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MANAGEMENT AND GREEN YACHTING: CHALLENGES AND OPPORTUNITIES IN THE MODERN ERA

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"...water will be used as fuel, the hydrogen, and oxygen
of which it is composed will be developed individually
or simultaneously providing a source of heat and
inexhaustible light that cannot be compared to carbon, right?"

Jules Verne "Mystery Island" 1874

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ΠΕΡΙΛΗΨΗ

Ο σκοπός της παρούσας πτυχιακής είναι η μελέτη και ο προσδιορισμός της έννοιας τι είναι πράσινο yachting. Το συνεχώς αυξανόμενο ενδιαφέρον για την προστασία του περιβάλλοντος και τις μεταφορές χαμηλών εκπομπών έχει επηρεάσει και την αγορά σκαφών αναψυχής, η εργασία αποσκοπεί στη μελέτη των προσκλήσεων αλλά και των ευκαιριών της ενσωμάτωσης των πράσινων στρατηγικών στην βιομηχανία του yachting.

Σε αυτό το πλαίσιο, και καθώς η κλιματική αλλαγή είναι μείζων θέμα, διερευνώνται οι νέοι τρόποι που παρέχουν οι νέες τεχνολογίες για την παραγωγή ενέργειας, η εργασία έχει σαν στόχο να παραθέσει αυτά τα θέματα ώστε να μπορέσει να επιτευχθεί ένα πιο στοχευμένο, βιώσιμο και πράσινο μέλλον.

Για την επίτευξη των παραπάνω, η παρούσα πτυχιακή βασίζεται στην βιβλιογραφική ανασκόπηση και γίνεται μια προσπάθεια εννοιολογικής αποσαφήνισης των όρων πράσινο yachting, πράσινη οικονομία, των συμβάσεων για την προστασία του θαλάσσιου περιβάλλοντος καθώς και μια προσπάθεια κατηγοριοποιήσεις τους, για την δομημένη και ολοκληρωμένη αξιοποίηση τους.

Keywords: Sustainable yachting, Environmental awareness, MARPOL, Carbon Footprint, Pollution, Climate Change, Sustainability, Yachts

ABSTRACT

The purpose of this thesis is to study and define the concept of green yachting. The growing interest in environmental protection and low-emission transport **is** also affecting the yacht market, the thesis aims to study the challenges and opportunities of incorporating green strategies in the yachting industry.

In this context, and as climate change is a major issue, new ways provided by new technologies for energy production are explored, the paper aims to list these issues so that a more focused, sustainable, and green future can be achieved.

To achieve the above, this thesis is based on the literature review, and an attempt is made to conceptually clarify the terms green yachting, green economy, conventions for the protection of the marine environment, and an attempt to categorize them for structured and integrated utilization.

Keywords: Sustainable yachting, Environmental awareness, MARPOL, Carbon Footprint, Pollution, Climate Change, Sustainability, Yachts

ABBREVIATIONS

CO2 (Carbon dioxide)

CSE (The Centre for Sustainability and Excellence)

ECAs (Emissions Control Areas)

EEDI (Energy Efficiency Design Index)

EPA (Environment Protection Agency)

EU (European Union)

FDHF (The Fast Displacement Hull Form)

FUBS (The Fort Lauderdale Boat Show)

IMO (International Maritime Organization)

ISM (International Safety Management)

LY2 (Large Commercial Yachts Code)

MARPOL Convention (International Convention for the Prevention of Pollution from Ships)

MCA (Maritime and Coastguard)

MEPC (IMO, Marine Environment Protection Committee)

NYYC (New York Yacht Club)

SEEMP (Ship Energy Efficiency Management Plan)

UK (United Kingdom)

USA (United States of America)

YETI (Yacht Environmental Transparency Index)

CHAPTER 1

1.1 HISTORICAL BACKGROUND

Since ancient times, there has been a desire for discovery and a need to explore even the most remote corners of the world. It was out of this constant need and search that the construction of the ship began. Even from time immemorial, romance has drawn people to explore the sea (Lynn Barnes, 2010).

There were ships and boats to protect the city's borders from pirates, sea trade, or invaders. Joyful crafts have not yet appeared. There was a ship, which usually carried the king, called the "State Boat" (Lynn Barnes, 2010).

The earliest reference dates back to 3000 BC and was the barge of Pharaoh Khufu, parts of which are found in his tomb in the Pyramid of Giza (Lynn Barnes, 2010). While in 42 BC the first mention is made of a royal yacht that belonged to Queen Cleopatra. Plutarch reported that the entire population of the city had gone to the bank of the river Cydnus, as they searched for Mark Antony none had ever seen such a yacht before. Cleopatra used her yacht to win over Mark Antony, who was impressed by her display of wealth and power.

Numerous accounts of the elite of the Greeks, Romans, and Chinese showed a great affinity for yachts, as descriptions of the interiors included furniture that suited their luxurious style (Lynn Barnes, 2010). Other rulers who used yachts for pleasure and state power were Ptolemy II (283-246 BC) who had a whole fleet of royal yachts and Caligula (37-41 BC) who had royal yachts with decks and attendants.

Ownership of royal yachts spread from Europe to Great Britain by the 7^{o} century (Lynn Barnes, 2010). In the 8^{o} century play, ships were mentioned which symbolized power and wealth. They were also considered "State Ships" because they too usually carried kings or other important persons. Play ships even had the ability to cook on board (Wikipedia, 2022).

The first attempt to define what a yacht was made was by Falconer in 1771 who states that these vessels were usually equipped with a variety of convenient compartments, with suitable furniture, depending on the quality of the people on board (Falconer, 1955).

The etymology of the term comes from the Dutch word "jacht", which means hunting, which was previously used to describe the fast-sailing boats used to chase smugglers, pirates, and criminals along the coast of Northern Europe (ASA, 2022). The Dutch navy first used yachts

to catch pirates (Wikipedia, 2022). Wealthy shipowners and merchants began using these small yachts to sail and celebrate returning merchant ships. It quickly became chic to use these yachts to take friends out for fun (Kseniya Kalinia 2021).

Yachting has evolved into a royal sport. The history of sailing dates back to prehistoric times, but sailing races are believed to have begun in the Netherlands around the 17th century and spread to Great Britain. Charles II (1660-1685) used a yacht for his personal use and enjoyed sailing in a luxurious environment as the interiors of his yachts had a luxury that gave them a grand effect, reference to royal yachts is common in works about European aristocracy. Royal yachts were an element of heritage and therefore remained in the hands of royalty until the late 18^{ου} century. The purpose of the yachts was for nobles to engage in water activities and rituals that accompanied royal duties. 'Yacht cruising' and racing remained exclusive activities for the nobility (Wikipedia, 2021).

In England, purpose-built racing yachts began to appear (Wikipedia (2021). The first organized regatta was in 1661, a 40-mile race on the Thames between Charles's newly built yacht Catherine and Anne, the Duke of New York's new yacht (ASA (2022).

Although sailing remained the sport of kings for over a century, in the 19th^{ο} century it was developed, and the world's richest people participated in it. As a result of this, the first yacht club was founded in 1720 in Ireland, called the Cork Water Club. Others followed, the most famous being the Royal Yacht Squadron, which was created on 1 June 1815 in London as "The Yacht Club" (Wikipedia, 2021). In America on 30 July 1844, the "New York Yacht Club" (NYYC) was started, in essence, they formed a syndicate to build a yacht to go to England and take part in regattas (D' Ambrosio, 2022). America's Cup wand as held in 1851, and although they had different scoring rules for their yachts, the English scored based on tonnage while the Americans scored based on length, America won the race and took the trophy (ASA, 2022).

From their first appearance until today there is no established definition, so a yacht is the use of yachts and boats called yachts for racing or cruising, either sailing or motorized, with at least one cabin that allows the crew to sleep on board (Kseniya, 2021). To qualify as a yacht, as opposed to a boat, a vessel must be at least 10 m long and be judged to have good aesthetic qualities (Wikipedia, 2022).

1.1.1 MOTORISED VESSELS

After the industrial revolution, yachts, along with other vessels, incorporated engines for propulsion. Coal-fired locomotives used fire-tube and water-tube boilers. Over the years, steam engines were replaced by modern fuel-powered internal combustion engines (Subhodeep, 2022). The development of power plants created a new class of vessels while sailing boats continued to exist. The power plant started with the steam engine and moved to the internal combustion engine. While sailboats continued to be steered from the rear of the boat, powerboats adopted the bridge to a forward cabin structure that provided better forward and side visibility (D' Ambrosio, 2022).

Early steam-powered vessels were propelled by oars, and by the late 18th^{ου} century steam engines became more efficient and large steamers were luxurious. The development of the steam engine also had an impact on yacht design (D' Ambrosio, 2022).

At the end of the 19th^{ου} century, compound engines began to be used, while steam engines remained the main source of energy until the beginning of the 20th^{ου} century. In England, they used fire-tube boilers. The hot combustion gases were passed through parallel pipes surrounded by water. This design required the water to be heated slowly to avoid damaging the boiler before steam was produced. In the United States, water-tube boilers were used where the water was surrounded by the hot gases of combustion, thus allowing steam to be produced more quickly. Advances in steam turbine design of electric motors and internal combustion engines gradually led to the replacement of reciprocating (piston) steam engines (D' Ambrosio, 2022).

In 1876 Nicolaus Otto and Gottlieb Daimler developed four-stroke engines, and in 1898 the engines increased in horsepower from 25 hp (19kw) to 500 brake horsepower (370kw) by 1906. Some were intended for speedboats and others for motor yachts. Diesel engines for boats were introduced in 1903, diesel engines became the most widespread type of engine in the 20^{ο} century because of their low running costs and reliability.

In 1885 Gottlieb Daimler patented the technology of forcing air into an internal combustion engine and in 1886 the first motorboat was built at the Lurssen shipyard. Rudoff Diesel invented the first diesel engine, and his expertise was that it was not the fuel itself that was compressed in the engine pistons but the air, during the compression of the air heat was created which helped the fuel to ignite. In 1903 the first diesel-powered ship was built, and it was a river tanker Vaudal, also in the same year the first powerboat races were held in Ireland, and diesel engines in yachts started to spread from the second half of the 20^{ου} century until then

they were huge and very heavy. In the 50s the Japanese to solve their weight problem developed high-strength cast iron with spheroidal graphite and increased the speed of the engine by reducing the piston stroke. At the end of the decade, Jim Wynne assembled the first pickup and Volvo Penta bought the technology and improved the concept by rotating the propeller in the nose. This type of tilt-turn propeller began to be fitted to wake surfing boats (Kseniya, 2021).

1.2 TYPES OF BOATS

From the invention of steam and internal combustion engines, internal combustion followed the steam engine and motor yachts were born. The Great Depression in America in the 1930s put an end to the fledgling scene of multi-year yachts and began a trend for smaller more sophisticated and less expensive yachts. From the 1980s onwards, new developments in materials science and computer modelling expanded the possibilities, and today yachts of all types and sizes are not only made of wood but also of various other materials such as steel, aluminium plywood, and veneer (Subhodeep, 2022).

Yachts often have very powerful engines that allow them to travel long distances easily, and they may also be equipped with sailing or mixed propulsion (Subhodeep, 2022), (D' Ambrosio, 2022).

The first important distinction is between sailing and motor yachts. The current global spread of the two families has shifted decisively towards motor yachts, which make up about 75% of the total sailing fleet. Progress and design have created many different categories of motor yachts. In terms of size, yachts tend to range in length from 10m to hundreds. A yacht shorter than 12m is usually called a cabin cruiser and sometimes just a cruiser. A super yacht is longer than 24m while a mega yacht tends to be anything longer than 50m (D' Ambrosio, 2022).

Classifications of yachts, also known as classification societies or class registrars, are an important part of safety at sea. These classifications dictate the design, construction, and ongoing maintenance of large commercial and recreational vessels. The classifications provide highly detailed and technical standards covering the yacht's hull, its engine, and essential safety systems.

The application of common safety requirements to personal watercraft is relatively new and the procedures are constantly evolving. It usually depends on the service and flag of the vessel. Vessels are classified into sections based on their overall length and the number of passengers

they can accommodate. The standard types of classification are large vessels or luxury yachts, and commercial and private yachts.

A large yacht has a load line length equal to or greater than 24m. Almost all flag administrations have adopted safety codes for large yachts. Both super yachts and mega yachts are also called offshore vessels for their ability to sail in deeper waters.

The Recreational Craft Directive requires all boats sold in the European Union and the United Kingdom to meet one of four design categories, based on the wind force and the sea they are designed to face (Association, Royal Yachting, 2018):

(i) A yachts are suitable for conditions that exceed the wind force of 8-40 knots (21 m/s); the maximum wave height of 4 meters is found in ocean passages and extended voyages.

(ii) B yachts are suitable for conditions that are less than the 8-40 knots (21 m/s) wind force and maximum wave heights of 4 meters found in ocean passages and extended voyages.

(iii) C yachts are suitable for wind conditions of 6-27 knots (14 m/s) with a maximum wave height of 2 meters, encountered in exposed coastal waters, bays, lakes, and rivers.

(iv) D yachts are suitable for winds of 4-16 knots (8.2 m/s) and a maximum wave height of 0.5 meters, found in protected coastal waters, bays, inlets, bays, lakes, and rivers.

The Large Commercial Yachts Code (LY2) of Great Britain and its territories defines a large commercial yacht as a vessel 24 meters or more in length at the waterline and used commercially for sport or pleasure, carrying no cargo or more than 12 passengers, with a professional crew. The Code regulates the equipment of such vessels, both at sea and in port - including matters such as crew duty hours and the presence of a helicopter on board. The Code has different levels of standards for vessels above and below 500 gross tonnages (Maritime and Coastguard Agency, 2007). Such vessels may be considered superyachts and are usually 40 meters or more in length (Nineham, 2016).

Superyachts can be identified by the flag - the country under which a yacht is registered. According to an industry publication, superyachts are classified by speed, and by size, into classic yachts, sailing yachts, and "exploratory" boats.

1.2.1 DEPENDING ON THE SIZE

Mega Yachts: most yachts in this category are over 50m in length and are mostly owned and operated by companies that are similar to cruise lines, but there is also private ownership. In terms of amenities and facilities, they are extremely comparable to luxurious cruise ships and often have everything from pools to cinema rooms, suites, etc. They have a dedicated staff to serve the passengers (Subhodeep, 2022).

Super Yachts: typically have lengths between 30 and 50 meters. They can be motorized or have sailed. They are frequently served by trained crew members (Subhodeep, 2022).

Medium Size Luxury Vessels: that are between 20 and 30 meters long. They may have a small, devoted staff, operating on rivers or close to the shore (Subhodeep, 2022).

Smaller Boats: 10 to 18 meters. They are mostly utilized for recreational or water sports activities and are largely privately owned. They might be motor-powered, sail-powered, or a mix of both. They have no more than two or three rooms and the main deck. They have an appealing look and are compact and streamlined. They have a bridge or a small promenade deck (Subhodeep, 2022).

1.2.2 WITH CAUTION

Sailboats: Yachts have developed from having large sails to move over the water with the aid of the wind to having powered propulsion, like most other types of vessels. The majority of sailing boat designs are evolved from classic single-hulled sailing versions such as sloops, catboats, cutters, schooners, or ketches. These vessels might be catboats, sloops with double- and single-sails, or other multiple-sail designs (ketches or scouna) (Subhodeep, 2022).

Sailing boats are vessels in which propulsion must be based mainly on the power transmitted by the wind. In the past, the engines of sailing vessels were of low power and were used mainly for entering and leaving ports, but nowadays, for practical reasons and ease of use, they have enough power to make the sailing vessel travel at a speed of at least equal to the theoretical speed of its hull (D' Ambrosio, 2022). This implies that because sailing boats have both two-stroke diesel engines for bigger designs and four-stroke petrol engines, especially for smaller, quicker designs, they may be employed effectively even when there is no wind at all. Depending on the requirements, yachts can employ single or double propellers with three, four, or even six blades (Subhodeep, 2022).

Gullet boats: Gullet yachts employ both sails and motors for propulsion and may have two or more masts. As was already stated, sails are frequently kept for aesthetic reasons even when they are no longer needed (Subhodeep, 2022).

Single bridge: These boats only have one type of hull, which may be displacement or planning. With displacement-type hulls, buoyancy is produced by the displacement, thus the average speed of these boats is limited. Planning-type hulls are relatively small and are used mostly for water sports or recreational activities. Some designs create a semi-displacement hull by combining the principles of planning and displacement characteristics (Subhodeep, 2022).

Multihull: Yachts may also have multiple hulls, such as catamaran-style boats with two hulls or triple hull boats with three hulls. Multihulls are not as fast as designed boats and rely mostly on their inherent stability.

Trimarans: These boats feature a central hull that is joined to two additional side hulls by superstructures, decks, or beams.

Catamarans: They feature many hulls that provide stability and volume. There are catamaran yachts with traditional sails and those with motors, both types are quite common and sometimes a catamaran has both. They are usually built with a shallow draft, which makes them suitable for shallow water exploration, leaving no spot out of bounds. They can also develop impressive speeds compared to traditional sailing boats.

1.2.3 ON THE BASIS OF THE PURPOSE

Cruise ships: Cruise ships are traditional yachts and can be between 12 and 46 meters long, intended for passenger leisure and holidays. These ships, which are mostly of the displacement type, are authorized for long-distance voyages to moderate ocean depths. Typically, luxury yachts fall into this category (Subhodeep, 2022).

Fishing boats: These are boats designed particularly for fishing as a leisure activity. They feature space for fishing gear and equipment, and they are distinguished by open decks that are ideal for both fishing and carrying catches. They may operate in areas with the best fishing opportunities but are prohibited from approaching the sea's deepest parts (Subhodeep, 2022).

Trawlers: These boats, which are between 24 and 30 meters long and serve a similar function to traditional fishing vessels, are designed for large-scale commercial fishing. A sportfishing

boat is designed to cope with all conditions when chasing a catch. With speed being an important factor in tracking fish (Subhodeep, 2022).

Sport fishing boats: They have fishing equipment just like fishing boats do. Fishing gear is available on fishing vessels (Subhodeep, 2022). They are inactive or move slowly during fishing operations, and they may move fast while leisurely fishing (Wikipedia, 2022).

Sports cruise ships: These cruise ships are designed for short fast trips and leisurely or sporting activities. These boats may be identified by their design hull or semi-displacement hull (Subhodeep, 2022). Since they are smaller than average, the accommodation is limited. They are even employed in racing (Wikipedia, 2022).

Expedition boats: They are built for lengthier trips and frequently have long-distance travel licenses, frequently to unexplored and isolated places. In order to accommodate the varied situations, they are likely to meet as well as for more affordable long-distance travel, these boats are notably large in size and are rigorous with hull displacement (Subhodeep, 2022). The hulls are created and constructed in accordance with Ice-Class standards for boats that operate in cold seas. These boats can traverse practically anything, including coral reefs and the Pacific wilderness (Wikipedia, Yacht, 2022).

Classic boats: classic yachts range from those built between the early 20th century and the seventies and tend to be made of either wood or aluminium and feature beautiful, classic lines (Tabahriti & Grace, 2022). They are only intended for recreational use in shallow water and close to shore (Subhodeep, 2022).

Commercial yachts: Whether utilized for recreation or charter, commercial yachts are employed for commercial purposes. These boats can only accommodate up to 12 passengers and do not transport goods. A specific code of safety for large yachts is required by all flag States and must be followed in order for commercial yachts to be certified. The most often utilized safety code is the MCA (Maritime & Coastguard Agency), Large Commercial Yacht Code (LY2) published in 2004.

Support vessels: Additionally called shadow boats; a high-volume vessel that provides extra storage capacity to a mother vessel and provides superyachts with more storage space in the fuel tanks, hence a longer cruising range. Some shadow vessels are used exclusively for transporting crew members and handling extra equipment for water sports, while others are dedicated to scientific research purposes. Constructed from aluminium or steel, they feature

semi-displacement or full displacement hull configurations, and some have even been built to ice-class regulations to cruise in icy waters.

Hybrid: This is a vessel that can be powered by several energy sources. Combining advanced hybrid technologies and efficient performance, hybrid yachts use hybrid propulsion systems, combining electric battery and engine power, for lower-impact travel. The first truly hybrid superyacht is widely regarded as the Ethereal, built by Royal Huisman in 2008, they were looking to create something special in their quest for a 'green' yacht.

1.2.4 MOTOR YACHTS

A motor yacht is a modern version of a sailing yacht. The U.S. Coast Guard (1966) categorizes powerboats-any vessel less than 20 meters (66 ft) in length that is powered by machinery into four categories based on the length: (Wikipedia, 2022).

Class A: power-driven vessels of less than 4,9 meters

Class 1: powerboats 4,9-7,9 meters

Class 2: powerboats 7,9-12,2 meters

Class 3: motorboats 12-20 meters

Full displacement, semi-displacement, and planning motor yacht hulls are the three primary types, and as engine power increases, so do their cruising speeds and fuel consumption per hour: (Thiel & Richard, 2013)

Displacement boats combine huge amounts of onboard space, deep draft, and rounded hulls that are ideal for long passages on the open sea. The fuel carrying capacity of this type of yacht, combined with the economical and efficient fuel travel capabilities, means that motorized displacement yachts have the range to carry passengers on longer voyages. The water is moved by the full displacement hulls up and out of the vessel. Depending on the units used, their speed is limited by the square root of the waterline's length multiplied by a specific factor. Only the size of the waves produced may be increased by the additional horsepower, not the maximum speed (Wikipedia, 2022).

Because they raise slightly above the water and produce fewer waves, semi-displacement hulls enable speeds that are greater than the hull speed of a displacement boat. In addition, they provide better comfort than planning hulls. By combining the best elements of a slip and displacement boats, a semi-displacement boat combines good speeds with stability and

generous spaces. The rounded hull of this type of yacht offers significant storage space, while the standard design incorporates flatter sections to reduce drag, eliminating the rolling of a displacement hull and making cruising at higher speeds more efficient. A typical semi-displacement boat features a wedge-shaped bow that facilitates wave penetration and transitions to flatter, broader surfaces at the stern that promote raising the boat out of the water The Ray Hunt's "deep vee" hull, which is present on around 75% of current powerboats (Prince, 2019, Wikipedia, 2022).

Planning hulls need enough power to slide the boat over the water, avoiding the necessity to utilize power to lift the water out of the boat's way. The undersides of these boats are flat (Wikipedia, 2022).

Explorer/Explorer vessel: the explorer or expedition vessel is designed for longer voyages or expeditions on all seas. With all the benefits and volume of a motor vessel, they have rugged hulls capable of moving effortlessly in all waters and conditions. Long-range capabilities ensure they can undertake extended cruises and visit even the most remote destinations.

1.2.5 STYLE

Flybridge: Flybridge boats are two-decked motor yachts that combine large onboard spaces with fast speeds. An additional steering station on the flight deck is a flybridge yacht's distinguishing feature. Owners typically choose flybridge yachts for the fast speeds and decent cruising range capacity as well as the luxurious living spaces they offer. Motorized flybridge yachts are usually designed with aggressive lines and a sporty appearance and range in size from 24 to 45 meters (D' Ambrosio, 2022). To achieve fast speeds and low draft, hull designs are semi-displacement or planning. Three propulsion systems may be used to achieve even higher speeds: pods, fixed pitch propellers, or waterjets. The flybridge design is one of the most popular styles for fishing boats. The large cockpit makes hauling fish easier compared to others. They are designed so that they can handle difficult weather conditions well. The flybridge is an upper deck that is completely open and frequently has a hard top, which is typically a fiberglass roof. The flybridge often features an extra rudder position so the captain may navigate from a more elevated position.

Open yachts: The main deck is usually all open and the helm can often be protected by a T-Top. Below the deck, depending on the length of the yacht, there are living areas for the crew, open boats may be walkabouts or may feature a closed bow and therefore a higher deck (D' Ambrosio, 2022).

Coupe: It has a sporty look and an open aft main deck. It frequently features a sunroof and is always built with side decks that link the bow and stern. It is a boat that, based on its size, may be used for cruising over medium to long distances (D' Ambrosio, 2022).

Lobster: Its planning or semi-displacement hull allows for rapid movement, and it is designed in the manner of a Maine lobster boat, where it was employed to capture lobsters (D' Ambrosio, 2022). A lobster is an important sort of yacht (Wikipedia, 2022).

Trawler: It is a prestigious cruising vessel with a displacement hull designed for economical and medium-distance cruising (D' Ambrosio, 2022).

Multihull: Known for its capacity and stability. It is often a catamaran built for extended periods at sea (D' Ambrosio, 2022).

Sloop: The presence of a single mast with a mainsail and a genoa or a jib characterizes a sloop. Sloop rigging has grown in popularity over the years since it has the best ease of use/sailing performance ratio and is the easiest to handle with a small crew (D' Ambrosio, 2022).

Cutter: A long-distance sailing vessel distinguished by the presence of a mainsail and two jibs set on a single mast. The genoa and foresail are usually the two jobs that are employed independently based on meteorological conditions (D' Ambrosio, 2022).

Ketch: The most popular rigging on two-masted sailing boats, with the main mast carrying a jenny and a mainsail and a tiny mast forward of the rudder shaft with a single mainsail. Because of the splitting of the sails, this sort of sailboat is good for sailing in inclement weather (D' Ambrosio, 2022).

Yawl: Similar to a ketch, except the mizzen sail is positioned behind the rudder axis. Sailing boats can be multihulls or monohulls, such as trimarans or catamarans, however, they can be classified as follows (D' Ambrosio, 2022):

Cruiser: Simple to handle and has ample space over and under the deck, this sort of yacht is often distinguished by an unbalanced length/width ratio that favors the latter, a modest sail area, and engines that are more powerful than normal (D' Ambrosio, 2022).

Cruiser-Racer: This is a class in which the total weight of the boat as well as the form of the hull are given considerable consideration. The hull lines are meant to improve performance, and as a result, the interior is slightly smaller than those of pure cruising vessels with a similar length (D' Ambrosio, 2022).

Racer: It is a sailboat designed only for racing. It is capable of planning and sailing downwind at extremely low wind angles, however, it is rarely employed for leisure activities (D' Ambrosio, 2022).

Racing boats are designed to emphasize performance over comfort while charter boats are run as a business for profit. By 2020 there are more than 15,000 boats of sufficient size to require a professional crew.

By the 1960s the motor yacht market had acquired a modern face. The Fort Lauderdale Boat Show (FUBS), the largest boat show in the world, was organized in 1959 by local yacht builders and dealers and featured only 13 boats. In 1969 the first boat show Boot Dusseldorf Boat Show was held in Düsseldorf, now the world's largest pavilion-based boat show. In 1997 the Cannes Boat Show was held in France. Today the market is dominated by motorboats up to 10m, with sailboats used for fishing, short trips, or water sports such as water skiing and wakeboarding. Compact motor yachts of 10 to 15 m in length have between 1 and 3 cabins, a small galley, and a bathroom.

The leading countries in the production of motor yachts are the USA, Italy, Germany, the UK, France, and the Netherlands. Italy, Germany, and the Netherlands are the leaders.

1.3 NEED FOR A GREEN APPROACH

For the modern travellers, there are few modes of transport that, as charming as they are, become as terribly polluting as a yacht. On the largest, state-of-the-art yachts, over 30 meters long, yachts can consume around 530 gallons of marine diesel in a single hour of 35-knot cruising which equates to six tonnes of carbon dioxide emissions per hour.

Today we often see the terms "green economy", "green growth", "clean growth", "sustainable growth", and "low-carbon economies", used to describe an economic model where environmental protection is a dominant component. As per the Washington State Department of Ecology, the green economy consists of the development and use of products and services that promote environmental protection, energy security, and economic growth. Environmental protection includes both prevention and reduction of pollution, including environmental restoration. Similarly, energy security includes the promotion of energy efficiency, the promotion of Renewable Energy Sources (RES), as well as 'smart' energy products and services in the production, transmission/distribution, and consumption of energy. In California, a 'clean'

or 'green' economic activity is defined as any activity or service that involves at least one of the following

(a) Renewable energy production and storage

(b) Recycling of materials

(c) Production, distribution, manufacturing, installation, and maintenance of energy-efficient products

(d) Education, information, and compliance activities related to the protection of the environment and natural resources.

(e) Production of natural and sustainable products.

By green growth, we do not only refer to a pro-environmental policy or a development that respects the environment but to a pattern of development that reconstructs the productive base of a country by creating new wealth driven by the environment, its available natural resources, and its human resources, that expands the productive fabric of a country and encourages the creation and transfer of know-how. Therefore, technological development, innovation, and green growth must go hand in hand and, as a result, the promotion and support of a green growth model will strengthen a country's competitive position while at the same time protecting its environment.

In an attempt to further specify what is meant by the term green economy, Aliva (2008) considers that it describes economic activities related to reducing the use of fossil fuels, reducing pollution and greenhouse gases, increasing energy efficiency, recycling materials, and developing and utilizing renewable energy sources. The adoption of a green growth model is an issue for the whole economy. The areas that can be considered key areas for adopting a green economic model are. (b) The promotion of energy efficiency in all end-use sectors (industry, transport, buildings), as well as in energy production and transmission.

Marine ecosystems, which comprise 90% of the biosphere, are under increasing pressure from human activities. Maritime transport is the third source of pollution of these ecosystems, in particular through fuel combustion, waste release, and noise emissions. The main environmental impacts of marine recreational activities are of 7 types (European Commission, 2022):

1. Emissions of hydrocarbons and other substances: their release to the environment from the engines of small recreational and commercial craft account for only a small share (2%) of total hydrocarbon releases from land-based activities, marine transport, and other marine activities, and natural deposition (European Commission, 2022).
2. Oily water and bilge water: unburnt or incompletely burnt fuels, particles, and traces of oil are released into the environment. When the quantity of these pollutants is small, they may accumulate locally, especially when vessels are stationary, resulting in an oil film in the surrounding water (European Commission, 2022).
3. Noise nuisance: as per the standards, the permissible noise level emitted by new engines has been reduced since 2006. However, when operating at high speed close to the coast, engine noise is mainly noticeable in sensitive areas such as beaches or protected natural areas (European Commission, 2022).
4. Sewage and grey water: grey water (wash water) from recreational craft contains a wide range of chemicals and fats and is often released into the sea. The systematic use on board and in ports of 100% biodegradable cleaning products would solve the problem of chemical pollution from grey water (European Commission, 2022).
5. Antifouling paints: used to prevent the growth of marine organisms on the hull's surface. The biocidal agents they contain may be toxic to the environment, but their use is regulated (European Commission, 2022).
6. Physical damage to the environment: moorings can be harmful to sensitive seabeds. Public authorities are responsible for providing the necessary infrastructure and guiding visitors, they should also prevent anchoring in sensitive areas (European Commission, 2022).
7. Depletion of fish stocks: compared to overexploitation and illegal, unregulated, and undeclared commercial fishing, recreational fishing has no significant impact on fish and fish stocks (European Commission, 2022).

For most of these impacts (hydrocarbon release, noise), raising user awareness and sensitization on appropriate behaviours is key to minimizing environmental impacts. However, for wastewater management, sustainable technologies need to be developed, taking into account the fact that equipping smaller vessels with wastewater tanks and onboard treatment systems faces difficult power and space constraints. The consultants point out that this issue is

included in the EU Waterborne Technology Platform in the EU Strategic Research Agenda. It is important to harmonize European and US regulations as the vessel market is international (European Commission, 2022).

Although a large luxury yacht is never really going to be an eco-yacht, in 2016 the USA enacted a law requiring that newer yachts over 25 m in length with a gross tonnage of 550 GT must reduce sulfur and nitrogen oxide emissions by almost 80 percent. While other countries have yet to follow suit, there are signs that the yachting industry is taking matters into its own hands. Increasingly, shipyards are incorporating environmentally friendly innovations in response to consumer demand. Efforts are multi-faceted, from construction with sustainable or recycled materials to the use of electric motors. There are now even golf balls that dissolve into fish food.

Two of the most well-known innovations for the ecological upgrade of boats are hybrid propulsion systems and low fuel consumption hull designs. With better-engineered hulls, fuel consumption can be reduced by up to 20 percent to create smaller waves, which in turn have less impact on the coastline. While hybrid propulsion systems are now among the most widely used, charging stations are not necessary.

The electric propulsion of a ship is not zero emission, however, Solar wave, a yacht built in June 2016, is a yacht that can be powered entirely by solar panels on its roof and is the first of its kind. These innovations beyond research and development are expensive, like Solar wave, which is a bespoke order.

CHAPTER II

2.1 GREEN YACHTING

One of the most important challenges today is protecting the environment as the issues of climate change, carbon emissions, and air and water pollution continue to be global challenges, sustainability and reducing the environmental footprint have received increased emphasis and a conceptual strategy should be developed in the yachting industry.

Knowing that the pollution produced by yacht engines has an impact on the environment, the presence of powerboats and sailboats in bodies of water can leave a trail of algae and sediment. Algae can contribute to the overall deterioration of water quality and sediment can block sunlight from reaching the water bottom, encouraging the growth of bacteria and algae that will change the area for the worse. Chemicals can also seep into the water through the hull, negatively affecting the water quality, which can affect both lives in the water and outside of it, especially if people then consume food from that body of water by fishing.

New technology brings us closer to a real harmony with nature, more efficient engines, new fuel sources, waterproof paints with less toxic chemicals inside them, and so on. For this reason, there are various organizations, the so-called classification societies, which define and implement technical requirements in regard to design, as well as rules governing the construction, maintenance, operation, and inspection of yachts and ships (Moretti, 2015).

Classification standards are established to evaluate the structural strength as well as the integrity of main hull sections, the operation, and reliability of steering, power generation, propulsion, as well as all other installed features on board the ship that provide key functions. The classification societies perform statutory tasks on behalf of the major flag governments under particular delegation agreements agreed upon with each country. The various flag administrations may carry out inspections on the safety aspects of recreational craft using their own inspectors or use classification societies or other recognized organizations to carry out these inspections. (i) RINA, (ii) Lloyd's Register, (iii) Germanischer Lloyd, (iv) Det Norske Veritas, (v) Bureau Veritas, and (vi) American Bureau of Shipping are the major classification societies in yachting (Moretti, 2015).

Although classification is not mandatory, the construction and maintenance of a private yacht in the class is the only proof that the vessel has been designed, built, and operated to the appropriate technical standards. The first stage in classification is to evaluate a yacht's plans

and conduct frequent inspections while the boat is being built or converted. A classification certificate is provided if all requirements have been confirmed to be met. It specifies the requirements fulfilled, the vessel's intended purpose, and if the vessel is to be operated solely in sheltered waters. It demonstrates that a leisure vessel fulfils industry requirements, but it is not a warranty of seaworthiness. Regular inspections are carried out to keep the classification updated. These inspections, often known as 'special' inspections, are typically performed every 5 years (Moretti, 2015).

Private pleasure boats

The mandatory requirements for these vessels are very low. For the majority of flag States, a registration inspection and a tonnage measurement, carried out by an authorized inspector, are sufficient. The only mandatory international conventions are those relating to the marine environment: MARPOL and the Convention on the Anti-Pollution System. The International Convention for the Prevention of Pollution from Ships (MARPOL) seeks to reduce unintentional and purposeful pollution of the maritime environment brought on by dangerous chemical compounds. The Anti-pollution System Convention aims to eliminate the presence of substances harmful to the marine environment contained in anti-fouling paints applied to ships.

Commercial yachts

All flag administrations require commercial ships to be certified in accordance with a large vessel safety code. The MCA Large Commercial Yacht Code (LY2), issued in 2004, is the most common of these safety codes and the first to be established. It superseded the 1997 Code of Practice for the Safety of Large Commercial Sailing and Motor Yachts (LY1). LY2 is used by the Red Ensign group flags (the United Kingdom, British Virgin Islands, Cayman Islands, Gibraltar, Bermuda, Isle of Man, and so on) and is acknowledged as the yachting industry standard. Similar codes have been established by other flags. Some examples are the Netherlands, Belize, Malta, the Marshall Islands, Italy, and Luxembourg. While imposing a more strict set of regulations and rules than private yachts (Moretti, 2015).

2.2 CONTRACTS

The commercial shipping industry is controlled by safety standards that date back to the early twentieth century and is well-versed in international conventions like Load Lines, MARPOL, and SOLAS (Moretti, 2015). The application of conventional safety rules to yachts is very recent and is heavily influenced by the yacht's service and flag. There are several international conventions dealing with the protection of the marine environment. Among them are the following (Moretti, 2015):

(1) The MARPOL Convention, which governs air and marine pollution

(2) The Convention on anti-pollution systems, prohibits the utilization of anti-pollution systems that contain hazardous compounds

(3) The International Convention for the Control and Management of Ships' Ballast Water and Sediments, seeks to reduce the spread of potentially dangerous aquatic organisms and microbes from one geographical region to another (Not yet in effect).

(4) The Ship Recycling Convention, which deals with ship recyclability and land-based recycling facilities (Not yet in effect).

In addition to these global regulations, several countries have imposed extra conditions for navigation in their territorial waters. Alaska has more strict requirements for oil, gravy water, and sewage pollution; California uses its own diesel engine emissions legislation; the Baltic and the North Sea have sulfur emission control zones; and in numerous regions of the Mediterranean, only specific vessels can approach and are obligated to keep potential pollutants on board (Moretti, 2015).

2.2.1 *MARPOL*

The MARPOL Convention, or the International Convention for the Prevention of Pollution from Ships, was the first global instrument to safeguard maritime ecosystems from vessel pollution, and it went into effect in 1983. It defines "ships" as any vessel that operates in the marine environment, including leisure vessels. Its declared goal is to protect the maritime environment by completely eliminating pollution from oil and other dangerous chemicals and minimizing inadvertent discharges of such pollutants. As of May 2013, 152 states, representing 99.2% of the world's shipping tonnage, are parties to the Convention. The latter has six annexes that cover air and marine pollution. Four of them apply to private and commercial leisure

vessels. The annexes detail record keeping requirements, what can be discharged or emitted, and where. In the UK, MARPOL was given the force of law by several new regulations, including the Merchant Shipping Papers and the Merchant Shipping Act 1988. IMO 2020 further extends the restrictions on air emissions and limits sulfur and nitrous oxide in stack emissions, and ozone-depleting substances (Moretti, 2015). All ships flying the flag of countries that have signed MARPOL are bound to its regulations, apart from their place of departure, and the Member States are liable for vessels having their nationality. MARPOL does not affect the majority of recreational craft, as vessels of less than 400 GT, carrying fewer than 15 persons, are not required to comply with MARPOL (MARPOL, 1972).

Annex I: Applies to all recreational vessels with a gross tonnage of 400GT or above. They must have a five-year international oil pollution prevention certificate and be subject to annual, intermediate, and renewal inspections (Moretti, 2015). The Annex specifies the operational and physical requirements for preventing oil pollution, addresses oil pollution from machinery, and controls, in particular, the minimal generation of oily water and oil residues, separation of oil from water, and release of oil into the water. A key requirement of Annex I is that ships over 400 gross tonnages (GT) must have an oil pollution emergency plan, known as SOPEP (MARPOL, 1972).

Annex IV: As with the requirements for the prevention of oil pollution, the requirements for the prevention of wastewater pollution cover equipment and machinery spaces, onboard preservation and storage, treatment and discharges, and reception facilities. It applies to vessels with a gross tonnage equal to or greater than 400GT or carrying more than 15 persons. It entered into force in 2003 with the last revision in 2005 (Moretti, 2015). The certificate has a five year expiration date and is subject to renewal. In order to comply with the provisions of the Annex, owners may either send the effluent ashore or discharge it at sea when more than 12 miles from shore or equip the vessel with an approved sewage treatment plant capable of discharging treated effluent to certified effluent standards. If an approved treatment system is in place, then treated effluent may be discharged at any distance from the nearest land, provided that the vessel is traveling at a speed of more than 4 knots and no extra-national regulations apply in the region (MARPOL, 1972).

Annex V: This Annex sets out the requirements for the disposal of waste generated on board ships. The key point is that all waste is prohibited from being discharged into the sea and the distance from the shore must be kept, unless otherwise expressly provided for. No global

certificates are needed, however, vessels with a big tonnage equal to or greater than 400GT or certified to transport 15 people or more should carry a plan for waste management that includes written instructions for the gathering, storing processing, and disposal of waste. A logbook is also required to record discharges at sea, accidental discharges discharge to reception facilities, and incineration (Moretti, 2015).

Annex VI: All recreational craft with a gross tonnage equal to or greater than 400GT must hold an International Air Pollution Certificate, valid for five years and subject to periodic renewal inspections (Moretti, 2015). This Annex sets out the requirements for the prevention of air pollution from ships. It restricts the major air contaminants found in ship exhaust emissions, including NOx (nitrogen oxides) and SOx (sulfur oxides). It prevents the intentional release of ODS (ozone-depleting substances) and also regulates on-board incineration (MARPOL, 1972).

2.2.2 *AMENDMENTS TO MARPOL*

Multiple amendments to the MARPOL Convention are becoming effective, frequently with retroactive applications (Moretti, 2015).

Annex I: All leisure vessels with a fuel tank capacity of more than 30 cubic meters that are delivered after 1 August 2010 must be covered by a double hull to avoid unintentional spills in the event of a grounding or collision (Moretti, 2015).

Annex IV: IMO Resolution MEPC 159(55) introduced more stringent discharge standards to be applied to equipment installed from 1 January 2010 onwards (Moretti, 2015).

Annex VI: Stricter requirements for NOx emission limits come into force from 2011 to 2016. The global sulfur cap was reduced from 4.5% to 3.5%, effective from 1 January 2012, and will be further reduced to 0.5%, effective from 1 January 2020. (Moretti, 2015)

CERTIFICATES

There are several compulsory categorization certificates. A ship's size will determine how many and what kind of statutory certifications it needs. The gross tonnage (GT) value is a key issue because it determines whether an international convention rather than a specific safety standard applies to a recreational craft. A vessel should be certified for unlimited service when it has a tonnage of (a) 300GT (stricter standards for life-saving equipment, load line, and stability). (b) 400GT: Almost all environmental treaties, including the anti-pollution system and MARPOL, have this as their upper limit. (c) 500GT: This is the SOLAS Convention's

upper limit, which entails more stringent specifications for safety systems, machinery, construction materials, fire protection, navigational tools, and life-saving equipment. Additionally, an external certified management firm is necessary for ISP and ISM certifications (Moretti, 2015). Key certificates that a ship should have on board include:

(1) International capacity certificate: The internal volumes of the vessel are expressed here in gross tonnes (GT). This measurement should not be confused with displacement capacity, which quantifies the vessel's weight (Moretti, 2015).

(2) Large recreational craft code certificate: It covers life-saving appliances, signalling and navigational equipment, firefighting equipment, means of escape, accommodation and manning of the crew, and intact and damaged stability (Moretti, 2015).

(3) Class certificate: It concerns the electrical equipment, machinery, hull, as well as yacht equipment (Moretti, 2015).

(4) International loading line certificate: It concerns the yacht's weather resistance and water tightness (Moretti, 2015).

(5) Wireless safety certificate: It is only valid if the total capacity exceeds 300GT. The capacity only covers 300GT (Moretti, 2015).

(6) MARPOL Annex I: This certificate covers the disposal of bilge oils as well as bilge water from machinery spaces (Moretti, 2015).

(7) MARPOL Annex IV: This certificate allows the vessel to carry more than 15 people and includes the discharge of sewage from the vessel. (Moretti, 2015)

(8) MARPOL Annex V: This certificate is valid for all ships and covers waste disposal (Moretti, 2015).

(9) MARPOL Annex VI: Covers the emissions from primary and secondary engines (SOx and NOx).

(10) Security structures and security equipment: These are additional requirements relating to engines, electrical parts, and rescue and navigation equipment for recreational craft with a gross tonnage of more than 500GT (Moretti, 2015).

(11) International safety management certificate: This only applies to vessels having a gross tonnage of more than 500GT. This service requires a certified management firm

to prepare drill procedures and operation manuals, as well as to maintain the vessel and its systems (Moretti, 2015).

(12) International Ship and Port Security Certificate: This applies to anti-piracy certification and is only applicable for ships and yachts with a gross tonnage of more than 500GT. Assistance onshore and the development of operational manuals and onboard procedures should be provided by a certified management firm (Moretti, 2015).

2.2.3 *GREEN PLUS YACHT*

Certain classification bodies have lately introduced internal requirements for certifying yacht and ship environmental sustainability. In the nineties, RINA emerged as the first organization to establish a set of guidelines particularly suited for cruise ships operating in vulnerable locations like the Baltic Sea and Alaska. It also created a new yacht standard, the Green Plus Yacht, which is being met by an increasing number of superyachts. The main Green Plus requirement is that a yacht must demonstrate a considerable investment in onboard equipment, design solutions, and operating methods that contribute to environmental efficiency above the minimum levels specified by IMO standards. In relation to emissions to the air and sea, Green Plus particularly highlights 12 sources of pollution, including hazardous substances, garbage, ballast water, grey water, sewage, pollutants, oil from machinery spaces, and other contaminants. By implementing the solutions and techniques listed in the Green Plus system, the environmental damage brought on by each of these sources may be minimized. Each of these has been given a relative score that is based on how challenging it is to execute the selected solution. The "yacht's environmental index" is the result of adding up all the scores (Moretti, 2015).

Green Plus certification is available in three levels: Green Plus Yacht, Green Plus Yacht Gold, and Green Plus Yacht Platinum. Projects that have made considerable investments in green technology are rewarded at various levels. The use of environmentally friendly design principles during the yacht's construction ensures not only that passengers will be sailing in a vessel that complies with the strictest local and international environmental laws, but also that it will allow for the introduction of cutting-edge technologies and the adoption of fuel-saving measures (Moretti, 2015).

Given that ships account for 4% of global CO2 emissions, the IMO is considering issuing a decision on the issue. Because these emissions are primarily caused by fuel consumption, the

industry has made significant efforts to reduce them by incorporating energy-saving solutions and procedures including alternative propulsion systems, high efficiency, and optimized hull design, regular hull and propeller cleaning, optimization of generator load sharing, management of air conditioning systems, minimizing waste in power supply, proper use of stabilizers, as well as staff training (Franklin, 2021). Biofouling, or the accumulation of plant and animal life in the hulls of ships, is one of the greatest threats to ocean biodiversity, as it brings in some species that can quickly disrupt the balance of the ocean ecosystem. But the use of excessive amounts of biocides to kill them pollutes the water and also threatens the balance of the marine environment; here we have a situation where chemical legislation, (designed to protect the oceans from toxic substances), can clash with environmental legislation, which is also designed to maintain the health of the oceans and waterways. Only a holistic approach involving all stakeholders and balancing all relevant criteria can achieve the most effective outcome (Moretti, 2015).

2.2.4 *WATER REVOLUTION FOUNDATION*

From the expansion of navigation regulations in different regions of the world to the growing popularity of energy-efficient systems. The Yacht Environmental Transparency Index, or YETI, is a superyacht-specific design index that was developed by the Water Revolution Foundation, which has brought together a large joint industry group that included practically all of the main superyacht builders and industry players (Wardley, 2022). All participants hope to provide a method for intelligently assessing and analysing the impact of a yacht's design and engineering so that manufacturers and clients will be driven to use that information to make the best technical decisions to really lessen the environmental impact of future yachts (The conversation, 2021). To limit global warming, countries must halve their emissions by 2030 and eliminate them by 2050 (ABB, 2021).

The goal of YETI, a joint industry project, is to create a reliable classification system that assesses the environmental effects of yachts. The project's objective is to create a general profile of a superyacht that will enable comparisons of yachts and concept ideas on the basis of their environmental impact. YAT is a piece of software that enables the superyacht industry to provide decision-makers with the knowledge they need to make ethical decisions. The ever-growing database can measure a superyacht's environmental effects over the course of its full life cycle, including emissions, energy use, raw materials, and other effects on ocean health (Franklin, 2021).

The path towards a lower carbon footprint for superyachts can only be achieved through a holistic and collaborative approach, taking into account the entire life cycle of a vessel. This implies that all disciplines, such as designers, manufacturers, owners, operators, and refit yards, need to have access to material data and design criteria identified to have the lowest carbon footprint over the lifetime of a vessel, on the side of both yacht design and construction, in recent years life cycle analysis (LCA) tools have started to be developed, as several universities are collaborating with various manufacturing, for example as all waste from a ship, during construction, during a repair and during consumption by the ship itself, needs to be controlled. Wastewater that was previously dumped into the seawater from ships should in the future be sent for treatment. Plastic pollution in the oceans and on land is one example; a developing sector must help to tackle a growing crisis (Franklin, 2021).

2.3 INVITATIONS

A big challenge for luxury groups & businesses is to invest in exploring greener and more sustainable options. The heavy green and sustainable global trend, (Henion & Kinnear, 1976) and the link to sustainability are therefore obvious (Cohen, 2012).

The superyacht sector has enjoyed 20 years of steady growth as annual average sales increase and projected expectations forecast close to 6,500 SY by 2025. The reality of the state of the ocean needs to be addressed to ensure that the superyacht sector has a place in the shipping cluster as it is dependent on the state of the ocean.

Certainly, the superyacht sector and yachting, in general, have begun to address some of these issues. One field where this is most noticeable is in propulsion engines. Designers and manufacturers are following in the footsteps of the automotive and transportation industries by incorporating zero-emission technologies like hydrogen fuel cell systems, electric drive systems, and hybrid systems. Lürssen, a German ultra-luxury yacht manufacturer, is developing a one-megawatt fuel cell boat powered by methanol converted to hydrogen. The system will provide the yacht with emission-free power for two weeks when at anchor or for 1,000 nautical miles of the low-speed cruise (Franklin, 2021).

Sustainability targets can be challenging to enforce if they are not addressed in local policies and laws. The EU is working on a directive that will require companies with a turnover of more than €50 million to conduct due diligence on their supply chain to guarantee that they adhere to governance, social, and environmental standards (Franklin, 2021).

Environmental awareness is shifting at every level and the benefits of a zero-emission yacht allow for the construction of quieter yachts, cleaner and simpler to build than yachts powered by an internal combustion engine. Zero emission technologies, such as batteries or fuel cells, ensure the highest standards of onboard comfort and allow greater flexibility in the overall layout of the yacht by eliminating exhaust and intake trunks, enclosures, and associated equipment. The same design features also harmonize with a great many destinations and geographical areas of global importance designated as zero carbon emission areas (ABB, 2021).

Oceanco's NXT initiative brings together experts from within and outside the yachting industry to combine innovation and sustainability to transform the way the world views superyachts. NXT offers new perspectives on future requirements, reflecting across all sectors, with the ultimate goal of zero impact on the environment. Speed has always been a primary concern while today the most sought-after technical features are related to sustainability and comfort, such as quiet operation, noise and vibration, and increased autonomy. This translates into the possibility of longer periods at sea without port calls, which is also related to requirements for lower fuel consumption and increased operational efficiency. Quiet operations, including reduced noise and vibration from technical systems, increase comfort levels and are considered an indicator of high quality in a yacht. Vibration also has the potential to damage structures on board through resonance, so lower vibration levels will also convey long-term benefits to the vessel itself (ABB, 2021).

Exhaust after-treatment systems have long been a typical feature of modern yachts, making the elimination of local pollutants in yachts another cutting-edge technological advancement. The International Maritime Organization's Class III NOx regulations and the Environmental Protection Agency's Class 4 requirements are both exceeded by newer versions of these systems, which additionally remove over 98% of fine particles. As local emission regulations are tightened by cities and port districts (ABB, 2021).

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2.4 OPPORTUNITIES

Yachts can be considered the testing ground for cutting-edge sustainable design solutions (Di Nicolantonio et all 2015), as the majority of superyachts are powered by an engine rather than sails, so dealing with the carbon footprint of a superyacht is inevitable and there have been huge leaps in research and development, with many impressive hybrid systems for superyachts, with no restrictions on speed and performance. As well as being able to switch between modes - operating in electric, diesel/electric, or full diesel mode, with the battery available to give an extra boost of speed if needed. The use of new technologies can create new standard models, and the advantages are several like those of hybrid systems including reduced engine noise, fewer gearboxes, and lower fuel consumption.

HYBRID & PURE ELECTRIC DRIVE SYSTEMS

Large boats can still run on pure electric power, but producers are emphasizing hybrid and electric power systems more and more. The yachting industry is evaluating boat fuel use and environmental effect across all phases of design, building, and operation. Lithium batteries and hybrid propulsion systems are now being combined to improve smart power management and result in a decrease in the use of diesel fuel. Operating expenses, energy consumption, and emissions of greenhouse gases are being reduced via energy-efficient solutions. Alternative fuels are still being researched, such as hydrogen fuel cells and liquefied natural gas. To lessen the influence on the environment, hybrid and all-electric propulsion systems continue to be attractive eco-trends. Design advancements to boost efficiency include dynamic, streamlined hull shapes, sharp entry angles, and superstructures created for frictionless operation in water.

A lighter, more ecologically friendly boat may also be produced by updating the materials used in yacht construction, such as switching from steel to carbon fiber and using reclaimed wood and vegan leather in the interior design. More environmental restrictions are being imposed as a result of increased maritime environment preservation and regulation worldwide (Wardley, 2022).

ABOLITION OF SINGLE-USE PLASTICS & INTRODUCTION OF GREEN PRODUCTS

Superyachts are disposable products and subtle changes in the products consumed by crew and guests may lead to significant impacts. Some practices may include installing an onboard water filtration system to distribute chilled and boiled water. In addition to creating more storage space and saving time and effort when buying and transporting bottled water in plastic

packaging, this results in a significant decrease in the use of plastic bottles. There are even ranges of toiletries and toiletries that are reef safe as they are made with zero plastic waste (Wardley, 2022).

ECOLOGICAL WASTE MANAGEMENT METHODS

Selective waste sorting can significantly reduce the weekly waste production of a yacht. The future disposal of all items and supplies should be considered and calculated before they are taken on board the boat. Another important step is to be aware of the environmental impact of all detergents and chemicals discharged from the boat directly into the ocean. The purchase of biodegradable and natural detergents, soaps, and other everyday chemicals is extremely important as they can come into contact with the sensitive marine environment. Another option may be to forbid or discourage the usage of disposable items while the ship is at sea. Additionally, a crucial step in responsible waste reduction and management is to follow "reduce, reuse, and recycle" principles as frequently as feasible (Wardley, 2022).

OFFER MORE VEGETARIAN MENUS

Reducing the consumption of seafood, meat, and dairy results in a reduction in greenhouse gas emissions and water use for feeding animals used by the meat and dairy industry (Wardley, 2022).

BRANDS WITH A FOCUS ON ENVIRONMENTAL IMPACT

Eco-friendly crew uniforms guarantee that each piece is created using organic cotton, without pesticides, fertilizers, or other chemicals that wind up in the seas, with the least possible environmental impact. Since 10% of the revenues from each sale are donated to a Canadian firm called The Plastic Bank, Ethical Yacht Wear has been able to support the removal of 3 tons (the equal to 150,000 0.5L plastic water bottles) from the ocean. The Plastic Bank pays people in less fortunate countries to collect plastic (as jobs), then pays workers to collect the plastic and sells it back to big companies, reducing poverty and saving millions of tons of plastic from our oceans. Other notable eco-oriented companies making drastic changes in the industry include Ginnacle Import & Export and The Rainbow Revival (Wardley, 2022).

Wind, solar electric and hydrogen-powered ships offer innovative low- or zero-carbon alternatives to fossil-fuelled cargo ships, and experts say the wind is set to return to shipping. New experimental sail designs include hard sails, rotating vertical cylinders, and even kites (Willner, 2021).

By using recycled and biologically generated materials while constructing ships as well as environmentally friendly production techniques, shipyards may significantly influence the green credentials of yachts. Vessels can reduce waste and carbon dioxide generation by using wood from sustainably managed forests and repurposed components including steel, aluminium, and natural composites. Further ensuring a green start to the vessel's life cycle is the usage of sustainable energy on board to power construction equipment. When it comes to decommissioning yachts, yacht owners must find environmentally friendly options. Yachts above 500 GT, similarly to other ships, are required to have a Ship Recycling Plan (SRP) in place and an Inventory of Hazardous Materials (IHM) on board under the EU Ship Recycling Regulation. For shipyards and yacht owners, this involves making sure that hazardous substances are disposed of securely and without endangering the environment when vessels are dismantled in line with rules (Bureau Veritas, 2020).

The systems will operate more quietly, emit fewer exhaust emissions, and provide a cleaner atmosphere when at anchor when they are electrified. Navigation is cleaner thanks to new hybrid technologies that enable a battery pack to be recharged while the diesel engine is operating. Legislation to reduce emissions is already being introduced, which is affecting yacht builders. In 2016, the IMO Tier 3 guidelines were implemented to control emissions of NO (nitrogen oxide). The organization has already mandated that the shipping industry decarbonize, and it is urging shipping firms and shipowners to reconsider the usage of fuels in shipping and maybe superyachts in the future (Swift, 2021).

The size of hydrogen fuel cell technology is increasingly shrinking while its power is increasing. There are several advancements in hydrogen fuel cell technology. As of early 2021, more than 30 nations have released hydrogen "roadmaps," and more than 200 hydrogen projects are in the works, as reported by the Hydrogen Council of the World Economic Forum. In order to make hydrogen energy affordable and widely accessible enough to replace fossil fuels with zero emissions, governments from all over the world have invested more than US$70 billion in financing these projects (Swift, 2021). Thus, the utilization of hydrogen fuel cell technology, in which hydrogen gas reacts with oxygen to produce electricity, is the subject of several initiatives throughout Europe. Both air and water are the by-products. Lürssen is testing methanol-hydrogen fuel cells (Swift, 2021). Lürssen's yacht will be able to spend more than 15 nights at anchor or sail more than 1,000 nautical miles without releasing any emissions.

SUNBAKED SOLUTIONS

One of the most alternative fuels for yachts is the sun. Catamarans are well placed to take advantage of solar energy. The twin hulls and wide beam means that large solar arrays can be mounted on the top surface of a catamaran, making it an obvious choice for a fully electric, zero-emission vessel. The power capacity of one kilogram in a battery pack is far less than a kilogram of traditional fuel, the main design goal of solar cats is, control and weight reduction. The largest commitments for solar-powered catamarans may come from one of the biggest names in catamaran production, Sun reef (Swift, 2021).

THE NUCLEAR OPTION

Researchers are investigating MSR technology, which was invented in the 1960s and employs molten salts as a coolant rather than water like conventional reactors. The environmental costs associated with the production, transportation, and storage of alternative fuels outweigh their environmental benefits. In theory, a nuclear-powered vessel would not have to worry about fuel availability. Scientists are still debating the merits of new nuclear reactor designs (Swift, 2021).

Emissions from the shipping and marine industries must be reduced if the climate crisis is to be mitigated. Shipping is a part of the transportation/recreation industry that is often neglected, even as the U.S struggles to lessen its significant contribution to global climate pollution. If emissions of greenhouse gases are to be considerably decreased, quick action is necessary given the constantly rising popularity of sailing. Although sailing uses very little fossil fuel, the resources needed to construct some of these vessels are growing exponentially.

Exhaust emission guidelines for marine diesel engines installed in a variety of marine boats, ranging in size and use from small leisure vessels to huge ocean-going vessels, were approved by the Environmental Protection Agency (EPA) last year. The average amount of gallons consumed by a vessel's engine(s) per hour may be calculated by multiplying that value by the total number of hours the engine(s) were utilized over the season or year (Sailors for the Sea).

The climate impact of the motor yacht industry, especially yachts, is significant. The propulsion systems of many yachts are arguably the least efficient modes of transport ever devised. The typical yacht of 40-50 ft consumes fuel. In 2010, the EPA implemented stricter pollution regulations for inboard and outboard marine engines. Private boats, however, are not inspected as cars are. The Coast Guard or law enforcement may inspect them, but there is no annual

emissions inspection. Two-stroke engines are found in many leisure boats and some jet boats. Traditional two-stroke engines pollute the environment 14 times more than four-stroke engines.

By absorbing around 30% of the Carbon dioxide generated by all sources, the oceans serve a crucial role in preserving the equilibrium of the atmosphere's carbon dioxide levels. But since the industrial revolution started spewing greenhouse gases into the sky, this blue carbon pool has been operating over time. Nevertheless, so much of this collarless gas can only be absorbed by the ocean. The acidification of the ocean is a process wherein saltwater absorbs CO2, which causes chemical processes that make the water more acidic. For marine species like mussels, scallops, crabs, corals, and oysters that have calcium carbonate in their skeletons or shells, ocean acidification is terrible news. More acidic salt water, according to research, slows the growth of their hard protection.

ENVIRONMENTALLY FRIENDLY SHIPYARDS

The future generation of boat purchasers could find themselves aboard a boat propelled by a colossal kite sail, turning what was once the realm of "what if" into something more achievable. The superyacht industry has made small and large strides in the last five years to become a global ecological player. Hybrid boats are becoming more commonplace, giant vessels like the 600-foot REV Ocean are doubling as mobile research boats, and the most forward-thinking manufacturers are testing zero fossil fuel propulsion - from full solar power to kite sails and science-grade converters which generate immediate, clean power. (Zaltzman, 2020)

Expect much more change at sea in the coming six months, not just in how the yachting sector monitors sustainability but also in how it deals with pollution. Feadship and Lürssen, the families behind the world's largest superyachts, are spearheading the shift by establishing the non-profit Water Revolution Foundation (WRF). The original purpose is to develop a scientific approach to yacht manufacturing. (Zaltzman, 2020)

However, its goal is much higher: to reduce the environmental impact of the superyacht sector in order to maintain what is so important to boat owners - the aquatic environment beneath them. (Zaltzman, 2020)

Fourth generation Feadship CEO Henk de Vries III said he and Peter Lürsen (fourth generation boss of a family shipyard) (Zaltzman, 2020) "*hope to revolutionize the WRF shipping industry by applying new technologies and environmental impact assessment*", De

Vries has big ambitions for Feadship. He predicts that by 2025, the superyachts of the future will only use hybrid power or run entirely on electricity. (Zaltzman, 2020).

Other manufacturers are investing in ecologically friendly boat manufacturing. The Ferretti Group's new plant in Ancona, Italy, combines heating, cooling, and power to minimize electricity use by up to 79 percent and includes photovoltaic panels to help make its own juice. Oceanco, a giant boat constructor, also adopts sustainable technologies at its shipyard in Alblasserdam, Netherlands. The new heat recovery and pump mechanism will cut gas use in half, while solar cells will offer around 10% of the facility's energy requirements. Taking things, a step further, Italian developer San Lorenzo recently installed enough solar panels to cover a soccer field and a half as part of its entire energy self-sufficiency initiative (Zaltzman, 2020).

The third major development affecting the yachting sector is an international law requiring a 70% decrease in nitrous oxide emissions - a major pollutant - from yachts 24 meters or more in length. To complete the task, a specific converter should be fitted to the engines, but it's cumbersome (Zaltzman, 2020).

Because of this lack of mechanical elegance, the engine and boat spaces are being redesigned. To fulfill requirements, producers such as Heesen have built quicker, more efficient hulls, such as the 5000 Aluminium class in its new Aquamarine design. CRN, Bilgin, and other manufacturers are also ahead of the curve with novel designs that have previously been tested across all regulatory frameworks (Zaltzman, 2020).

This is all great news for yachting and yacht owners. In addition to creating cleaner boats, the world's yards are now considering the broader picture - the health of the oceans where their boats sail - so that the enjoyment will be just as exciting and beautiful in 3020 as it is today (Zaltzman, 2020).

As part of the Green Wings Challenge, Gym Marine has partnered with Yacht Carbon Offset in order to provide support to the superyacht sector in decreasing its air travel carbon footprint. Non-essential travel nearly ceased during the peak of the COVID-19 pandemic, resulting in a beneficial environmental impact with considerable decreases in recorded carbon pollution. This prompted Edward Thomas, director of Gym Marine Yachts & Interiors, to consider his own carbon footprint and how he might reduce it both personally and professionally. Gym Marine Yachts & Interiors is a global company that installs gyms in luxurious settings, such as prestigious residences and ultra-luxury yachts. As is the case with many businesses in the

international yachting sector, air travel is a crucial component of the company, from traveling to customer meetings and installations to industry shows, exhibitions, and events (Mccabe, 2020).

Yacht Carbon Offset is a company that deals with carbon offsetting for superyachts. Yacht Carbon Offset more specifically is a company that specializes in carbon offsetting for superyachts. Yacht Carbon Offset promotes greenhouse gas reduction initiatives in coastal areas or areas visited by superyachts and works with various clients in the yachting sector. (Mccabe, 2020).

When we go to the carbon dioxide society, we try to develop an integrated solution for exemplary cases that eliminate dangerous discharge and recommend sustainable energy solutions. It is difficult to find general decisions due to its extended intensity and requirements for general maritime movement. Importantly, better fields and broader solutions are offered, including the multidisciplinary collaboration of these specialized companies.

The electric drive system is proven reliable and offers benefits such as flexible load profiles, variable torque rejection, redundancy and improved fuel efficiency through an advanced power management system. Current fuel flexibility includes the use of carbon-neutral fuels such as hydrogen and ammonia. Because these fuels do not emit greenhouse gases. Furthermore, hydrogen has an infinite lifetime and can be broken down into renewable energy.

The electrochemical process of a hydrogen fuel cell generates electricity and water vapor, so the hydrogen supplied to the fuel cell can be converted into other fuels. Diesel engines running on ammonia do not emit greenhouse gases. The development of hybrid electric propulsion systems provides a platform for renewable energy sources. The DC bus can provide a hybrid platform for a variety of DC power sources, including renewable energy. These energy sources represent an ever-changing landscape and include fuel cells, diesel and turbo generators, batteries, supercapacitors, wind turbines, solar panels, heat recovery systems and hydro turbines. These combined technologies have enabled pollution-free/carbon-neutral, efficient, quiet and autonomous megawatt power solutions for applications in all sectors of the marine industry, including superyachts. (Eastlack Edward et al. 2019)

CHAPTER III

3.1 GENERAL PRESENTATION OF ENERGY SOURCES

The new age of sailing is not only developing on the high seas reflecting seasonal changes in the way goods and people are transported along inland rivers and along the sides. New ships require a different kind of port: electric and human-powered supply chain, from start to finish, maintaining, renewing, and combining old maritime, shipbuilding, and shipbuilding skills with 21st-century experience.

As sustainable development is one of the most important challenges of the 21st century and the case of the yachting industry, which directly and indirectly affects the environment, has gained increased importance in all sectors of the global economy, it has resulted in the need for sustainable management tools that include a wide range of environmental, social and integrated management tools such as environmental performance assessment, life cycle assessment (LCA), environmental management systems, environmental management systems, environmental management systems, environmental management systems, and environmental management systems.

These tools often include strategies and the accumulation of knowledge that an organization needs to support social and environmental integration efforts and the development of specific ways of operating, quality is essential for any organization. (Ramos, 2019). Some have pointed out that well-organized sustainability management requires the use of tools to effectively measure, manage and communicate sustainability issues (Morioka and de Carvalho, 2016).

The luxury yacht industry is riding a wave of sustainability as commercial yacht owners seek greener methods of construction and operation. Yachts now have an advantage over passenger and commercial vessels as they travel shorter distances and use greener fuels. However, there is room for green building methods as well as other forms of movement. These changes have several benefits, including reducing the ship's emissions and carbon footprint and improving the onboard experience (Bureau Veritas, 2020).

For enhancing yacht sustainability, hybrid-electric technologies are suggested. Running on electricity ensures a calmer ride while also drastically reducing underwater pollutants. This is a significant benefit for both passengers and marine life, that can be injured and disoriented by underwater engine noise. Additionally, hybrid-electric propulsion enhances ship mobility, cutting down on the amount of time and emissions required to arrive at ports and harbors. Solar

panels and kite sails are two other low-carbon technologies that are currently present onboard yachts. Yachts may cruise on wind power, a carbon-free source of energy, thanks to kite sails. A low resistance hull may be added to this technology to increase energy efficiency, and eco-friendly propulsion can be added on moments when sailing is not possible. When used in conjunction with electric propulsion, solar panels provide similar benefits, resulting in a sailing experience with less noise, maintenance, and emissions (Bureau Veritas, 2020).

3.2 SUSTAINABLE YACHTS' FUTURE

Public attitudes toward sustainability are evolving rapidly as the number of Emission Control Areas (ECAs) increases, environmental legislation increases, and port emission reduction standards become more stringent. All signs point to a green future for commercial yachts, and owners have already started in that direction. In fact, there are many power and engine alternatives for yacht owners with easy access to environmentally friendly materials and minimal technical limitations. With the right knowledge of classification societies, green solution providers, and shipyards, the luxury yacht industry can move forward smoothly into a green future. Sails contribute to emissions, global warming, and more, etc (Bureau Veritas, 2020).

The yachting world is experimenting with clean engine technology. A truly zero-emission future is still a long way off, but technological advances in the shipping and automotive industries could eventually help the yachting industry combat climate change. Ferns have been green for thousands of years. With the help of the donkeys and the wind, boats and ships moved everywhere without leaving a trace of a footprint. High – profile engines and the world’s greenhouse gas emissions emission followed. Yacht manufacturers and designers are turning to electrification and alternative fuels to adopt diesel engines and generators (Swift, 2021).

The yachting industry must follow the evolution of the automotive industry and electric vehicles, and the electrification of yachts will be the first step towards zero emissions, followed by hydrogen propulsion solutions. The automotive industry's spending on electrification and battery technology will determine how the yachting industry moves forward. Although fully electric boats are already being explored, there are still more several factors to consider, including the provision of marine vessel charging stations. The current costs currently associated with electric motors only allow them to emerge as a niche market (Swift, 2021).

3.3 AGENDA FOR SUSTAINABILITY 2030

World Sailing is the 2030 Agenda for Sustainable Development and the World Sailing Sustainability Commission, which provided the 2030 Action Guidelines, has set the following goals through the (UN) Sustainable Development Agenda.

To develop a strong sustainability strategy, reduce the carbon footprint of global travel and improve resource efficiency by sharing best practices and setting standards and targets. It contributes to protecting and respecting biodiversity and ecosystem health. It also promotes accessibility by ensuring that swimming education and training frameworks incorporate sustainability.

Promote the adoption of sustainable practices by NAA, events, venues, and related industries by sharing best practices and raising awareness of sustainability issues. By 2030, set technical standards to reduce the environmental impact of the maritime industry, focusing on end-of-life propulsion and power technologies and composites. Use inquiry-based strategies to understand the meaning and find answers. The Committee on Sustainable Development leads the implementation of the initiative in line with how the 2030 Agenda for Sustainable Development contributes to the UN's 2030 Agenda for Sustainable Development and supports the International Olympic Committee's (UN) Sustainability Strategy.

3.4 NET ZERO BY 2050

Under pressure from NGOs and governments, shipping could move towards net zero by 2050, instead of its original goal of reducing emissions by 50% by 2050. The IMO's Marine Environment Protection Committee (MEPC 78) was mainly involved in IMO policy initiatives to establish effective greenhouse gas (GHG) reduction strategies, to be implemented in the MEPC 80 by 2023. The aim is to provide a plan to achieve sufficient decarbonization while ensuring a fair transition process that will receive broad support from the Member States. (Rusanoglu, 2022).

The next goal is to achieve zero carbon emissions by 2050, rather than to reduce emissions by only 50%. The technical guides for the EEXI, CII and SEEMP regulations have been completed and approved for future implementation. This is crucial in setting the pathway for industry emissions up to 2050. Several environmental groups are advocating for a pathway to achieve zero emissions by 2040 and halving emissions by 2030.

MEPC 79 is expected to authorize the establishment of a Mediterranean Sulfur Emission Control Area (SECA) by December 2022. This would require the use of fuels with a sulphur content of no more than 0.1%, such as low-sulphur MGO or a scrubber system for ships trading or transiting the Mediterranean. If there are no delays, the Mediterranean SECA could be implemented as early as 2025. It is also worth noting that the possible inclusion of shipping in the EU ETS from 2023 will add an additional level of complexity and cost to the already very high fuel prices. (Roussanoglu, 2022).

Green yachts could be the next wave as climate change reaches park awareness as more people become concerned with sustainability and how the yachting sector can reduce CO2 carbon emissions, now that the problem of climate change has reached the highest level of awareness. (Safety4sea, 2016). The industry is concerned about the environment and all buckets involved should consider the options available and pay particular attention to the design, materials, construction, and operation of the yachts. The hull and superstructure are simplified through design advances to provide frictionless operation in the water. Precise vessel performance can be determined by the manufacturer thanks to advanced computational fluid dynamics. Green building methods produce less waste and do not release volatile gases into the atmosphere. The directive now draws attention to the operational fact that fuel consumption increases logarithmically with speed and slows down to protect the environment.

It appears that the industry is ecologically conscious. The most conscious shipbuilders were those who built both superyachts and smaller vessels. Today there is a lot of interest in both diesel-electric and hybrid systems." "Smart power management also helps to reduce fuel consumption. In addition, rumored and confirmed environmental restrictions in some parts of the world may require zero-emission ships to enter their waters.

3.5 REVIEW OF PROPULSION AND ENERGY SOURCES

As the rapid development of the marine renewable energy sector has led to an increase the requirements for marine spatial planning (MSP) and is increasingly implemented within an ‘‘ecosystem approach’’ (ES) to management. (Karen A. Alexander, et.al ,2012). As we can see, the effects of many marine environments in the world are the results of human activities (Pauly D, et.al, 1998), (Worm B, et al. 2006), (Halpern BS, et al. 2008), (Karen A. Alexander, et.al 2012).

Recognize that human activities are inherent in and dependent on the ecosystems that support them (Boumans R, Costanza R, et al. 2002), leading to the concept of an ecosystem approach

(EP) to management (Karen A. Alexander, et.al 2012). The EU issued the Maritime Strategic Framework Directive (MSFD) (European Union, 2008) which calls for the achievement of good environmental status in regional waters in Europe (Karen A. Alexander, et al. 2012). Concomitant with the realization of the WFD, the demand for the use of ocean space is increasing. In particular, concerns about energy security (Johansson TB, Turkenburg W, 2004), economic competitiveness, regional development and the need to reduce greenhouse gases (Johansson TB, Turkenburg W, 2004) have increased support for the renewable energy sector. The target at the level of the European Union is 20% of renewable energy (Commission of the European Community, 2007), (Karen A. Alexander et al. 2012) as well as much of the world's coastline is already fragmented, meaning that the marine renewable energy industry is another user of offshore space that could have a negative impact on existing marine users such as shipping and fishing (Ladenburg J, Dubgaard A, 2009), (Karen, Alexander et al. 2012).

The recreational boating industry is a fundamental marine health industry. In recent years, it has been under great pressure to become more sustainable, so environmental awareness has increased and efforts are being made to become a global ecological player, both in terms of how it is built and the impact of its operation. It is expected that over the next year there will be an even greater change in the way sustainability is assessed, as well as in the way emissions and environmental impacts are addressed. It is important to note that the yachting sector is directly related to two of the 17 SDGs. In particular, 'No. 14 Life Below Water', which deals with the conservation and sustainable use of water, and 'No. 13 Climate Action', which aims to reduce greenhouse gas emissions.

Some of the concerns in focus are waste, the use of plastics and the use of cleaning products that are harmful to aquatic ecology. Along with yachts, the idea of sustainability has also been discussed in relation to industry-wide competitions or events that have a negative impact on the environment. To reduce carbon emissions and support the health of marine species, World Sailing has now made it mandatory to create a thorough sustainability strategy that is in line with the 2030 Agenda. In addition, events must commit to annual reporting on their achievements and long-term sustainability goals and their organisation must adhere to the ISO 2012 Sustainable Event Management System.

Volvo claims that the upcoming races in 2026 and 2030 will place a strong emphasis on sustainability throughout the race. For example, each city stop along the route will include a

programme to raise awareness and educate the public about sustainability. It seems that sustainability reporting is an ideal way for the yachting sector to communicate responsibly, as it is for other industries. There are already sustainability reports from the yachting sector's largest organisations, such as Royal Akarana Yacht Club, Beneteau and Corpus Christi Yacht Club. The initiatives and guidelines of the UN Global Compact and GRI seem to be setting the pace.

The latest new trend is superyachts that are environmentally friendly. A major issue for the sector is the reduction of pollutants when at sea. Environmental sustainability and eco-efficiency are key focuses of the new technology. Van Oossanen Naval Architects, for example, is researching the eco-friendly vessel of the future. An in-house initiative called "The Yacht of 2030" aims to exceed the IMO's timeline to halve CO2 emissions by 2050 (Oossanen, 2021).

What arises as a question is how much can CO2 emissions be reduced? The size of the vessels in the marina, sea traffic, profile range, emission ratios for different modes of operation, etc. were factors considered by Van Oossanen Naval Architects. Their key finding was that an efficient hull can reduce fuel use. The fast displacement hull form (FDHF), the solution they proposed, combines the maximum speed associated with a semi-displacement hull with the low speed efficiency of a full displacement vessel. Smart on-board technologies may also help, but for now, the shipbuilder is only focusing on individual customer needs rather than future planning. The use of a wind system in the business sector also demonstrates some innovative ideas. As discussed above other solutions include battery hybrid systems, such as that of the Bravo Eugenia or the hybrid diesel-electric propulsion system of the Artefact (Oossanen, 2021).

There are many topics to discuss, but unfortunately, the literature on how the yachting industry is sustainable is incomplete. Not only because the problem is approached from an energy perspective, but also because there are not enough sustainability indicators for yacht companies to operate in a sustainable manner. Road (Ramos, 2019). It is clear that humanity is already moving towards a smaller ecological footprint (Oossanen, 2021). Because this is a continuous evolutionary work. But as advanced as the technology is, today's green sails are only for swimming.

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