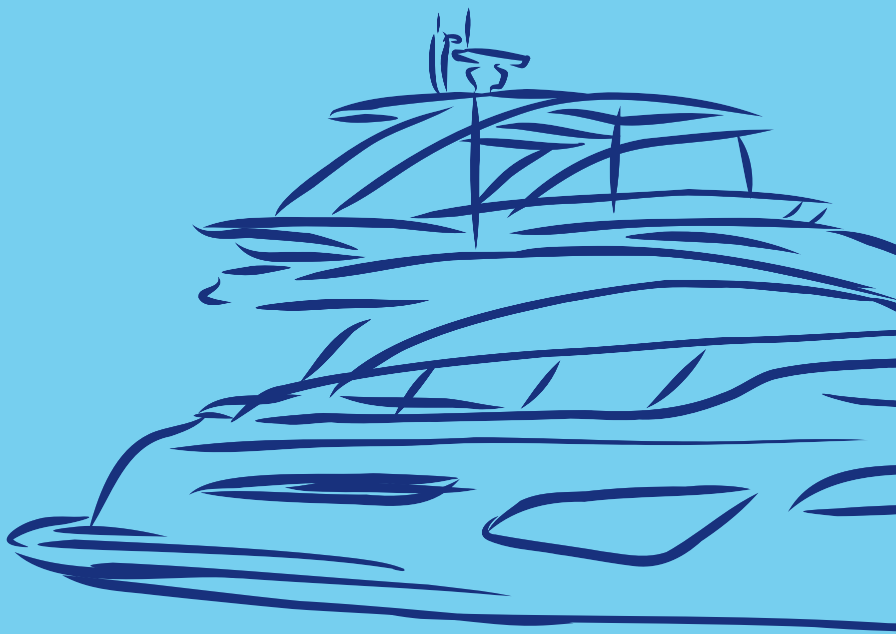
Sustainability principles for yacht designers



DESIGNERS' PROTOCOL

INTRODUCTION

The Designers' Protocol: stronger together. That small apostrophe represents the collective intent of the yacht design community to put sustainability conversations at the heart of their relationships with clients. One common document, developed with input from leading design studios, naval architects and sustainability specialists at Water Revolution Foundation, to spark thought and reflection about what goes into the design and operation of a yacht. At a high level, the United Nations define Sustainable Development Goals (SDGs) as keystones of environmental ambition and guidance, with six of these in particular having direct relevance to our industry's activities. They may not be familiar to our industry, and the clients who sustain us, hence a need for a rather more granular and approachable which this Protocol attempts to set out.

Sustainability is a dauntingly broad subject, prone to over-simplification, susceptible to deliberate misrepresentation, and sometimes rendered somewhat vague as an issue by jargon or attempts to define it: how many people are aware of the concept of 'system pressures' and some of its components including climate change, resource scarcity, environmental degradation, pollution, poverty and social inequality? Read those again, and think how many are issues which apply to the yacht industry. The honest answer would be all.

Quite correctly, governments and organisations use policy and regulation with the intention to drive behavioural change. Obvious examples in our world include MARPOL and emission regulations. These instruments and levers will only become more prescriptive over time. At its simplest, yachting should be pursuing sustainable manufacturing: developing technologies to transform materials without emission of greenhouse gases, use of non-renewable or toxic materials or generation of waste [Brennan & Vecchi 2015]. And it should be striving for sustainable operation, the definitions for which are many and varied.

The Designers' Protocol seeks to raise both manufacturing and operational issues with the end-user. It is a significant statistic that more than 80% of the environmental impact of a product is determined at the design stage [Build Up 2012]. Who better, then, than the designer to tackle this with their client? It is a deliberately targeted document, focusing on easily-understood concepts and subjects, with aims typically associated with eco-design (for want of a better term): Efficiency; Durability; Longevity; Dematerialisation; Effectiveness; Substitution and Mitigation.

The Protocol is one piece of a carefully considered and formulated approach from the Water Revolution Foundation to drive sustainability in the superyacht industry through collaboration and innovation. Designers are in a unique position to influence their clients to make responsible and well-informed choices.

DICKIE BANNENBERG

Bannenberg & Rowell Design

Initiator of Designers' Protocol

SUPPORTING COMPANIES

The Designers' Protocol was developed by organisations spanning various sectors of the yachting industry, from suppliers and design studios to naval architects and engineers. The collective expertise and shared dedication of these contributors have been instrumental in shaping this essential document.

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DEFINING THE ENVIRONMENTAL AMBITION

Author: Water Revolution Foundation

HIGHLIGHTS

- Define the client’s ambition on a simple scale of 1-5
- Set sustainability goals early on to boost a yacht's environmental performance and future compliance
- Apply the Life Cycle Assessment (LCA) methodology

A yacht is a highly complex product, encompassing a variety of fields of knowledge and expertise, numerous industries, and thousands of people and working hours - from the first visionary sketch to the final result.

In order for a yacht to be future-proof, it is essential to define sustainability goals at the early stages of project planning. Establishing such goals will not only enhance the vessel’s environmental performance and ensure compliance with future regulations, refit operations, carbon taxes, material selection, and supplier choices, but will also be instrumental in clarifying limitations on navigation areas, anchoring, bunkering and access to ports and marinas.

Water Revolution Foundation strongly advocates for incorporating a Designers’ Protocol which clearly states a new project’s environmental ambitions alongside its technical specifications. Assigning an ambition level, ranking from one to five, provides clarity for the involved companies regarding requirements for building materials, supplier selection, naval architecture, shipyard practices, maintenance standards, and the vessel’s operational profile.

Specific indicators, such as an environmental notation by Classification Societies or a Yacht Environment Transparency Index (YETI) score, can distinguish vessels within the fleet. However, at the early stages of design, a simple indicator between 1 and 5 will suffice.

A yacht’s environmental performance encompasses much more than just its emissions during operations – the overall impact spans the vessel’s entire life cycle, including the build process, maintenance, and refit stages.

The Life Cycle Assessment (LCA) methodology is recommended to accurately measure and understand the environmental impact of all yacht components, materials, and operations. This method also enables the evaluation of alternative solutions that significantly improve the yacht's environmental performance, including materials, pre-made systems, and processes of building, operating and refitting.

With the aim to build to an environmental notation recognised by Classification Societies, Water Revolution Foundation is committed to centralising and strengthening the framework for environmental requirements.

Over time, the ambition of a new build project will be indicated by the client's desired YETI energy label, which is currently in the works and expected to be available by the end of 2024.

LIFE CYCLE APPROACH

Authors: RWD & Viken Group

HIGHLIGHTS

- Take the yacht's life cycle into account during the design phase
- Prioritize renewable, recycled materials, local sourcing, and designs that minimize waste and energy use
- Opt for durable, adaptable designs to extend product life and support a circular economy

The lifecycle approach compels us to view each yacht not merely as an object, but as a living entity with a distinct lifecycle, encompassing its build, operational life, and eventual decommissioning. This comprehensive perspective drives all parties to scrutinise the origin of materials, the manufacturing process, the yacht's operational efficiency and its end of life disassembly, ensuring sustainability is interwoven at every stage.

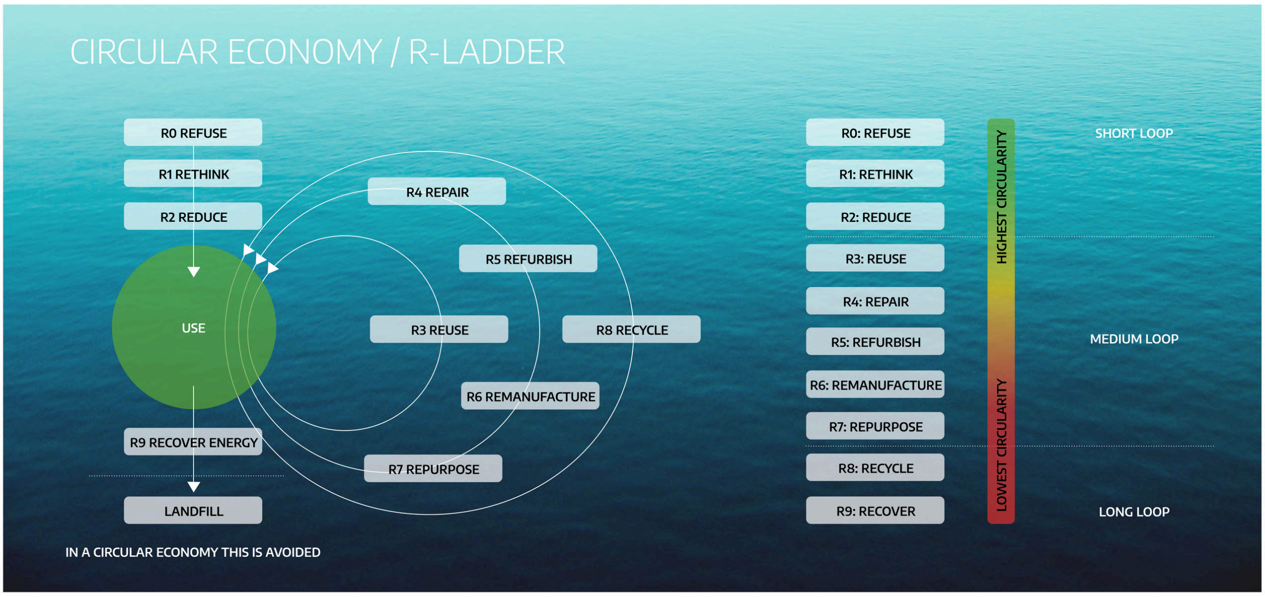
By adopting the 'lifecycle approach' to the design of every element of the yacht, it is important to consider what the operational profile of the vessel will be. This understanding should influence the specification of systems and materials. It drives the selection of materials where waste is minimised, recycled content considered and energy-intensive production limited where possible. By asking suppliers to develop more sustainable solutions and demanding that claims are verifiable, it is possible for designers to drive positive change.

Another crucial consideration is what drives energy consumption during the yacht's active years. Systems that are over-specified for normal operations consume more power. Designing to minimise solar gain, capturing excess heat and repurposing it, and developing crew-only modes when guests are absent are just some of the options that can significantly reduce hotel load.

For a truly full-circle approach, we also have to consider how the yacht is constructed. Yachts are designed to be durable and a well-crafted interior can last for decades. By designing with disassembly, repair and material recovery in mind it allows replacement of components and enables successful refits. Embracing principles of the circular economy ensures that the end of a yacht's life actually marks the beginning of a new lifecycle for its components.

This circular thinking not only minimises waste but also plays a significant role in protecting our environment. By thinking of all of the component parts of a yacht's lifecycle, we advocate for a regenerative and restorative design philosophy, ensuring our creations are not only luxurious and innovative, but also sustainable and mindful of their environmental and social impact.

(Section Author: RWD)



Refuse

Everything we build has a negative impact on the environment, thus our job is to find a way where this effect is as low as possible. Efficient design practices are not only about saving money, but also saving our environment. Dare to refuse specifying materials or products that do not meet the new requirements.

The following points are the prime areas we consider when specifying interiors, and are relevant for both new builds and refits:

- Renewable and recycled materials;
- Certified materials;
- Consider using local suppliers;
- Alternative materials from responsible production.

Rethink

The cradle-to-cradle can be defined as the design and production of products of all types in such a way that at the end of their life, they can be truly recycled (upcycled), imitating nature's cycle with everything either recycled or returned to the earth, directly or indirectly as completely safe and non-toxic. We must, however, be wary that cradle-to-cradle is a paid scheme and therefore does not guarantee the optimal choice.

Reduce

Designing with high quality and long-lasting design not only saves money but also raw material consumption and energy. Keeping the permanent core of the interiors somewhat generic also increases the chances that it may remain relevant over long periods of time, thus increasing the lifespan.

The following suggestions can guide your efforts to reduce:

- Consider how spaces will be used at different times of the day or for different itinerates;
- By using the highest quality to the high traffic areas e.g.- in front of the elevator, the first step on a stair, a walkway in a restaurant, etc. - to make that part stone instead of carpet you save quite a lot of maintenance and does not need to be replaced as often.

Reuse

What should be done with old furniture or items that will not be used onboard?

- Create your own library system to gain a better overview of what furniture can be refurbished and reused for the next vessel;
- Sell them by using existing portals that buy old furniture or create your own library and system to sell to companies/ private persons;
- Donate to charity

Repair

Design for longevity and flexibility:

- Products with good quality and long-lasting design;
- Furniture with spare parts to be able to replace broken parts only, not the whole furniture;
- Repairing instead of replacing. Repairing furniture significantly reduces carbon emissions, as producing new furniture consumes a substantial amount of energy. Extending the lifetime of a chair to 20 years through repair and reupholstering can reduce CO_2 emissions by 40-50%.

Refurbish

Refurbished items save money, raw material consumption and energy. Taking raw materials like wood or steel carries the most CO_2 impact, unlike using existing furniture. Restore an old product and bring it up to date for the most environmentally-conscious option.

Remanufacture

Remanufacturing is the rebuilding of a product to specifications of the original manufactured product using a combination of reused, repaired, and new parts.

Remanufacturing is not the same as refurbishing. A refurbished piece of furniture has had something added or changed, while remanufactured furniture is disassembled and rebuilt according to the original design by using parts of the discarded product in a new product with the same function.

Circular economy and sustainability enthusiasts love remanufacturing for one very good reason: it provides enormous eco-benefits, cutting environmental impact by two-thirds.

Repurpose

Upcycling is the process of converting waste materials or useless products into new products of higher environmental value. The most important resource in upcycling is creativity. Opportunities for repurposing include:

- Use discarded product or its part in a new product with a different function;
- Giving new life to waste that would otherwise be incinerated, offering new value as wall/ceiling features, furniture, artwork, installations, etc.

Recycle

Art is a powerful source of inspiration – stimulating our emotions and opening up our perspective for a new way of thinking. Yachts have so much potential to create such spaces by:

- Using environmentally-friendly/recycled materials on furniture, walls, ceilings, etc.;
- Creating architectural features from recycled items.

(Section Author: Viken Group)

OPERATIONAL PROFILE

Author: Water Revolution Foundation

HIGHLIGHTS

- Define operational profile with clients to identify the yacht's intended usage
- Optimize hulls and engines for real-world conditions
- Balance functionality with environmental responsibility

Discuss the client's intended operational profile, main cruising area, expected range of navigation and speed, time at anchor, and time in port in order to optimise for these elements.

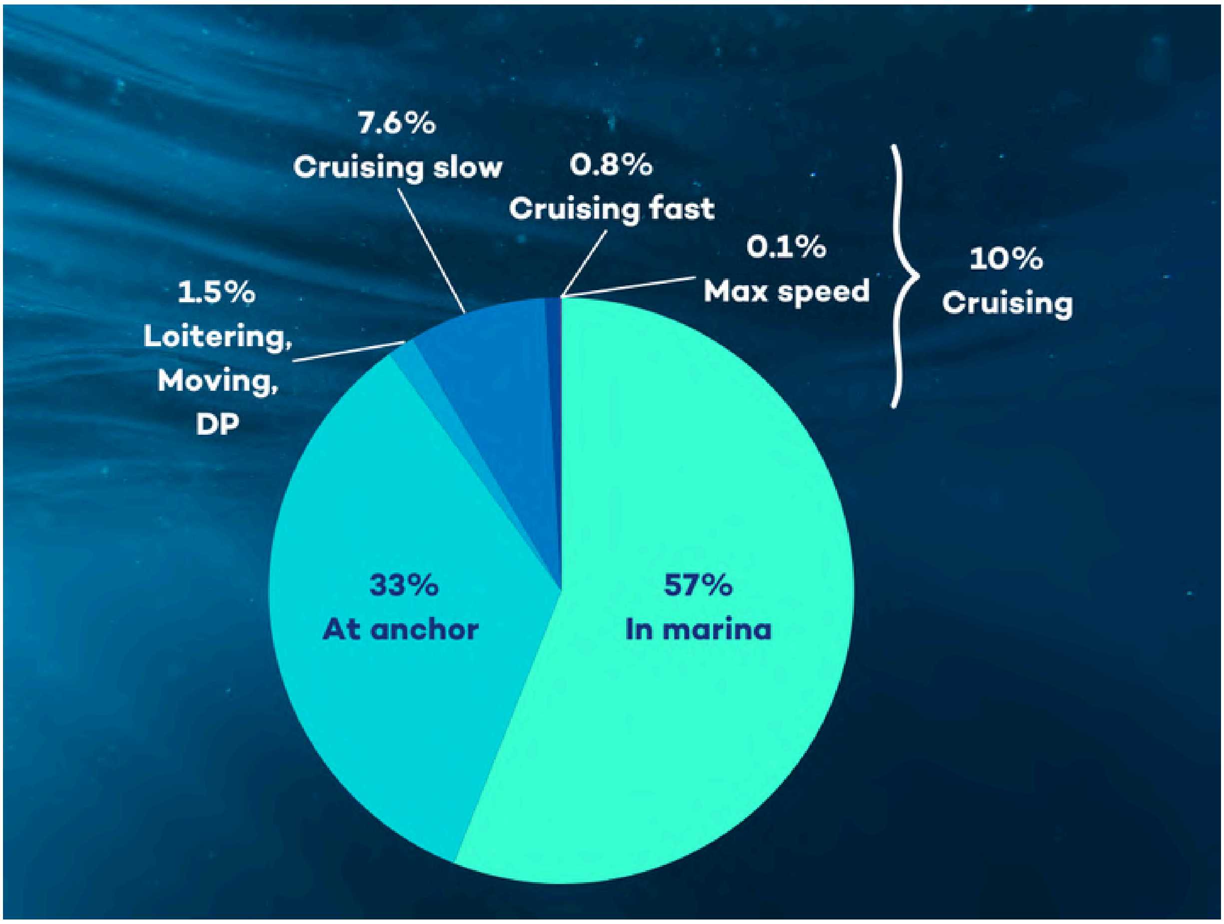
In the superyacht design process, a crucial initial step involves thorough discussions with the client to precisely define the yacht's intended usage. This includes considering how and where the yacht will operate over the course of the year, as these factors significantly influence the yacht's design and construction.

This determination leads to the creation of an operational profile, a vital tool for predicting the yacht's usage patterns, including the time it will spend at anchor, in port, or under sail. Traditionally, many yachts are designed with hulls and primary engines optimized for high-speed sailing. However, the reality is that most yachts spend only approximately 10% of the year actively sailing, with a mere 1% reaching top speeds.

This disparity between design and actual usage has notable consequences, including higher fuel consumption and increased emissions. Specifically, yacht hulls are shaped for speeds that aren't typical for year-round operations, and engines are often overpowered.

To mitigate these issues and enhance environmental efficiency, modern superyacht design focuses on aligning the yacht's performance characteristics with its real-world operational needs. Hulls are to be tailored for efficient cruising speeds, ensuring a more balanced and sustainable approach. Engine choices should be calibrated to match actual sailing patterns, reducing both fuel consumption and emissions.

In this renewed approach to yacht design, the emphasis is two-fold, covering both functionality and environmental responsibility. Beginning with a clear operational profile, designers should aim to create vessels that are both well-suited to their intended purpose but also environmentally conscious. The average operational profile as displayed below can be used if the client cannot or does not want to specify a specific operational profile for this project.



ENERGY SOURCES

Author: Water Revolution Foundation

HIGHLIGHTS

- Ensure yacht's power demand does not exceed shore supply to avoid reliance on diesel generators
- Support alternative fuels like HVO to reduce emissions
- Utilize strategies like PTO systems, battery peak shaving, and heat recovery to improve energy efficiency on board

Ensure that the yacht's electric power demand does not exceed the shore power supply in order to avoid depending on diesel generators for the same purpose. Prepare the yacht for the future through fuel flexibility. Advocate that yachting can and should lead the way with the support of alternative fuels, e.g. HVO to immediately reduce emissions and support increased production for mass availability.

After estimating the yacht's electric power demand, the next crucial consideration is the source of this energy. For environmentally-conscious energy consumption on board, meticulous planning of the energy source is imperative. There are several approaches to achieving this.

One effective strategy involves designing the electrical systems and their power management to ensure that the instantaneous power demand while in port does not exceed the available shore connection. This design ensures that energy can be sourced from the land grid instead of relying on onboard generators when the yacht is docked. During sailing, the power demand can be met through power take-off (PTO) systems. In specific high-power-demand situations, such as during manoeuvres when bow thrusters are in use, using batteries for peak shaving can reduce the need to activate additional generators to meet the extra power demand.

Furthermore, integrating systems like heat recovery systems can enhance overall energy efficiency. These systems capture and repurpose heat generated in the exhaust or by generators to power luxury amenities such as heated pools or jacuzzis on board, effectively utilizing waste heat for improved energy efficiency.

PHOTO : BANNENBERG & ROWELL DESIGN

HULL FORM & PROPULSION

Author: Espen Oeino International

HIGHLIGHTS

- Select the marine platform, power plant, and propulsion based on the yacht's operational profile and client needs
- Hull form choice impacts speed, comfort, and efficiency
- Diesel-electric systems and dual-fuel options improve energy efficiency and design flexibility

When embarking on a new build adventure, one of the first decisions to take is which marine platform, power plant, and propulsion system to choose for the intended operational profile.

Whereas commercial cargo ships generally sail long distances at given speeds, yachts tend to have a more diverse operational profile. Statistically, yacht spend about 10% of the time under way and 90% stationary (ref. Water Revolution Foundation, YETI's Operational Profile).

However, given that yachts are built for individuals with unique purposes, it is paramount that the designer or naval architect consult the client on navigating through the choice of marine platform, power plant, and propulsion method in order to achieve an energy efficient design.

Hull Form

The hull form is generally driven by the desired speed, comfort levels, seakeeping characteristics, and the real estate which it must carry. Fast vessels feature long, slender hulls with small under water surfaces for low friction and wave making resistance. However, they are limited in their carrying capacity and roll characteristics.

Catamarans have very low resistance and feature ample space due to their wide beam. Their slender hulls contribute to limited carrying capacity and space within the hull. Compared to monohulls, their wide beam gives a very different motion in waves. In heavy seas, catamarans can be prone to strong slamming in the tunnel between the hulls.

This effect can be mitigated by a wave piercing bow. Beamier monohulls can be optimised for comfort more easily and feature good carrying capacity, but have less favourable length to beam ratio, which results in higher resistance when under way, particularly at higher speeds.

Matching the right hull form to the intended operational profile is of utmost importance to design an efficient, safe, and fit for purpose platform for a yacht.

Power Plant & Propulsion System

The choice of power plant and propulsion system is very much driven by the operational profile, desired speed and expected hotel load. As mentioned above, yachts statistically sail much less than commercial ships and rarely sail at full power. For most displacement vessels, the speed power curve behaves in a cubic manner, meaning that power required to double the speed is 8 times. By reducing the target of maximum speed by a few knots, significant impact can be made on the required power plant and subsequent weight, size and overall efficiency of the yacht. Optimising the hull for the speed at which the vessel will operate most frequently or cover the longest distances, rather than for maximum speed, can significantly impact fuel consumption over time. This approach also affects the size of the engine room and ventilation trunks, leading to more efficient overall design and operation.

When investigating the most suitable power plant, it is important to look holistically at the overall energy consumption and how to provide the necessary power in the most efficient way. For yachts, which fall under the statistical profile, the diesel electric power plant tends to be the most flexible and efficient option when the vessel is propelled by PODs with higher efficiency compared to shaft lines. The energy demand for hotel load and propulsion can be managed through several generators from one system as needed running at optimum rating.

Dissociation of power plant and propulsors also provides flexibility in the layout, especially the position of the engine room. Electric drives such as pods may be installed, which tend to emit less noise and vibrations for increased comfort on board. Furthermore, with continuous development in alternative power sources and alternative fuels, diesel generators can be replaced in the future without changing the entire propulsion train. With that in mind, it is advisable to already consider dual fuel systems in the development of a new build yacht.

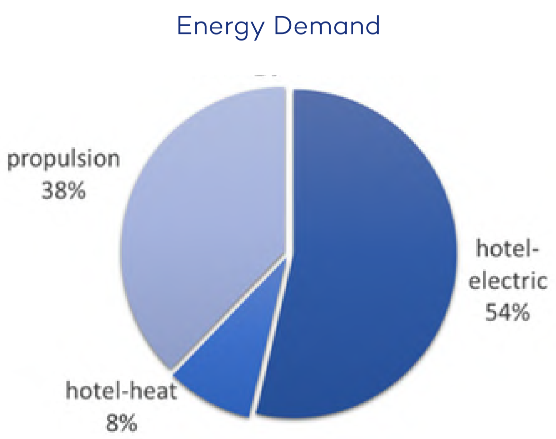
HOTEL LOAD & A/C

Author: De Voogt Naval Architects

HIGHLIGHTS

- Reduce HVAC energy by minimizing sunlight heat gain and optimizing fresh air supply
- Improve HVAC efficiency with better insulation, waste heat utilization, and strategic system placement

Although the propulsion power is much larger than the hotel load, it equals to approximately 40% of the total consumption as yachts typically sail only about 10% of the time. Part of the energy demand is heat load for heating fresh water, pools and Jacuzzi's and HVAC. This heat is often supplied electric but can also be supplied by waste heat.



From the hotel load over 50% is used by the HVAC system. Several options are available to reduce this load.

Operating Conditions

Yacht specifications often only specify maximum conditions, like 35° and 80% RH or 45° and 40% RH. These extreme conditions occur <0.01% of the time. A realistic normal condition is 25° and 80% RH. HVAC design and capacity calculations should take both extreme and normal condition in to account.

Reduction of Energy Consumption

The energy demand of the HVAC system can be reduced by:

1. Lowering the energy demand:

- Keep sunlight off glass (large overhangs, skylights with covers, exterior louvres, etc.). Assess with a 45 degree angle of sunlight;
- Keep sunlight off decks above accommodation;
- Avoid dark colours in exterior. Consider infra-red reflective paint or additional insulation;
- Avoid operation with open doors of conditioned spaces or trying to condition exterior spaces with HVAC;
- Glass with lower heat transmission for example by tinted, coated, double pane glass. This will have an influence on the design as darker colors might be required or limitations on shape and maximum size apply. NB: even the best glass is much worse than a normally insulated exterior shell. Incorporating sills on top and bottom of full height glass improves the overall insulation;
- Fresh air supply is a major factor in the energy use of HVAC. For central ducted air in extreme conditions this may be up to 75% of the cooling demand. Reducing fresh air demand, both in specification and using active control (CO_2 sensors), will reduce energy use. Fan coil installations tend to have less fresh air supply than central ducted HVAC.

2. Creating a more efficient HVAC system:

- In central ducted HVAC installations air will be cooled down and afterwards heated again to achieve the correct temperature and humidity. Using waste heat for the heating will reduce the electrical load. This has influence on the layout of the yacht as more area is required to accommodate these systems;
- More efficient chiller systems are available but also adsorption chillers can be used which use waste heat for cooling;
- Strategic placement of HVAC spaces, avoiding long or convoluted routing (heat losses and flow resistance).

6. HULL COLOUR

Author: AkzoNobel

HIGHLIGHTS

- Dark hulls absorb more heat, raising interior temperatures and increasing energy costs.
- Low Solar Absorption (LSA) coatings and proper insulation can reduce heat absorption, easing the load on air conditioning systems, and improving crew comfort and equipment protection

The topcoat finish is the representation of all the thousands of hours of hand-crafted labour that goes into making a superyacht. A yacht with a dark hull stands out, making a statement on the water and showcasing its craftsmanship. However, the choice of the hull colour impacts not only aesthetics but also the functionality of the boat. Understanding how different colours affect energy efficiency can empower more informed decision making.

Depending on vessel type, substrate, undercoat, and coating, the external areas have the potential to absorb infrared radiation (IR)—heat—from the sun. When energy from the sun hits a surface, the irradiance is absorbed, converted to heat, and transported to the substrate via thermal conduction. This can result in a rise in the hull temperatures and subs those of the internal vessel areas.

A dark-painted hull, such as navy blue or black, tends to absorb more radiation than lighter-coloured hulls. As a result, dark hulls can become significantly hotter when exposed to direct sunlight, which could cause substantial temperature differences between dark and light-coloured surfaces. For instance, a white-painted hull and a black-painted hull can have more than a 20°C (36°F) temperature difference. This increased heat absorption can also increase the interior temperature, which can strain the air conditioning units used to maintain acceptable internal operating temperatures. This, in turn, can increase fuel expenses and impact the vessel's overall energy efficiency.

If a dark vessel is desired but there are concerns about high heat absorption, consider low solar absorption (LSA) coatings. The LSA coatings are designed to mitigate the impact of solar energy by minimizing the amount of energy absorbed by the material. This type of coating is used not only on hulls but also are likely used on hardtops, painted decks, cabin roofs and even tenders.

The benefits of these coatings include minimizing the workload and operational cost of the air conditioning unit and providing a better working environment for the crew and sensitive electronic equipment. It is important to highlight that a white primer is required underneath for LSA coatings to work effectively.

The appropriate insulation thickness should also be considered to improve thermal comfort and increase energy efficiency. The insulation thickness for a vessel can vary depending on the specific application and materials used. The effectiveness of insulation is often measured by its R-value. This value represents the resistance to heat flow through the material, and it can have different recommendations. Choose the appropriate thickness based on your specific needs and vessel type.

Another consideration when selecting the vessel colour is that darker colours may be more susceptible to visible scratches and fading if not well maintained. This impacts the longevity of the coating, the time between dry dockings and, consequently, the resources needed, such as spray materials, energy, and indirect resources. The coating's ability to become slightly softer in direct sunlight may have an impact on this as well, so fender damage may be noticeable sooner on a darker colour. To reduce these consequences, you can look for new technologies of coatings' resins that offer extended longevity by exhibiting enhanced scratch resistance and polishable properties. This way, in service scratches and damage can be restored. Another option is the basecoat and clearcoat system since, if necessary, clearcoats are much easier to buff, polish, and restore. To dive deeper into effects of colour, refer to the ICOMIA Colour Guide (costs apply).

When it comes to choosing the hull colour, there is no one-size-fits-all solution. Different environments, owner personalities, and goals require different colour choices. With these insights, more functional considerations can be made with your regional coating expert and the project manager to determine the best route for the yacht.

GLAZING TREATMENTS

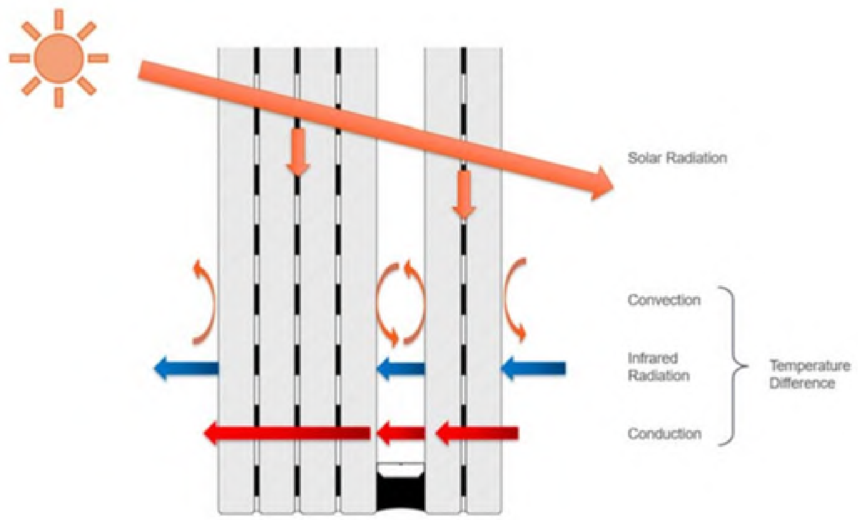
Author: Eckersley O'Callaghan

HIGHLIGHTS

- Solar gain warms interiors, and lower g-values and U-values in glazing help reduce energy needs and carbon emissions
- Various methods enhance both solar and thermal performance
- Standard glass is the most suitable for recyclability

Performance Definitions

The diagram below shows the key mechanisms of solar gain and thermal losses through glazed panels:



Solar Gain

Solar gain is when energy absorbed from solar radiation, leading to surfaces heating up – including internal surfaces. In cooler climates, solar gain helps to warm interior spaces, but in warmer climates, excessive solar gain can cause overheating. The g-value of glazing describes the percentage of solar energy transmittance through glazing. The g-value is coordinated with MEP systems to ensure that heating and cooling requirements can be achieved, lower g-values help to reduce operational carbon.

Heat Loss

Energy use for heating and cooling devices is heavily governed by energy transfer through the envelope. The U-value is a measure of the thermal transfer through material. Reducing the U-value decreases the conduction through the envelope, which in turn lowers the demand on internal heating and cooling systems. Energy is transferred through glazing due to differences in temperature between warm and cold sides.

Improving Performance with Glass Technologies

Glass technologies can improve solar and thermal performance, thereby reducing the demand on internal heating and cooling and therefore cutting operational carbon emissions. Technologies can be used independently or in combination to improve the performance of the glass.

Solar Control Methods

- Body tinted glass increases solar radiation absorption and therefore reduces solar gain. Tints, such as grey or blue, are added to the float glass to change its appearance;

- Coloured interlayers are used to laminate multiple plies of glass together – typically these are transparent, however coloured interlayers are also available. These reduce solar gain in a similar fashion to body-tinted glass, by increasing the absorption due to the darker colour of the glazing;

- Ceramic frit is an enamel pattern which is fused onto the glass surface during the tempering process. The percentage coverage is varied to change the overall transparency of the glass and therefore reduce solar gain;

- Louvres and blinds can be placed in the internal space with a reflective finish to re-direct solar radiation and reduce solar gain;

- Smart glass or dynamic glass is a glass whose light and solar transmissions are altered when voltage, light or heat is applied. Generally, the glass changes from translucent or tinted to transparent; this affects the way in which it blocks and transmits solar radiation at different wavelengths;

- Darkening the tint of the glass increases solar radiation absorption, therefore reducing solar gain.

Thermal Control Methods

- Insulated glass units (IGUs) have a sealed gas cavity between two panes of glass. The gas has a low conductivity and therefore the U-value is improved compared to single glazing. IGUs are available in both double and triple glazed formats, with the latter offering the best thermal performance.
- Low-e coatings can be implemented as part of an IGU to improve performance further, see below for more information.

Thermal & Solar Control Methods

Coatings can improve either solar or thermal performance or both. Different coating types are summarised below:

	Has to be in IGU?	Can be used with Chemically Toughened Glass?	Can be used with curved glass?	Effect
Solar Control	No	No	Yes	Reduction in g-value proportional to light transmittance
Low-e Coating	Yes	No	Some available	Provides reduction in U-value.
High Performance	Yes	No	Some available	Provides reduction in g-value, without compromising light transmittance. Provides reduction in U-value.

Note that type of glass curvature, such as how tight the bending radius is and whether curvature is cylindrical or non-standard, affects whether it can be coated.

Coatings cannot be applied to chemically toughened glass because they interfere with the chemical treatment. However, a layer of coated annealed glass can be incorporated into a chemically toughened glass assembly.

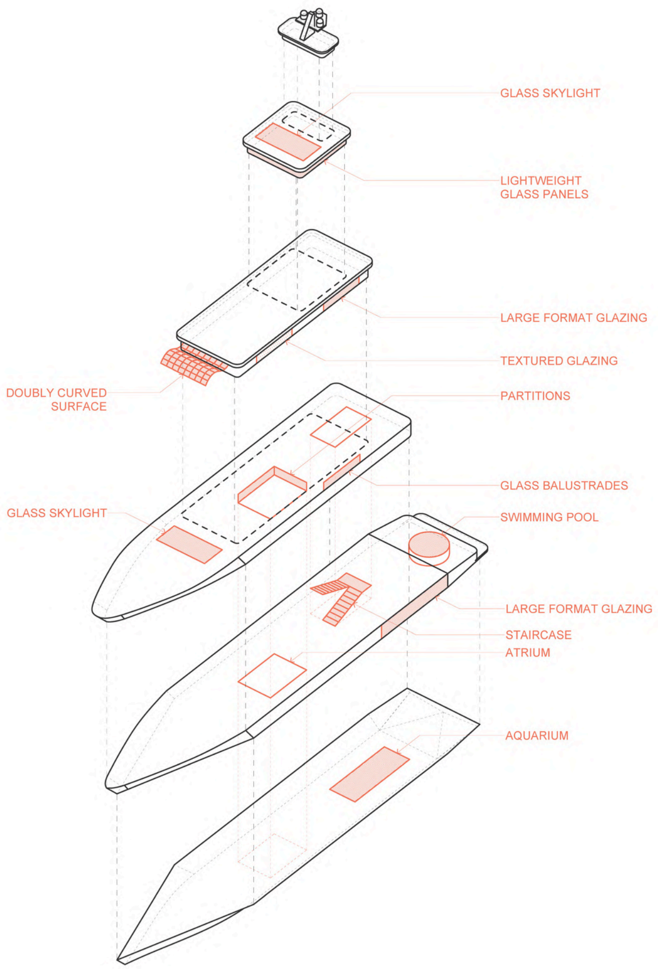
Embodied Carbon

Embodied carbon refers to the CO_2 emissions associated with a material or product's entire lifecycle, from production to disposal. It can be expressed as "cradle to gate," focusing solely on emissions during production. Suppliers can develop Environmental Product Declarations (EPD) which sets out various data, including embodied carbon, which are calculated using a standardised process.

Most of the embodied carbon in glazing products is associated with the initial float line process and subsequent strengthening processes. Processes like bending, fritting, and strengthening have higher embodied carbon due to gas-fuelled heating, whereas lamination and coating processes are less carbon intensive especially in regions with green electricity. The assembly process into Insulated Glass Units (IGUs) is not carbon intensive, however the additional material required to form the inner and outer packages does have an impact. Interlayers have a high embodied carbon and so should also be considered in the overall embodied carbon of glazing.

Chemically toughened glass has a significantly higher embodied carbon footprint—estimated to be 5 to 15 times greater than traditional oven-tempering processes—because of the continuous energy required to maintain high temperatures in the tempering bath.

Initial studies have also shown that switchable glazing has a significantly higher embodied carbon value when compared to standard coated glass. Many switchable glazing products are produced in Asia where the energy mix is more reliant on fossil fuels, therefore the associated embodied carbon is higher compared to production in Europe.



Low Carbon Glass

A number of glass suppliers are now producing 'low-carbon' glass by increasing the proportion of recycled material, called cullet, into the feedstock. Since cullet has a lower melting point than raw materials like sand, the embodied carbon is reduced.

Optimisation

Embodied carbon is related to the volume of material used, therefore if glazing thicknesses can be optimised then the embodied carbon can be reduced. Finite Element Analysis can be used to accurately model the behaviour of glass under different loading scenarios, and the thickness can be optimised to meet strength and deflection requirements.

Stiff interlayers like SGP improve shear transfer in laminated glass, increasing the effective bending thickness compared to softer interlayers. The glass build-up can also be optimised by selecting the strength class carefully, for example chemically toughened, heat strengthened or fully toughened glazing.

Circularity

Glass is inherently recyclable, it can be crushed and then re-introduced into the float line as 'cullet'. However, some types of glass can't be reintroduced to avoid contaminating new glazing.

Standard clear glass is the most straightforward to recycle. Laminated glass can be recycled, the interlayer burns off during the melting process which avoids contamination. Likewise, coated glass can also be recycled, with its coating burning off. The glass from IGUs can be recycled but is currently done less commonly than monolithic glazing. This process is more labour-intensive process compared to single glazing because the spacer bar must be separated from the glass.

Body tinted glass is generally harder to recycle because it cannot be re-introduced into clear glass production, it is possible to introduce into new batches of body-tinted glass but this is produced infrequently compared to clear glass. More often, it is introduced into container glass production which is a form of downcycling. Fritted glass cannot be recycled due to the contamination that the ceramic material introduces into the feedstock.


PHOTO : AKZONOBEL

MATERIALS & FINISHES

Authors: RWD & Viken Group

HIGHLIGHTS

- Use certified materials and processes to minimize impacts
- Partner with suppliers who have verifiable ESG standards
- Incorporate modular designs and durable materials to reduce waste and promote reuse

Across superyacht operations and designs, it is crucial to responsibly choose services, products and materials that meet a set of exacting, internationally-acceptable environmental, social and ethical standards. By opting to use certified healthy materials and substances, we can help minimise impact on human health and the environment during manufacture, use and at the end of their life.

Activities to consider include:

- Minimising waste and efficient use of resources: Maximising resource use and energy efficiency in the manufacturing and supply process to help minimise environmental impact and be more cost effective. Embracing material imperfections to avoid wastage. Using fast-growing species, recycled materials, recyclable and biodegradable materials is prioritised. Understanding the materials we are working with and designing responsibly with those in mind.

- Lowering carbon impact: Minimising the carbon footprint from transportation is a priority, either by sourcing as locally as possible or using low carbon transport options.

- Protecting communities: Engaging with local artisans means bespoke and more sustainable design options can often be achieved. This helps local craftsmanship thrive as well as creating a strong connection through the design story.

- Protecting animal welfare: Suppliers of animal-based products must guarantee high standards of animal welfare across their supply chain. We will not specify any products of any species listed on the International Union for Conservation of Nature Red List of Threatened Species (IUCN).

- End of life: Ensuring that appropriate substances and materials are used so that they can be responsibly disposed of, recycled or reused at the end of their life. Special attention to typical details should be given to aid easy disassembly.

Verifiable Supply Chains & Collaborations

We must strive to work with responsible suppliers, contractors, and companies. Partners should deliver a high standard of workmanship and provide safe, ethical and fair working conditions for all staff and communities throughout the supply chain. They should understand the nature and origin of their products and materials, taking measures to protect the environment and limit GHG emissions. With this in mind, collaboration with suppliers who have verifiable supply chain and ESG certifications is paramount. Processes should be put in place to ensure that supplier's practices align with our sustainability ethos. Furthermore, building strong collaborations with IOCs ensure a holistic approach to creating an authentically sustainable interior.

By fostering transparency and accountability, designers can build a foundation of trust with clients and collaborators, ensuring that, where possible, elements of our yacht interiors contribute to a sustainable future.

(Author: RWD)

Making Sustainability the Definition of Ultimate Luxury

As sustainability increasingly becomes the new normal, achieving truly circular maritime interior goals requires purposeful collaboration among all stakeholders. Sustainability must be a design requirement - not an afterthought - and should be as integral to decision-making as safety, aesthetics, price, and function. From exterior to interior design, it is essential to adopt a mindset focused on refusing, rethinking, and reducing in the initial stages.

Understanding the flow of the layout allows to strategically place high-quality materials in areas of high wear, such as walking paths, elevators, and the first step of stairs. This approach is a crucial first step in creating long-lasting designs.

It is also essential to specify long-lasting materials with the appropriate quality and certifications, addressing questions such as: Can we reduce the number of materials by understanding their quality and certifications more thoroughly? Could we incorporate more light effects, such as wall washer lighting, to enhance the design approach?

Adopting a modular design philosophy means creating elements that are easier to replace and refurbish, thus promoting reuse. For example, if the back legs of a chair break, replace only them instead of ordering a new chair, thereby reducing raw material usage. This modular approach can also be applied to fixed furniture.

Another must-do is engaging the outfitter throughout the process. Through transparent discussions surrounding the sustainability goals, associated costs, and potential solutions, better outcomes can be achieved.

Ultimately, a holistic approach encompassing elements of refusing, rethinking, and reducing is essential to prevent unintended costs and negative environmental impacts. By working in multidisciplinary teams, we can better understand the possible obstacles and opportunities to solve problems with circular, strategic design methods.

(Author: Viken Group)

PHOTO: VIKEN GROUP


PHOTO : VIKEN GROUP

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