of main dimensions of ship | ISO 8666 |
| Operation of electric bilge pump | ISO 8849 |
| Fire prevention instructions for boats of 15 m and above | ISO 9094 - ISO 10133 - ISO 13297 |
| Identity coding system | ISO 10087 |
| Max. Load capacity | ISO 14946 |
| Stability and Buoyancy classification | ISO 12217-2 |
| Country unit and code | ISO 3166 |
| Man overboard and rescue situation instructions | ISO 15085:2003 |
| Points of anchorage, connect to backup, mooring to buoy | ISO 15084 |
| Measuring sound emitted on pleasure boats | ISO 14509 |

**Development Process of the Hull**

In the process of developing the form, adjustments were made using points in 3D CAD programs to achieve the most optimal shape. Various types of forms were experimented with during these adjustments. Attention was paid to ensuring the desired displacement, and each area could be utilized without any technical area being lost. Resistance and power analyses were conducted on semi- displacement, planing, and single-chined forms using Computational Fluid Dynamics (CFD) applications.

Table 3. Main Dimensions and Features of the Boat

| | |
|---|---|
| $L_{OA}$ | 23.42 m |
| B | 13.5 m |
| T | 0.86 m |
| Mast Draft | 30 m |
| Sail Area | 220 $m^2$ |
| Vcr | 16 knot |
| Vmax | 36 knot |
| Range | 2160 miles |
| Referral System | Hydrofoil Pod |
| Electric Motor | TM4 SUMO LD HV1200 |
| Propeller | Pod System |
| Material | Composite/Carbon Fiber |
| Guest | 8 |
| Crew | 2 |
| Certification | CE/A |
| Displacement | 32.22 t |

Lithium-ion batteries, known for their higher energy density compared to other battery groups and their environmentally friendly nature, have been preferred. The carbon footprint of lithium-ion batteries is significantly lower than other propulsion systems. A seawater cooling system will be used as the cooling system. The closed-loop fresh water cooling circuit will be cooled by seawater continuously circulating from outside. A total of 48 modules were used for one electric motor-battery unit in a configuration of 8 series and 6 parallel modules. A battery pack with a capacity of 500 kWh was prepared for a total of 1 electric motor unit.


Figure 1 - ZADA Main System Diagram.

Sails were selected from the NACA series profiles. This choice was made because NACA profiles are highly efficient and successful in directing flow. The wing selected as a sail is the NACA-0018 profile.

For foil selection, wings from the NACA series were examined. The lift coefficient (CL) required to lift the boat from the water depends on the wing profiles, speeds, and angles. Graphs were used to determine the angles at which the wing profiles should be for the same CL. Initially, it was understood that symmetric wings were not suitable for the foil because higher angles were required for lift in symmetric wings. Therefore, asymmetric wings were preferred. Among asymmetric wings, examinations were conducted on NACA-63412, NACA-63145, and NACA-4412. It was found that the NACA-63412 profile was more suitable for this purpose.

Electric marine vehicles with long range capabilities need to be able to charge themselves without connecting to a port. This system, which will charge the boat's batteries as long as access to sunlight is available, will efficiently utilize these energy sources provided by nature.

There is space available on the upper deck for flexible solar panels totaling 57.16 $m^2$. Flexible black monocrystalline panels have been integrated into the roof in a way that is integrated with the boat's aesthetic structure without compromising its appearance. 38 panels are used, and it is calculated that 88.16 kW of energy will be gained after the most effective 8 hours of sunlight between 09:00 and 17:00. The efficiency of the panel is in the range of 22-23%.

Hydro-generators are a system installed to charge the battery while the boat is underway. When the boat is sailing solely with sails, the rotation generated by sailing will enable the propeller to charge the batteries. For this system, the one developed by Watt and Sea for integrated use with a shaft keel has been utilized. This system, easily controlled from its screen, starts charging the battery by adjusting the blade angles of the propeller when activated.

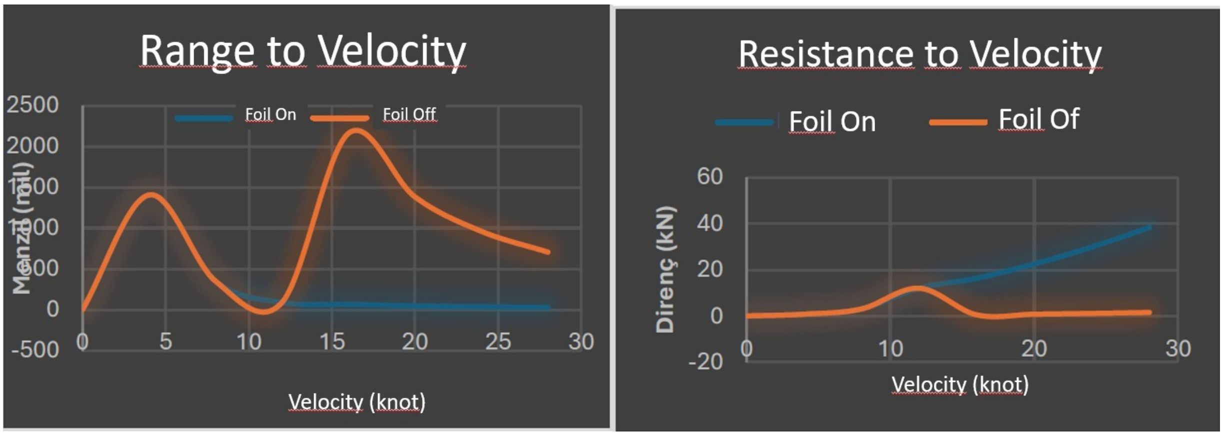



Figure 2 - Range and Resistance graphs versus speed.

Figure 3 - Hydrofoil arrangements.

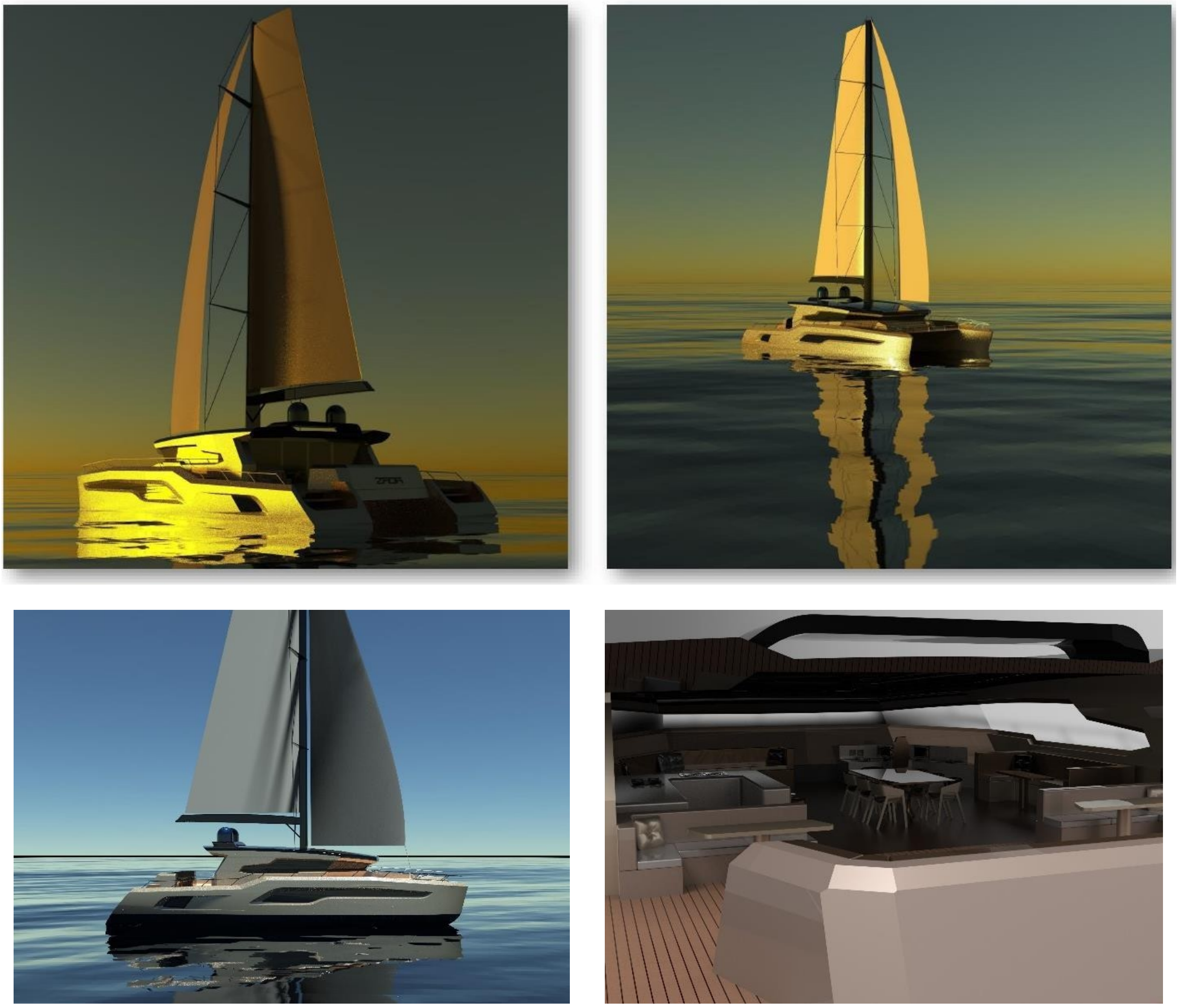


Figure 4 - Rendered views.


**Introduction**

The NOVA catamaran, with its 24-meter overall length, standsout as an innovative design with a modern approach aimed at reflecting nature and harmoniously blending with its surroundings. The word "NOVA", meaning new, is embodied in the design of the yacht. Designed with organic forms and natural colors, NOVA offers users an aesthetic and harmonious boating experience .

Additionally, the design focuses on minimizing environmental impacts by using sustainable energy and materials. These features ensure that the NOVA catamaran provides users with an eco-friendly and aesthetic maritime experience. The energy needs of the sailing NOVA catamaran are met through sustainable energy sources such as solar panels and wind turbines, reducing dependence on fossil fuels. This not only lowers operational costs but also aligns with the global shift towards renewable energy. Furthermore, using recycled or renewable materials in the boat's construction reduces waste and utilizes natural resources as well. The aluminum selected for the hull and superstructure stands out for its recyclability and lower impact compared to traditional materials. The material choice also contributes to the boat's longevity and ease of maintenance, ensuring it remains in top condition for many years.

The primary aim of this design is to create an efficient yacht while interacting lightly with the environment. The NOVA catamaran appeals to users seeking a high-quality experience by combining comfort, sustainability, and timeless design. The spacious deck layout provides space for relaxation, rest, and entertainment, while the latest technology enhances comfort and ease of use on board. High-end amenities, such as luxurious cabins, modern navigation systems, and advanced safety features, make every journey a pleasurable and secure adventure.

Combining the elegance of the design with a nature-friendly approach, ensures an unforgettable sea journey without worrying about environmental impacts.

**Principle Features**

| | |
|---|---|
| $L_{OA}$ = $L_{WL}$ = 24 m | Range: 300 nm at $V_{Trial}$ = 12 kn (Cruising speed) |
| B = 11.3 m | $V_{Service}$ = 10 kn |
| T = 0.88 m | Range: 350 nm at $V_{Economic}$ =7 kn |
| D = 47.5 t | Prime mover: Hybrid, Torqeedo Deep Blue 50i 2000/1200 rpm 80HP |

**Interior - Main Saloon**

The interior design of the NOVA catamaran aims to seamlessly blend with its natural surroundings by incorporating light and natural colors. Featuring a palette of open and bright tones, the interior creates a spacious atmosphere that enhances comfort and fosters a deep connection with the surrounding environment. This approach meticulously integrates the organic forms of NOVA‘s exterior into its interior, ensuring users experience consistency. Large windows are strategically placed to flood the interior with natural light, effectively bringing the outside scenery inside and amplifying the sense of being surrounded by natural beauty. This not only maximizes natural illumination but also enhances the overall ambiance of the living spaces. Materials selected for interior furniture and details are thoughtfully chosen, prioritizing recyclable and environmentally friendly options. This commitment ensures that every aspect of the interior design contributes to a greener and more responsible maritime experience. Overall, the interior design of the NOVA catamaran aims to create an inviting atmosphere onboard. It provides users with a comfortable and high-end experience while integrating seamlessly with the natural world.

**Innovative Features**

***Solar Sails***

Solar sails are an innovative and eco-friendly techno- logy that harnesses the power of sunlight. The sails con- sist of lightweight and integrated flexible solar panels into the fabric of the sail, generating electricity as they capture solar energy. The electricity produced can be used to power the boat's electrical systems and reduce reliance on conventional fuel sources, promoting a gree- ner and more sustainable sailing experience. Solar sails provide a clean energy solution and enhance the yacht‘s performance by reducing drag and improving efficiency. Embracing this cutting-edge technology allows sailors to enjoy a harmonious coexistence with nature while contri- buting to a cleaner and more environmentally responsible marine industry.

***Solar Panels***

Nova glides smoothly through the water, powered by ad- ditional solar panels that harness the energy of the sun to generate electricity. These photovoltaic panels are environ- mentally friendly, converting sunlight into clean, renewable energy that reduces the boat's reliance on traditional fuel sources and minimizes its carbon footprint. The solar panels effectively charge batteries, providing power for various onboard electrical systems, navigation instruments, lighting, and more. Their lightweight and compact design allows for seamless installation on the deck or mast, maxi- mizing energy generation potential without compromising the boat‘s appearance or performance. By embracing solar technology, sailors adopt a more sustainable approach to sailing, promoting eco-friendly practices in the marine in- dustry and fostering a harmonious coexistence with nature.

***Hydro Generators***

Hydro generators, also known as water generators or hy- dro-turbines, are innovative devices used on sailboats to generate electricity from the kinetic energy of water as the yacht moves through the waves. These eco-friendly gene- rators provide a sustainable energy solution, particularly during extended sailing voyages or when at anchor, as they continuously produce electrical power from the boat's motion. Hydro generators are designed to be compact, easy to install, and generate minimal drag, making them suitable for sailboats. By harnessing the power of water, sailors can reduce their reliance on traditional power sources, lower carbon emissions, and embrace a more environmentally conscious approach to sailing. Embracing hydro genera- tors contributes to a greener and more self-sufficient sailing experience, aligning with sustainable practices in the marine industry.

***Wind Generators***

Hydro generators, also known as water generators or hy- dro-turbines, are innovative devices used on sailboats to generate electricity from the kinetic energy of water as the yacht moves through the waves. These eco-friendly gene- rators provide a sustainable energy solution, particularly during extended sailing voyages or when at anchor, as they continuously produce electrical power from the boat's motion. Hydro generators are designed to be compact, easy to install, and generate minimal drag, making them suitable for sailboats. By harnessing the power of water, sailors can reduce their reliance on traditional power sources, lower carbon emissions, and embrace a more environmentally conscious approach to sailing. Embracing hydro genera- tors contributes to a greener and more self-sufficient sailing experience, aligning with sustainable practices in the marine industry.

***Eco Teak***

Eco Teak is a sustainable and eco-friendly alternative to traditional teak wood used in sailboats. It is sourced from responsibly managed teak plantations or reclaimed teak, thereby reducing the impact on natural forests. Eco Teak undergoes a chemical-free treatment process, ensuring it is free from harmful substances and environmentally friend- ly. This eco-conscious teak option maintains the aesthetic appeal and durability of traditional teak while promoting a more sustainable approach to yacht construction. By choo- sing Eco Teak for the deck and interior of sailboats, sailors can enjoy a beautiful and luxurious finish without compromising their commitment to environmental conservation.

***Antifouling***

Antifouling coatings play a crucial role in protecting sea- farers from biofouling, preventing the growth of algae, barnacles, and other marine organisms on the hull. These coatings create a smooth surface that reduces drag, enhan- cing the yacht‘s performance and fuel efficiency. Choosing eco-friendly alternatives that are biocide-free and environ- mentally friendly is the preferred option over relying on traditional antifouling products that may contain harmful chemicals. Bio-based antifouling solutions, such as copper- free coatings or photocatalytic technologies, offer effective fouling protection without harming marine ecosystems. Embracing eco-friendly antifouling practices is not only beneficial for the environment but also ensures cleaner waters and a more sustainable sailing experience for all.

The electrical propulsion system on sailboats is an eco- friendly technology that replaces internal combustion en- gines with electric motors. It utilizes electricity from re- newable sources such as solar panels or hydro generators, thereby reducing reliance on fossil fuels and lowering car- bon emissions. This system ensures quiet, smooth opera- tion and precise maneuverability, enhancing the sailing experience. Regenerative braking optimizes energy efficiency by converting kinetic energy back into electricity. By adop- ting electrical propulsion, sailboats contribute to cleaner and more sustainable sailing practices, aligning with the sustainable practices in the marine industry.

**Electrical Propulsion System**

The electrical propulsion system on sailboats is an eco-friendly technology that replaces internal combustion engines with electric motors. It utilizes electricity from renewable sources such as solar panels or hydro generators, thereby reducing reliance on fossil fuels and lowering carbon emissions. This system ensures quiet, smooth operation and precise maneuverability, enhancing the sailing experience. Regenerative braking optimizes energy efficiency by converting kinetic energy back into electricity. By adopting electrical propulsion, sailboats contribute to cleaner and more sustainable sailing practices.

1 - Exterior views.

2 - Interior views.


Our design takes advantage of the width of catamarans and their high stability characteristics to maximize both comfort and green energy production. Featuring a total of 4 decks, including fly bridge, is a rare feature for conventional boats under 24 meters. The high depth of our boat provides spacious main and guest cabins not typically seen in conventional catamarans. The crew's cabins are also kept on a separate deck. By chosing main production material as Marine Grade Aluminium, we took advantage of light and strong hull.

Convenient for transatlantic voyages, our electric propulsion system-equipped catamaran integrates solar panels, wind turbines, and hydro generators, resulting in a green power generation capacity of up to 77 kWp and the ability to self-propel at speeds of up to 5 knots without running the generator. With robust diesel generators and large tank capacities, it will continue uninterrupted voyages even in adverse weather conditions.

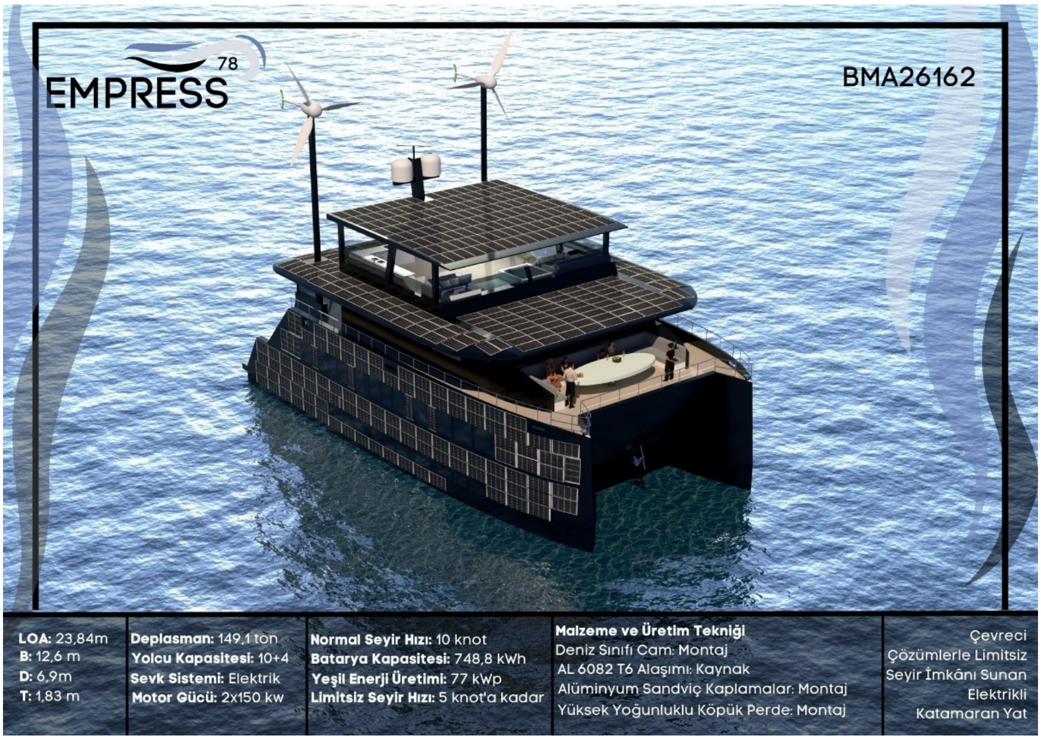
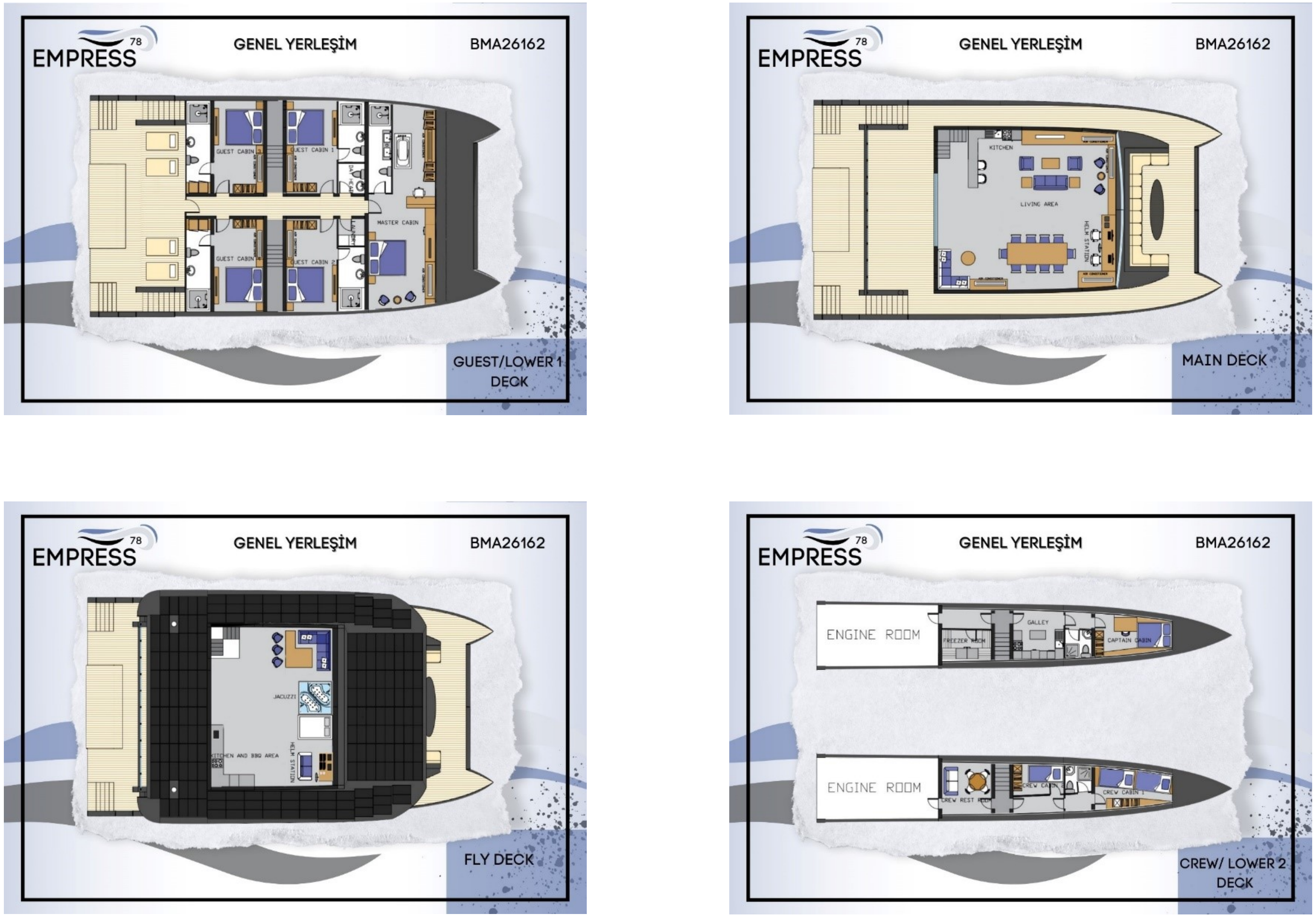



Figure 1 - Exterior view and specifications.




2 - General arrangement plans.

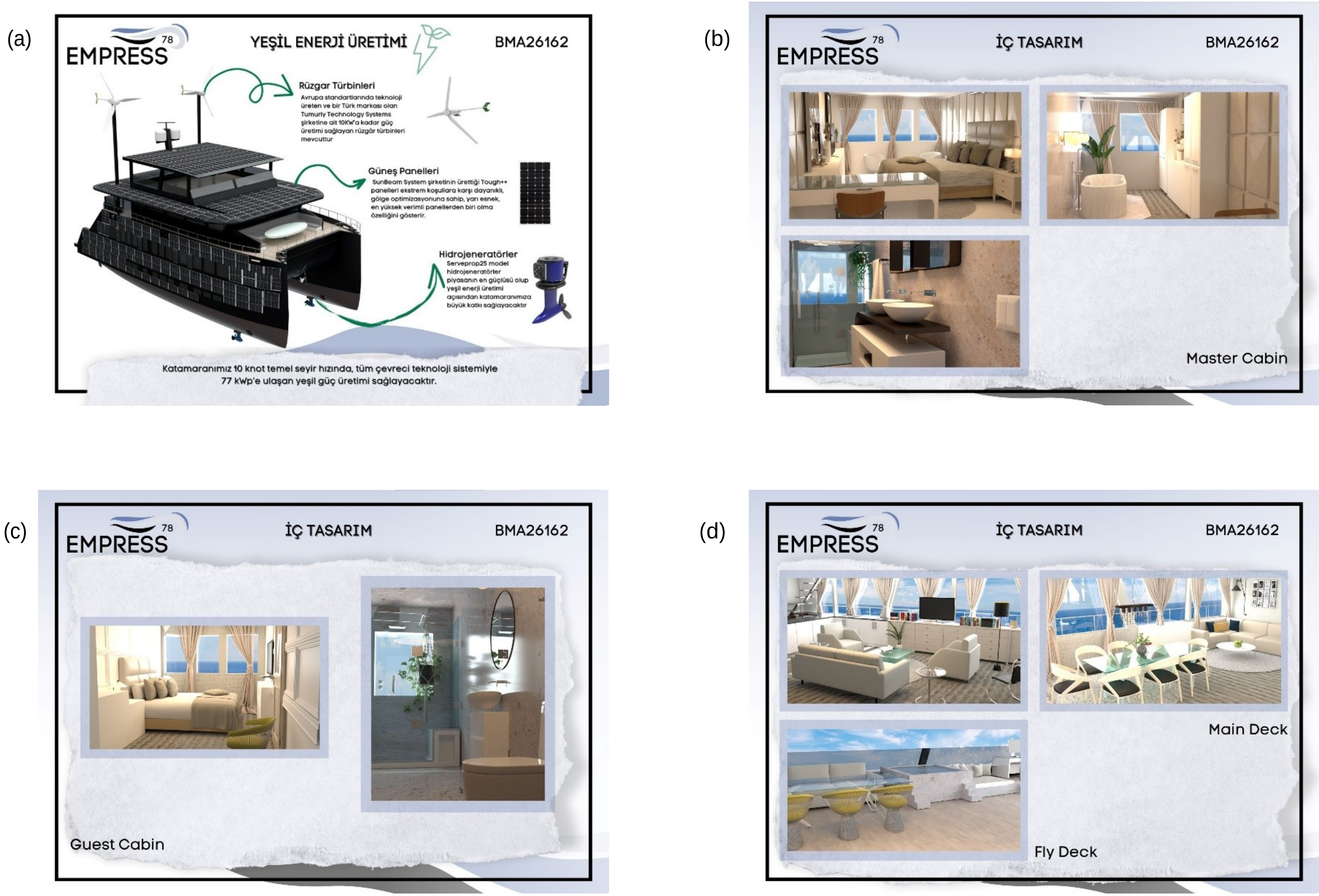



Figure 3 - a) Energy production; b), c) and d) Interior views.


HERON is a composite electric concept catamaran with modular hydrofoils. Thanks to hydrofoils, it can reach speeds that require a lot of power for a standard 18 meter long yacht, but with lower power. In addition to the efficiency they provide, hydrofoils also add an impressive visual appearance to Heron when closed. This visuality forms a whole with Heron's sharp and aggressive design lines.

In addition, it can meet this power at lower values by using sharrow propellers, which are more efficient than normal propeller profiles, and thanks to the hydraulic pump-driven power transmission system. This system works by rotating the propeller with high pressure hydraulic fluid sent to the centrifugal system in the propeller, instead of connecting the propeller to the engine with a shaft. Heron has a very environmentally friendly concept in line with all these developments. However, if a propeller integrated into the standard hull was used when lifting the boat onto the hydrofoils, the propellers would also remain out of the water. For this reason, the propellers are not integrated into the hull, but into the system at the back, which has a hydrofoil wing and functions as a rudder, so that the propellers do not lose their function when the boat lifts out of the water.

Since HERON is a catamaran, there was a lot of space to work with, so we tried to utilize them as much as possible. The space between the Heron's hull was suitable for a hydraulic deck, which enabled a 2-meter openable deck at the bow of the boat. Thanks to this deck, it provides an extra deck area of 4 square meters and can also be accessed in cases where the wings prevent access from the side and rear.

HERON is a comfortable catamaran having a large main deck lounge as well as a large aft deck outside the 18 meter standard. A hydraulic deck in the middle of the aft deck was designed to perform boat loading and unloading operations and to expand the deck area slightly by lifting it to the main deck level.

This width of the rear deck and low board height offer a high level of comfort in fishing activities. The front deck, which is at least as wide as the rear deck, can be used as a sunbathing area.

HERON also has an upper deck that can be accessed by climbing up from the main deck lounge. The upper deck offers a very spacious area with 360 degree visibility and a glass ceiling.

In addition to the comfort provided by all exterior decks, it also offers comfort and luxury living space inside with its large master cabin, guest cabin, kitchen and bathroom.

HERON is a highly technological electric catamaran with all its efficiency and comfort features. All the controls that the captain will need have been integrated so that they can be controlled from the large touch screen. Thus, confusion and difficulty of use in the control panel was prevented.

Figure 1 - Exterior views.

Figure 2 - Principle deck view.

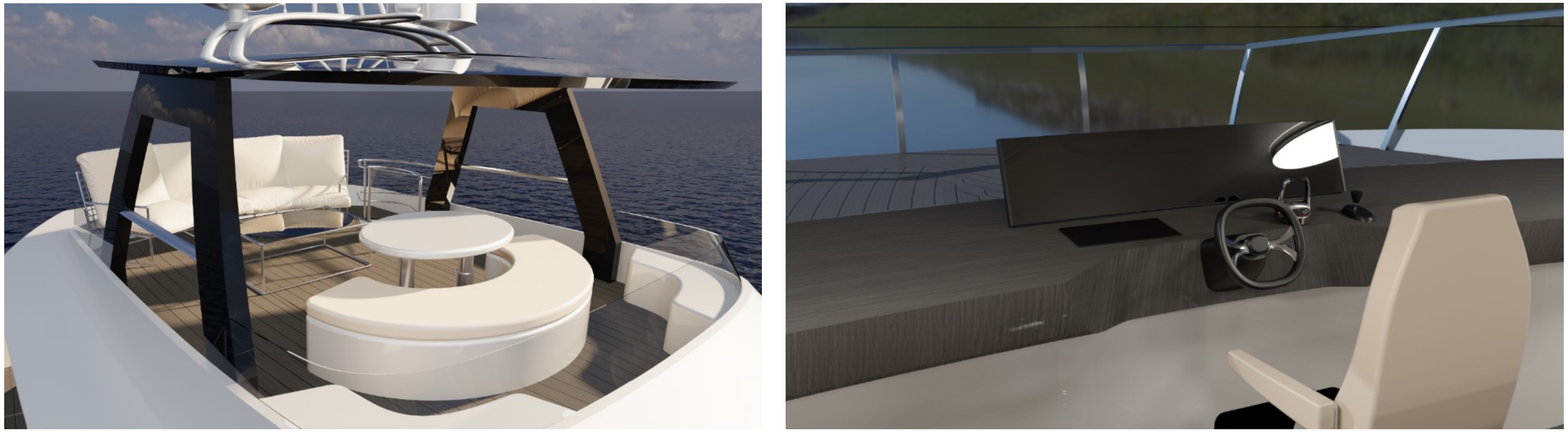


Figure 3 - Upper deck and bridge views.

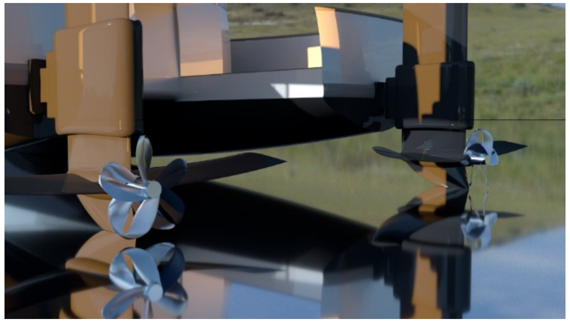


Figure 4 - Propeller arrangement.

Figure 5 - Interior views.


HYCata-HOPE (Powered by Hydrogen) is a zero-emission, environmentally friendly, zero-emission cruising catamaran that uses Sodium Boron Hydride as fuel and promotes the use of renewable energy sources. The Paris Agreement aims to mitigate climate change and its risks globally, and the maritime sector is expected to contribute to this goal. The Paris Agreement directs companies to new investments and research to reduce greenhouse gas emissions and reduce carbon emissions in order to keep the increase in global average temperature below 2 degrees Celsius compared to pre-industrial levels and to limit the increase to 1.5 degrees Celsius as much as possible. This catamaran has the potential to reduce carbon emissions and their impacts. And in these times when green energy is on the agenda, it could be a good alternative for companies.

**Specifications**

HYCata-Hope is a CE certified luxury cruising catamaran that complies with ILO, IMO, SOLAS,MARPOL international rules and prioritizes energy efficiency and passenger comfort.

Length Overall: 21.57 m

Breadth moulded: 9.89 m

Depth: 5.487 m

Draught: 1.879 m

Displacement: 148.8 t

Cruising Speed:12 knot

Wetted Surface Area: 210.684 $m^2$

$C_B$ = 0.578

$C_M$ = 0.829

$C_P$ = 0.708

HYCata-Hope engine room consists of 2 decks and 1 bridge. The main deck consists of five cabins. There is one master class, two A class and 2 crew cabins on the main deck. The second deck consists of the galley and social living areas.

**Propulsion System and Components**

**Power supply - Hydrogen and solar panels**: Using Hydrogen from Sodium Boron Hydride, a proton exchange membrane (PEM) fuel cell generates 4080 kW of power in 12 hours. The solar panels installed on HYCATA-Hope cover an area of 23 square meters. Each solar panel provides 440 W of power and can generate 27.5 kW of energy per day. The energy from the solar panels will be used for the equipment.

**Fuel cell:** PEM fuel cell was selected to use in HYCata-Hope. Two 130 kW PEM fuel cells were selected per vessel, totaling 4 PEM fuel cells.

**Battery System:** For HYCata-Hope, there are two batteries on each boat and 4 batteries in total. Each battery is selected to provide 125 kW/h of energy.

**Electric motor :** For the motor, a 4-pole electric motor producing 160 kW of power was selected.

HYCata-Hope is an innovative zero-emission catamaran powered by Sodium Boron Hydride. Its aim is to reduce emissions, especially carbon emissions, and minimize the effects of global warming within the framework of the Paris Climate Agreement.

Unlike conventional ships, it uses Sodium Boron Hydride as fuel. Sodium Boron Hydride is stored in a tank on board. This ship converts the Hydrogen gas produced as a result of the reaction of Sodium Boron Hydride with water into electrical energy with a fuel cell and provides propulsion by means of an electric motor. After the reaction of Sodium Boron Hydride with water, Sodium Metaborate ($NaBO2$) is produced as waste. This component is stored on board for the production of Sodium Boron Hydride again. A Proton Exchange Membrane Fuel Cell was selected for the conversion of hydrogen to electricity in the system. This fuel cell has a high power density.

It is intended to use waste wind turbine blades in the production of HYCata-Hope. The blades of large modern wind turbines consist of 95% glass reinforced plastic material (Dan and Veigh, 2001). Glass reinforced composite materials are preferred because they are lightweight, have high strength and corrosion resistance, and are easy and economical to produce compared to other fiber reinforced plastics. The lifetime of wind turbines is 20-30 years on average. It is estimated that waste wind turbine blades constitute 10% of fiber reinforced composite material waste in Europe.

Mechanical grinding method will be used for the recycling of wind turbine blades made of glass reinforced plastic material. Mechanical grinding is one of the effective methods that can be used for the recycling of glass fiber reinforced wind turbine blades. This method aims to break the wind turbine blades into small pieces and pulverize them. Other methods are pyrolysis, gasification and solvolysis, which are more complex and costly processes. In addition, these processes have not yet reached industrial solutions. Mechanical grinding is a more suitable and practical option. Glass fiber wind turbine blades subjected to mechanical grinding can be pulverized and then prepared with epoxy, a type of thermoset resin, and reused in composite boat construction. Thermosetting resins are used in many areas such as automotive parts, aircraft components, shipbuilding, wind turbine blades, composite structures and insulation materials. Epoxy is preferred as a resin because it has superior mechanical properties and strength, is more waterproof than polyester, which is also a type of thermoset resin, is less sensitive to temperature and humidity than polyester, and can be used even at temperatures below zero degrees with special hardeners. In addition, suitable parts can be cut from waste wings that have passed the preliminary examination and have sufficient strength and can be used as structural elements such as curtains, beams, decks, etc. in boats.

Innovative ideas include digital twin system, Gate Rudder, Power Management System, Battery Management System, liquid glass application as underwater coating for ships, and utilization of waste wind turbine blades.

**Innovative Features**

**Recycling of Waste Wind Turbine Blades:** Waste wind turbine blades will be used in the construction of the ship. According to research, wind turbine blade waste is estimated to increase to approximately 2 million tons globally by 2050, and this problem reveals the importance of recycling waste wind turbine blades. Thanks to this ship, waste turbine blades will be utilized.

**Power Management System:** Examination of resources, consumption analysis and energy stability an automation system that performs activities and ensures the continuity of the electrical power system

Power Management System (PMS) will be used in HYCata-Hope for its benefits in energy efficiency and battery management. PMS prevents unnecessary energy expenditures and optimizes energy according to demand. It also balances loads, helping to use energy resources efficiently and prevent overloading. PMS also enables remote monitoring and control of energy consumption. PMS for batteries prevents overcharging and discharging and increases battery life. In short, PMS ensures the continuity, safety and reliability of the electric power system.

**Battery Management System:** Battery Management System (BMS) will be used to secure and control the battery used in HYCata-Hope. The BMS controls and manages the charging and discharging processes of battery packs that are formed by connecting one or more batteries in series or parallel. This system will measure various parameters such as voltage, current, temperature and keep the battery within safe limits. At the same time, BMS can increase battery life and efficiency

**Digital Twin:** Digital Twin can predict problems, prevent failure, and plan the future by monitoring, analyzing and simulating data. In this way, inspection costs can be reduced and inspection quality can be increased. This system can be used in many areas such as capacity planning, efficient use and optimization of resources, passenger comfort, fault prediction. Currently, digital twins are used as design support in the maritime industry and are used for visualization, analysis and calculation, and various improvements. HYCata-Hope will be equipped with sensors for the digital twin system, which will perform functions such as passenger comfort, performance analysis, fault detection and prevention.

**Liquid Glass Application:** Liquid glass forms a protective layer on surfaces, increasing the durability and resistance of surfaces and providing surface protection and resistance to abrasion. When used in contact with water, it prevents the accumulation of organisms and substances on the surface thanks to its anti-fouling feature, thus reducing the friction of the ship under water. This can save fuel and prevent corrosion. Liquid glass will be applied to the underwater section of HYCata-Hope.

**Gate Rudder:** HYCata-Hope is designed to provide additional thrust, increase maneuverability, energy and An innovative rudder system "Gate Rudder™" is used to reduce fuel requirements. Gate rudder provides up to 14% fuel savings. This value can increase up to 30% in extreme weather conditions. The gate rudder can generate additional thrust with the twin rudder fans around it, giving the ship the ability toIt can provide a great advantage over conventional rudder in port and pier maneuvers. This reduces energy use, cavitation, vibration and underwater noiselevels, resulting in a better navigation.

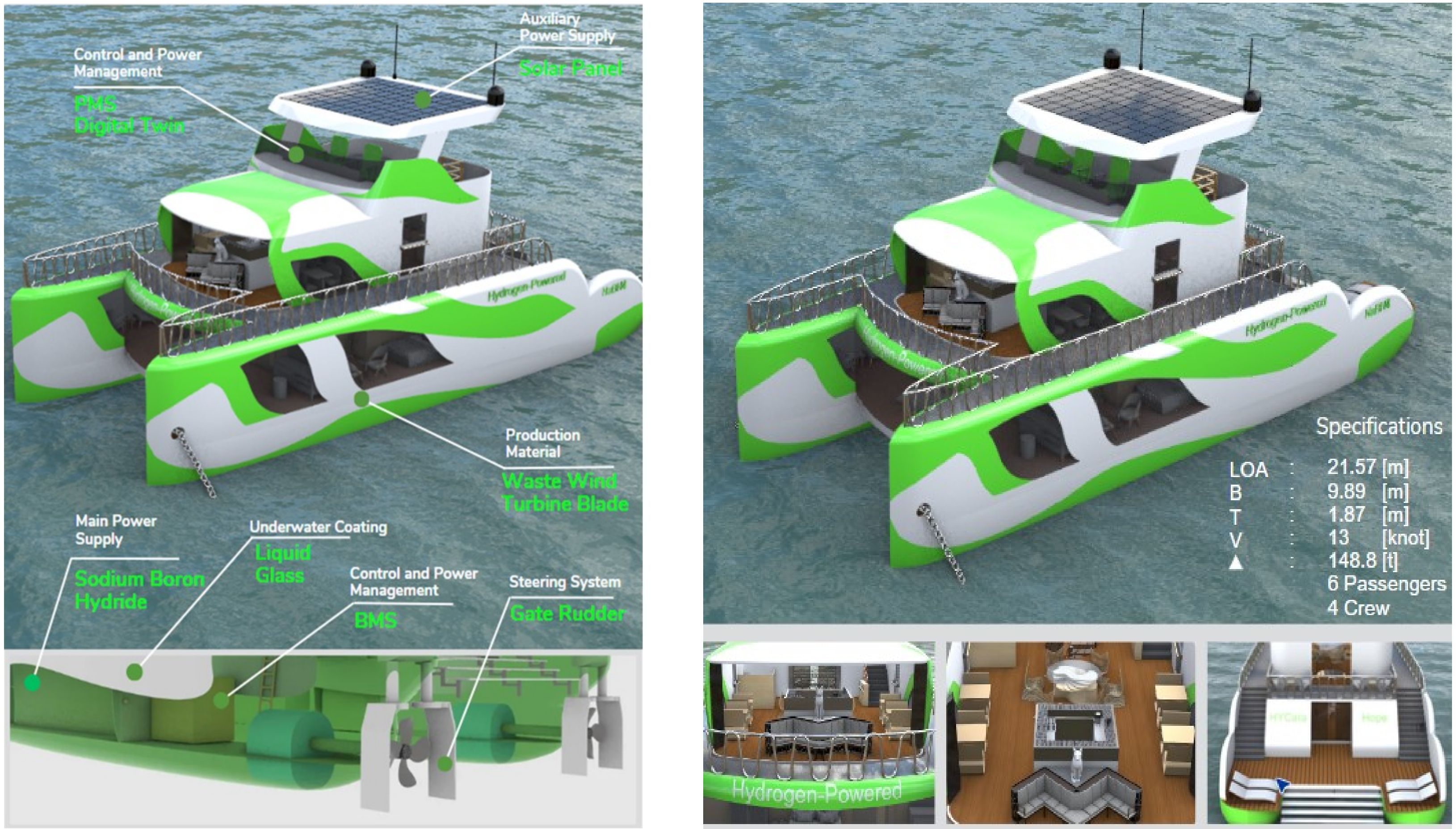



Figure 1. General Features and accomodation spaces of HYCata-Hope.


Figure 2. Deck plans and accomodation spaces.

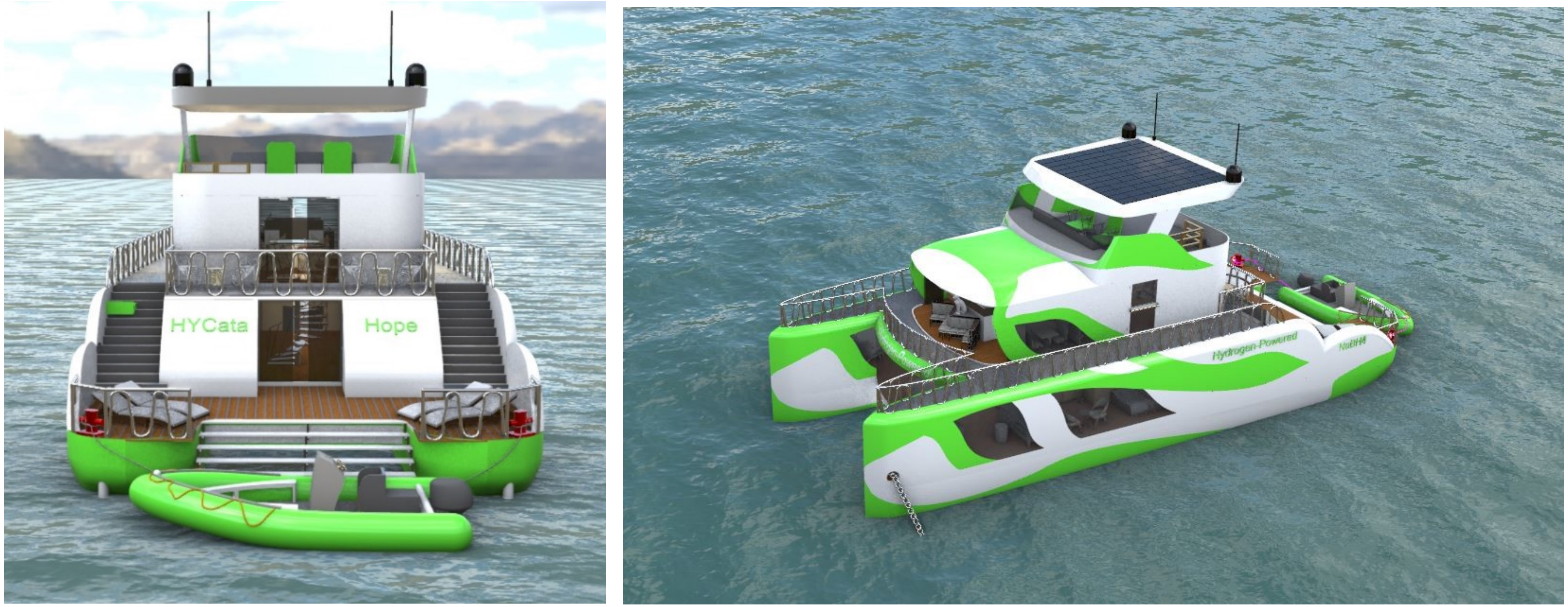



Figure 3. Outside views.