JANUARY 2023

The future of **sustainable on-water propulsion**

Developed by European Boating Industry
Initiated by boot Düsseldorf

EBI
European Boating Industry

Prepared by
Sea Teach SL

STUDY FRAMEWORK

This document represents the results of the study on “The future of sustainable on-water propulsion", developed by European Boating Industry and initiated by boot Düsseldorf.

European Boating Industry contracted Sea Teach to undertake a set of face-to-face interviews and to collaborate with the ADAC (Allgemeiner Deutscher Automobil-Club/ General German Automobile Club) to conduct an online survey, both with the aim to discover from the nautical industry and its customers the trends and strategies for the future of the propulsion systems and fuels in the boating industry.

A sample of 38 representatives from the nautical industry, including boat manufacturers, engine manufacturers, associations, and customers participated in the face-to-face interviews and 532 users from ADAC completed the online survey. Two types of user surveys were executed:
a) qualitative surveys through interviews that lasted for an average of approximately 40 minutes, and
b) a quantitative survey of about 10 minutes length in cooperation with the ADAC.

TABLE OF CONTENTS

BACKGROUND

Companies are increasingly offering more environmentally friendly alternative propulsion systems for boats. The range is diverse and developing in different directions. Manufacturers know their own customers and needs well, but there are few reliable studies on how customer needs will develop overall in the different segments and across brands. This is where European Boating Industry (EBI) together with boot Düsseldorf, wants to provide the industry with relevant information that will help to further develop their business approach.

The European Climate Law enshrines the goal of the European Green Deal into law and requires Europe's economy and society to become climate neutral by 2050. The law also sets an interim target to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels.

A number of pieces of legislation are currently on the table at EU level that target the maritime sector, automotive and many others. The expectation is that this will next also focus on the recreational boating sector even if it is relatively small in emissions compared to other sectors (0.4% of EU transport sector CO2 emissions according to study done for European Commission).

The questions asked in this study are therefore:

- What are companies in the boating industry doing regarding the implementation of the EU targets for 2030 and 2050 respectively?
- Have they set targets until 2030/2050?
- Which green technologies are they focusing on, which technology do they think has the most potential and why?

The EU has also agreed to phase out internal combustion engines for new cars and vans from 2035. Although there is no clearly stated date for the boating industry, the following was asked:

- Do the companies have a fixed date by which combustion engines will no longer be offered?
- And to what extent can the industry benefit from the developments in the automotive industry?
- What does the boating industry expect in terms of customer demand?
- And what are the barriers and the accelerating factors to the implementation of alternative drives?

BACKGROUND

Addressed in face-to face interviews were representatives from the management of boatyards who are responsible for product strategy in the various segments of the boating industry, engine manufacturers and national boating industry associations. This report also contrasts its findings against qualitative interviews and a quantitative survey with existing and potential customers. The results evaluate customer needs and the development of product ranges of manufactures, puts them into relation and comparison with each other.

SUMMARY

38 qualitative interviews with industry representatives as well as 532 quantitative responses from customers paint a diverse, but also connected picture of the current market situation with regard to the change to alternative drives in the boating industry.

Customers are in favour of sustainability and are open to alternative propulsion options, but are not prepared to pay significantly higher prices or make compromises regarding comfort, range and safety.

This confronts the industry with a difficult situation where it has to accelerate the development of alternative drives in the boating industry, whilst catering for customers' needs of affordable prices, range and comfort.
As there is not yet a clear focus on one technology to decarbonise boating and the existing options all carry their own set of challenges for implementation in the marine environment, market players are engaged in understanding the alternatives and developing suitable solutions for the different market segments.
Currently many companies in the industry are still in the process of defining their strategies and different segments of the industry are waiting for other segments to start the initiative, such as boat builders relying on engine manufacturers.
Regulations are likely to be put in place and customers will react to them in the coming years, locally, nationally and at European level. Therefore the boating industry needs to be ahead and ready to react to new requirements and expectations.

This study aims to raise awareness within the boating industry that it is time for boat builders, engine manufacturers, associations and consumer representatives to come together, form a Task Force and develop joint strategies.
This strategy could include a joint agreement of the entire industry on a date to phase out the (current fossil fuel) combustion engines that can be communicated to policy-makers, stakeholders and consumers.
The EBI and boot Düsseldorf should, as one action, repeat studies like this for the industry to have a clear picture of market interests and developments.

Call to Action: Join the Task Force!!

Support for this call to action is needed at all levels and ideas and initiatives are welcome!

SUMMARY

COMPARING ALL RESULTS

The following table provides a quick overview of the most prominent answers from the different market segments that have participated in this study.

This table includes on one side six categories of respondents and on the other side the four main topics asked during the research process.

SEGMENT	Favoured sustainable alternative propulsion systems (in future)	Factors that facilitate the implementation of sustainable solutions	Customer demand	Life-cycle
Consumers (qualitative)	Electric Propulsion	Price, regulations and social pressure	Price, comfort and sustainability	Materials being considered during boat purchase
Consumers (quantitative ADAC Survey)	Electric Propulsion	Price and regulations	Price, comfort and design	It is important to a clear majority that boats are manufactured from environmentally friendly materials
Up to 10 metres and outboard	Electric propulsion	Social Pressure, Customer demand and government grants	Price and environmental awareness	Use of as recycled plastic or hemp fibres
Over 10 metres and inboard	Combination of diesel and electric in hybrid propulsion systems and moving towards hydrogen	Price and infrastructure	Price and sustainability	Preparing initial plans
Sailing Boats	Correlated with the customer experience	Customer demand and value depreciation of combustion engines (when they get phased out)	Not much demand yet	Preparing initial plans
Engine manufacturers	Electric and hybrid propulsion	Regulations and infrastructure	Price and sustainability	Not relevant

Table 1. Comparison of the results from all segments participating in the study

SUMMARY

Summarizing the different market segments and subjects of the study:

Customers favour electric propulsion, but focus firstly on factors such as price, comfort, design and range as a decision-making factor when buying a boat, sustainability is only of subordinate importance, although it is an important factor to many. They are also interested in hydrogen and other future technology options.

Builders of boats up to 10m with outboard engines prioritise electric engines as future propulsion and experience rising customer demands for this technology. Some companies in this sector have specialised on electric propulsion solutions and change to sustainable materials. Other technologies are also being considered.

Builders of boats over 10m with inboard engines are mostly in the planning phase and are developing hybrid solutions of diesel and electric propulsion systems. Electric propulsion is not viable for them in most cases because of its restrictions in range, power and charging infrastructure, which are are detrimental to the purpose of their products and their customer's expectations. Other technologies are also being considered.

Builders of sailing boats are less concerned about the future of propulsion, as they only use the engine as an auxiliary form of propulsion and the customer demand is not very strong yet. Solutions can be tailored to customer expectations, including electric propulsion for short distance and hybrid systems for offshore use.

Engine manufacturers mostly focus on electric solutions for outboard engines and on hybrid propulsion systems for inboard engines, depending on the layout and purpose of the boats. Price and sustainability drive their customer's demand, whilst better regulations and improved infrastructure would facilitate the implementation of sustainable drives.

Associations are guiding the companies by participating in different research studies, pilot projects, and monitoring how new start-ups are developing new prototypes, so the best models can be replicated on bigger vessels. They are also monitoring regulations and are in exchange with policy makers to ensure that the specific requirements of the sector are observed.

Life-Cycle factors and recycling of boats at the end of their life is of interest to many customers, although not a deciding factor. Boat builders are increasingly moving to changing materials and are making plans for further developments.

METHODOLOGY

In the preparation phase of the study proposal, Sea Teach checked with existing contacts and affiliations and used its intimate knowledge of the sector to target companies that suit the groups foreseen for the interviews.

A total of 38 representatives from the boating industry, including boat manufacturers, engine manufacturers, associations, and customers participated in the face-to-face interviews and 532 users from ADAC completed the online survey.

The study focused on boats under 24 metres and priority was given to EU-based companies. As some UK and US brands are very popular, researching their strategies was also of great interest as it strongly influences the market developments.

The companies, associations and customers were contacted in week 38 and appointments for the interviews were arranged: Having chosen companies that represent a large part of the market, Sea Teach conducted 18 B2B interviews, 9 Association interviews and 11 B2C interviews during weeks 39 to 42.

The B2B and association interviewees were given the prepared questions upfront so that they could be well prepared for the interview. The interviews were mostly held online by videocall and were recorded with the permission of the interviewee. Each interview took between 30 and 60 minutes, the answers were noted down by hand, afterwards checked against the recording and then transferred into digitally written records.

Additionally, between November 16th and 27th, 2022, more than 1,500 participants from the ADAC skipper club were invited to answer the survey on the topic of “Alternative Drives”. The participation rate was 35%, with answers from 532 participants. The results were deeply analyzed, and compared to the qualitative data.

RESULTS

FROM THE CUSTOMERS

THE CUSTOMERS

Interview Sample

A total of 11 qualitative interviews were held with customers who are broadly representative. These customers were from Belgium, Netherlands, Romania, Sweden, Turkey, Portugal, Finland and Germany, giving the results a complete European perspective.

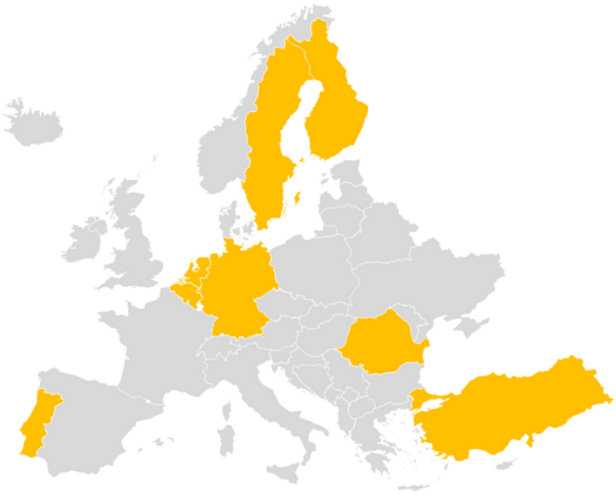


Figure 1. Nationality of the customers

The majority of respondents were male, and more than half of the group was was between 40 to 50 years old.

More than half of the respondents are currently owning a boat while only a third are planning to buy a boat in the near future.

In this qualitative study, the majority of interviewees are owning or planning to buy a sailing boat, whilst the majority of respondents in the quantitative ADAC favour motor boats.

THE CUSTOMERS

a) Factors influencing the decision-making process

When analyzing the results of the factors influencing the decision-making process, “price” was the most chosen factor, followed by “comfort” and “sustainability”. It is important to mention that “sustainability” was only selected after the interviewer mentioned it, otherwise the results would have been 0. Furthermore, two of the respondents answered, “sustainability is not important”.

Other relevant answers were “easy to handle”, “speed” and “size”, while “quality”, “brand”, “easy maintenance” and “usability” were only occasionally mentioned.

The least mentioned factors included: safety, layout of the boat, electric propulsion, coolness and nerdiness, weight, technology and looks.

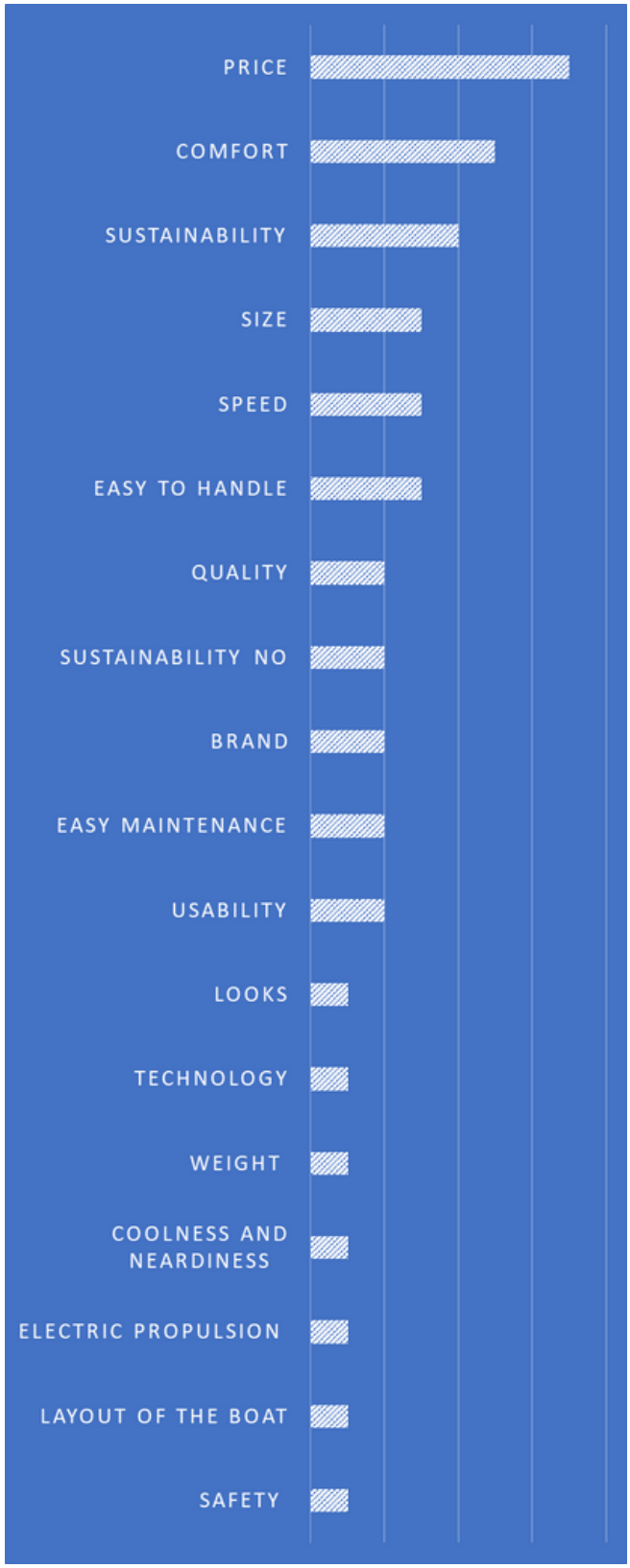


Figure 2. Factors influencing the decision-making process

THE CUSTOMERS

b) The role of new technology in customer's life.

New propulsion technologies play very diffenerent roles in customer's life:

Some had very specific reasons for favouring electric propulsion technology as it can provide them with "an advantage in racing and performance", others were positive about electric engines in their cars but not yet in their boats.

The most repeated answer in this group was "electric engines are too expensive and not yet reliable".

On the other hand, some respondents were very positive as electric engines are "quieter, use less space within the vessel and provide advantages in getting a mooring which means less restrictions in some marinas" .

1. Not yet for boats, electric engines are too expensive and the range of about 3 hours is not enough for the required purpose of wakeboarding.
2. I would like to have an electric engine on my motorboat, but the sources of energy should be sustainable.
3. So far not, if electric engines would be feasible (is reliable, has the right range and the price is within reach), then that would be a huge plus.
4. An electric engine, it is quieter and has advantages in getting a mooring and less restrictions in some marinas.

Figure 3. Results of the answers to the question "If new technologies play a role, why and when has this played a role for you?"

THE CUSTOMERS

c) Willingness to make compromises with regard to the performance of the engines when opting for new technologies.

More than half of respondents have a negative attitude towards making concessions with regards to the performance of the engines when opting for new technologies (55% “no” versus 45% “yes”).

The reasons for not making concessions include:

- Technology is not advanced enough to do cruises for more than 3 hours offshore.
- Electric engines are dangerous when in contact with water.
- The industry should give incentives to the user.
- Not possible to use the motor for 3 or 4 days in a row.

On the other hand, those who answered positively said:

- Prepared to make concessions in horsepower.
- The propulsion of electric engines is lower but sailors use the engine very little.
- Already done in form of an electric backup motor.
- There is minimum limit of horsepower needed with a sailboat in difficult conditions, but apart from that, wind, and solar power in combination with an electric engine are good technologies which will not require many concessions.
- If the concessions do not interfere with the reliability and if it only means that the handling is maybe a bit more complicated.

d) Changes in customer’s behaviour for environment

55% of respondents were positive to the question “Are you making any changes in your behaviour for the environment? On the other hand, 18% answered “no” and 27% answered “I’m not sure", or “Not applicable”.

THE CUSTOMERS

The customers actions to protect the environment include:

- Use of GTL (Gas to Liquid) diesel. Which means less CO2, less particles, sulphur free, and no bacteria in tanks.
- Use less power by installing an electric motor.
- Upgrading of a sailing boat with solar panels.
- Limit the use of the engine.
- Reducing water use.
- Respect waste management systems.
- Sailing more rather than using the engine.
- Being sensitive to the environment in day-to-day actions.

On the other hand, those who are not making changes, stated:

- “No, I’m only doing short trips on the river anyway. But wakeboarding is not compatible with slower driving or shorter distances” and;

- “I don’t do any long trips so water consumption and energy efficiency on board are not really relevant”.

e) The most trusted propulsion type in the future

Electric power was the most voted option by respondents, followed by Hydrogen, and GTL Diesel, Diesel, Ammonia, Methanol and a combination of hydrogen cells and solar power.

The reasons for choosing “electric power” as the main option included:

- It is the most developed technology, although it still needs further developments and innovation.
- Good infrastructure for basic electric engines in their country.
- Accumulating and storing energy will change in the future.
- There is a need for more brands that make electric boats, which would bring the prices down.

THE CUSTOMERS

- Most interesting and more convenient, especially for a dinghy. Other fuels are not interesting as it still means to take dangerous liquids on board.

Those who selected hydrogen, thought that it will be an option for the future, but its implementation could be difficult with the current technology and developments.

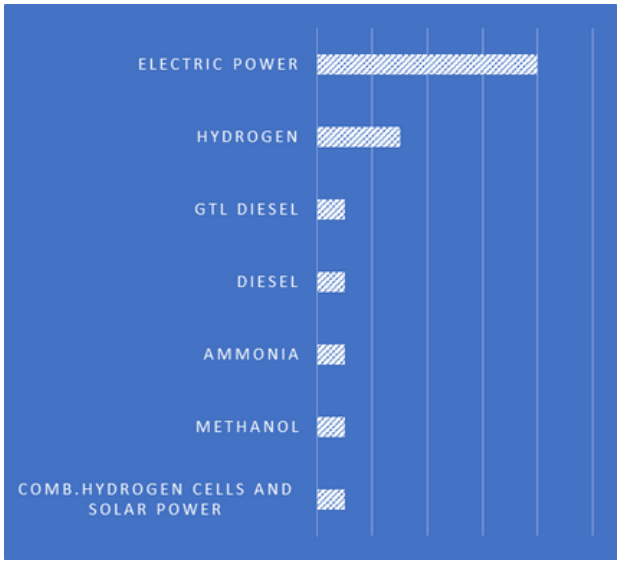


Figure 4. Most trusted propulsion type in the future

f) Factors to purchase a boat with low- or zero-emission propulsion technology

Price was the main selected factor, , followed by "other" which includes, range and infrastructure, and social and regulatory pressure. The less voted option was doing something for the environment.

The reasons to choose price" included comments that electric power is more practical, but that the price is higher or that hydrogen boats for over 100.000 Euros are not feasible right now.

On the other hand, those who chose the option societal pressure commented that: young people are more aware and more prepared to make changes and concessions, while those opting regulatory pressure were arguing that collaboration of all governments would be good (like in ColRegs) and that the industry needs to be more active and innovative.

Last but not least, those who were leaning more towards doing something positive for the environment commented that it is not about the pressure, but that in life you should do what you like to do for the environment.

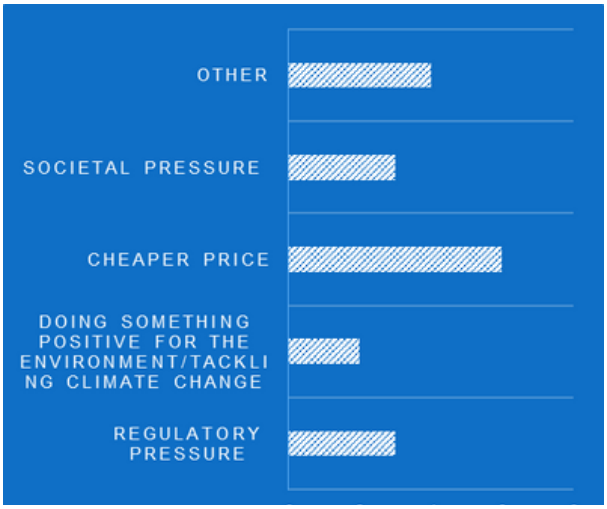


Figure 5. Results by factors to purchase a boat with low- or zero-emission propulsion technology

THE CUSTOMERS

g) Satisfaction with what the market is offering in terms of low-, and zero-emission propulsion technologies for boats

Only 18% of respondents answered "yes" to the question "Are you happy with what the market is offering in terms of low-, and zero-emission propulsion technologies for boats?".

On the other hand, the answers of those who said "no" can be categorized into four main reasons: misinformation, the industry should innovate or offer more possibilities, lack of offer in certain countries, understanding of the difficulties in implementing new technologies in boats. *(See figure 6).*

1. The industry needs to be encouraged to be more inventive, they are still working on the base of electric motors invented in the 50's. They need to make concessions for a sustainable future.
2. I don't think there is enough offer, as the manufacturers don't make alternative propulsion as visible as the car industry.
3. I understand it takes time for new technologies to be usable in smaller boats.
4. The industry does not do enough, especially for boats from 12 metres, you can only see changes on small ones and only on demand.

Figure 6. Answers to the question "Are you happy with what the market is offering in terms of low-, and zero-emission propulsion technologies for boats?"

RESULTS

FROM THE ADAC SURVEY

ADAC

THE ADAC SURVEY

Survey details

The ADAC Skipper Club has been a pilot project of ADAC eV and ADAC SE since May 2022. Boaters and those interested in boats can take part in regular surveys on various ADAC topics related to boating and, for example, actively help shape ADAC's digital products.

Between November 16th and 27th, 2022, more than 1,500 participants were invited to answer the survey on the topic of “Alternative Drives”.

The participation rate was 35%, with answers from 532 participants from the ADAC Skipper Club.

Boat ownership and purchase consideration groups break down these results as follows:

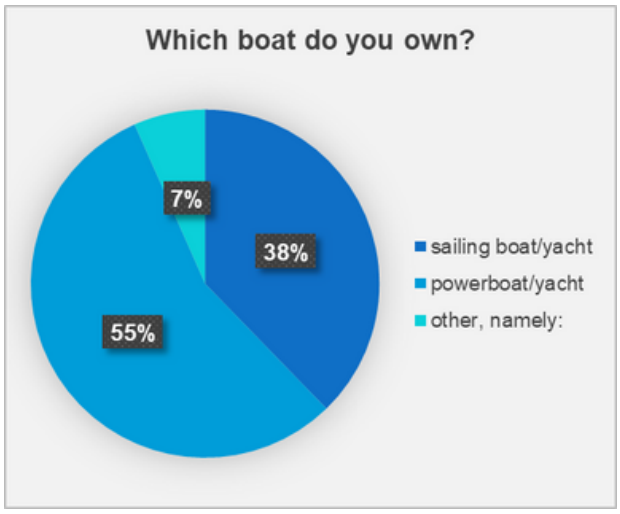


Figure 7. Boat ownership

9% of respondents say they would like to buy a boat but (probably) cannot afford it. They estimate the price of their "dream boat" to be around €170,000, which is significantly higher than the budgets named by other respondents: Those respondents who are planning to purchase a boat in the next years name a budget of around €80.000 to 140,000 in the next 5 years.

10% of respondents say they would not buy their own boat even if they could afford it. The most common reasons they give for this is that they only want to charter and would not use their own boat enough.

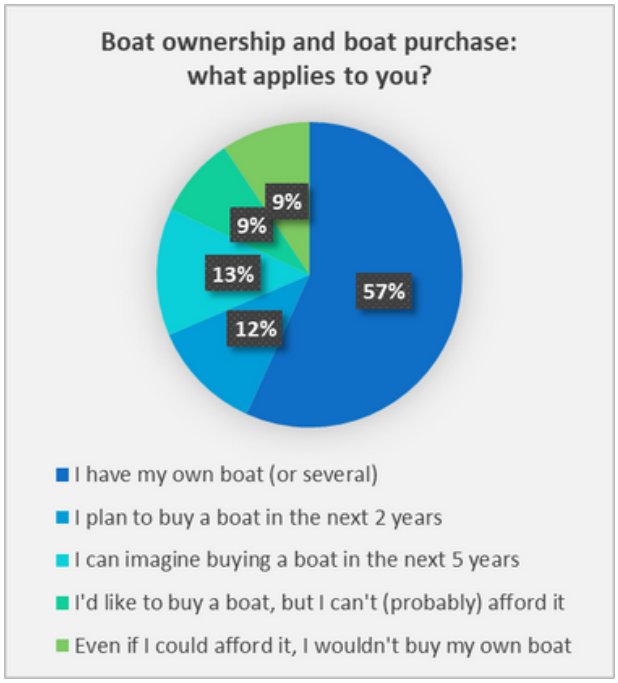


Figure 8. Type of Boat ownership

THE ADAC SURVEY

a) Deciding factors when buying a boat

When deciding whether to buy a boat, price is the most important factor (59%), followed by comfort (50%) and appearance/design (40%). Among those who plan to buy a boat in the next two years, price is behind convenience, and among those who can only imagine buying a boat at the moment, "safety" also plays an important role after price.

The most interesting type of propulsion when buying a boat is an electric drive (37% of respondents), but still one in three stay with fossil fuels (diesel or petrol). Hydrogen/fuel cells are following in third place (under 30%), whilst about every fourth potential customer is interested in hybrid solutions of electric and diesel. Synthetic fuels are of interest only to around one in five. Less than 40% consider an energy/sustainability label to be valuable in decision-making.

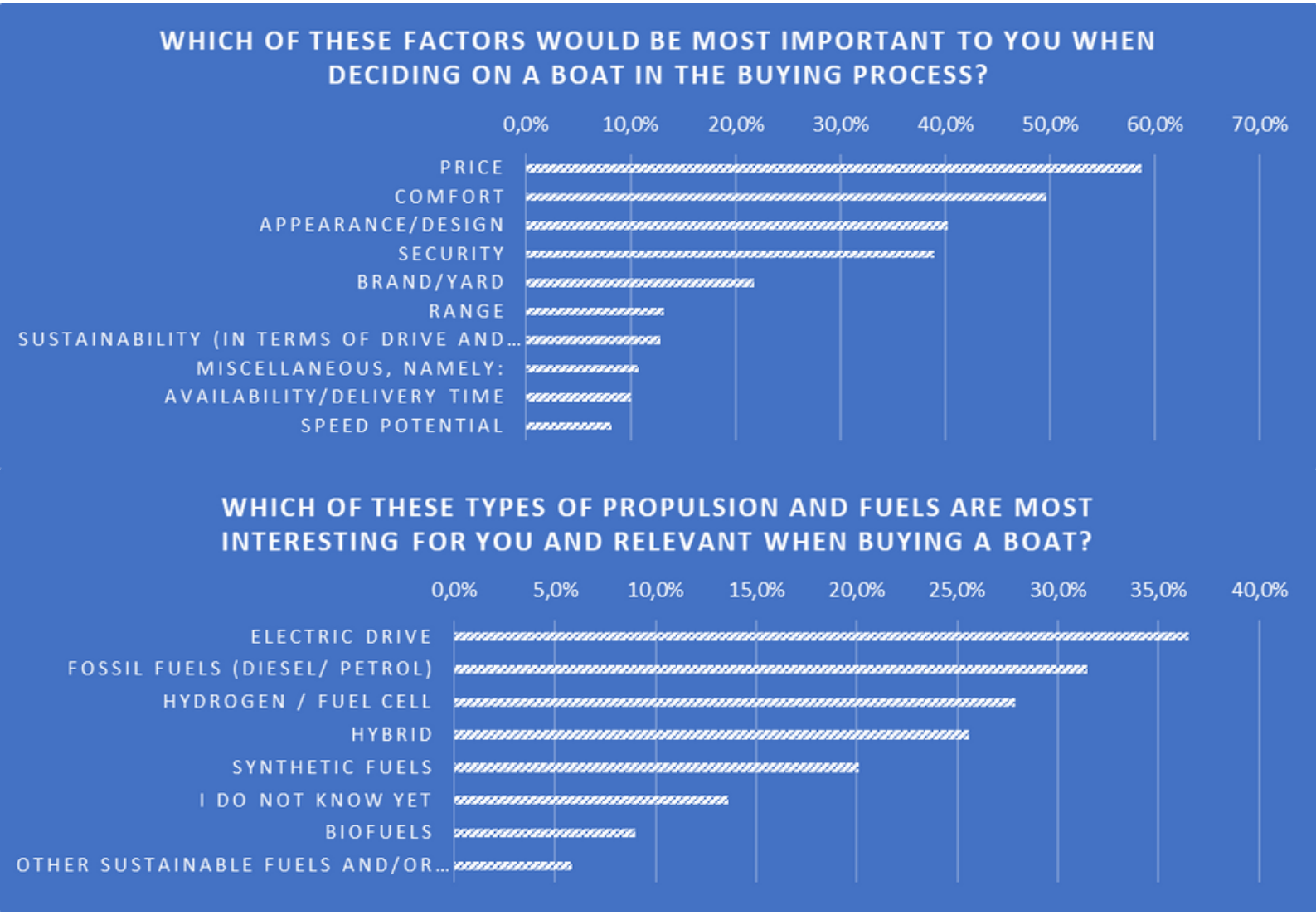


Figure 9. Factors to buy a boat and most interesting propulsion system

THE ADAC SURVEY

b) Disposal and recycling

Half of the boat owners say their boat is less than 20 years old, and a third of the boats are more than 30 years old. Two-thirds of boat owners consider it unlikely that they will convert to zero- or low-emission drives (within 5 years). If so, then it is most likely that they convert to electric propulsion and on-board power generation.

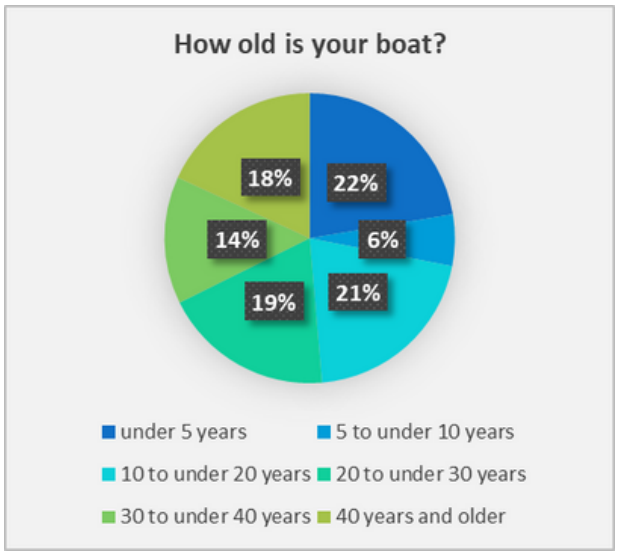


Figure 10. Average age of baots

Only a minority of respondents (6%) already have experience with boat disposal/scrapping.
However, the mostly hypothetical question about the relevance of certain aspects of disposal shows that sustainability aspects are just as important as costs: environmentally friendly disposal is most important (over 80%), followed by cost-effective disposal (approx. three quarters) and that boat can be recycled (over 70%).

Manufacturing the boat from environmentally friendly materials is important to a clear majority (almost 60%), but is least important compared to the other aspects .

c) Sustainability on boats

Spontaneously and openly asked what sustainability in boating means to them, environmental and climate awareness (ecology) plays a particularly important role for the participants in the ADAC Skipper Club. The respondents very often mention engine-related issues, such as fuel consumption or the type of drive, water protection, waste separation, waste avoidance or waste water.

The topic of sustainability as a whole is very important for more than half of those surveyed - in terms of ecology, social issues and the economy. For less than one in ten it is not (at all) important.
Water protection (e.g. waste disposal, handling gray water/ holding tanks/ bilge, antifouling) is important for 90% of the skippers, for almost 60% it is even the most important issue. The offers and infrastructure of the marinas and also the energy supply on the boat are important for around 50% of those surveyed and thus come in 2nd and 3rd place.

THE ADAC SURVEY

d) Actions & measures for successful climate/environmental protection

Three quarters of those surveyed see industry measures as suitable for successful climate/ environmental protection in the area of boats and boating, just as many consider their personal responsibility through personal decisions to be suitable.

Nearly 60% of the respondents see regulations by politicians to being suitable when it comes to successful climate/ environmental protection in the area of boats and boating. For consumer protection associations this suitability is only considered by half of the respondents.

Of the specific measures presented, only “subsidies for the purchase of boats with alternative drives” are supported by more than half, and the proportion of those opposed is the lowest here at around 25%.

Reduced mooring fees as a way of promoting alternative drive systems for boats is the most polarizing possible measure: the measure is supported by slightly less than one in four and rejected by more than one third.

The majority rejected "own boat docks only for boats with alternative drives" (over 50%) and "restrictions (up to and including bans) for boats with non-sustainable drives or combustion engines with fossil fuels" (approx. 70%). Manufacturing the boat from environmentally friendly materials is important to a clear majority (almost 60%), but is least important compared to the other aspects .

RESULTS

FROM THE INDUSTRY

THE INDUSTRY

Face-to-face interviews were conducted with different segments of the boat industry and the analysis of the answers revealed that the following boat types can be grouped together as they are each facing similar set-ups and circumstances with regard to their customer base, the intended use of their boats and the engine set-up needed:

- **Boats up to approx. 10 meters with outboard engines**, as they are generally built for short distance, coastal or inland water use. Their outboard engines are custom built for marine use, are not integrated into the main construction of the boat and are relatively easy to be exchanged.

- Boats over 10 meters with inboard engines, as these boats are built for long range (coastal and offshore), comfort and speed, leading to the need for providing high powered engines that can propel larger boats (between 10 and 24 metres), high weights and long-distance autonomyThe inboard engines manufactured for these boats are often developed from the automotive industry or other sectors, then adapted to the marine industry and integrated into the hull design of these type of boats.

- **Sailing Boats,** which generally use their engines as an auxiliary form of propulsion to their sails. They often have inboard engines which must provide a certain range for security and have to fit into restricted spaces, whilst speed is of no main concern.

- **Engines manufacturers,** who produce either outboard or inboard engines.

- **Associations,** who are trying to guide the companies, by participating in research studies, pilot projects, prototypes, exchanging knowledge and providing advocacy.

UP TO 10 METRES AND OUTBOARD

Interview sample

The interviews conducted with different companies that produce boats up 10 metres with outboard engines include manufacturers of wooden-electric boats, traditional boats, inflatables, hybrid boats, or companies that are doing retrofitting from combustion to electric. The companies are from Germany, Spain, Switzerland and Italy.

a) Actions for the implementation of EU environmental targets for 2030 and 2050

When asking companies about the actions they are implementing to meet with EU targets for 2030 and 2050, half of them stated that they don't have a strategy yet, and that they are focusing mainly on reducing the emissions and energy consumption in their production sites or are participating in pilot projects.

On the other hand, those who have a clear strategy, are pioneers in the field and stated that they specialise on producing e-boats or were the first ones producing electric propulsion. (*see figure 11*).

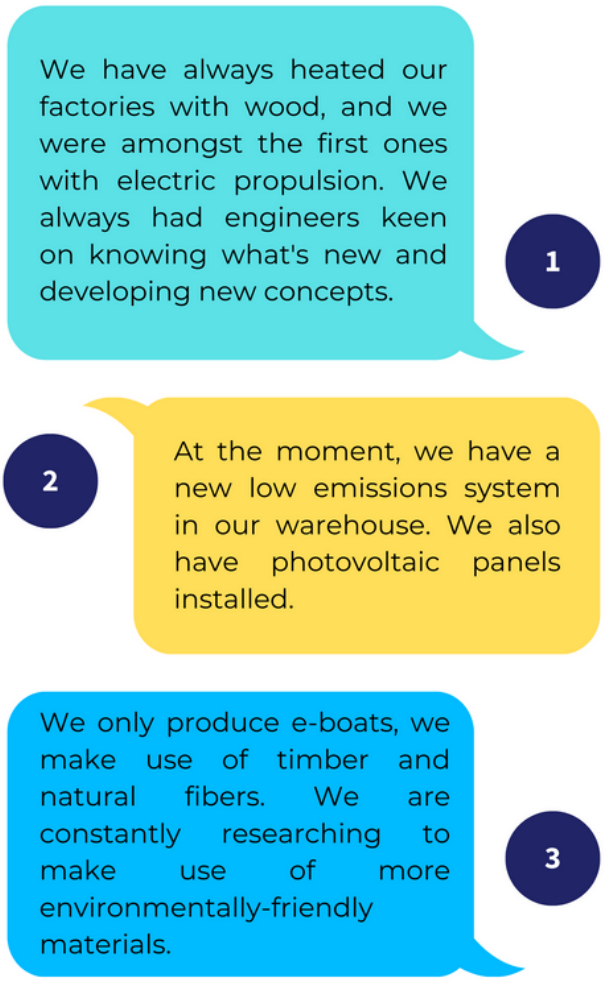


Figure 11. Answers to the question "What is your company doing regarding the implementation of the EU targets for 2030 and 2050 respectively?"

UP TO 10 METRES AND OUTBOARD

b) Potential of green technologies

Companies producing boats up to 10 metres that use outboard engines find electric propulsion the most promising technology with the highest potential, followed by hydrogen. Solar and wind were only viewed as supplementary technologies.

Whilst electric propulsion is currently favoured by most respondents, it was also often remarked that it is not considered to be the final future solution. Especially those mentioning hydrogen consider electric engines to be more of a "stepping stone".

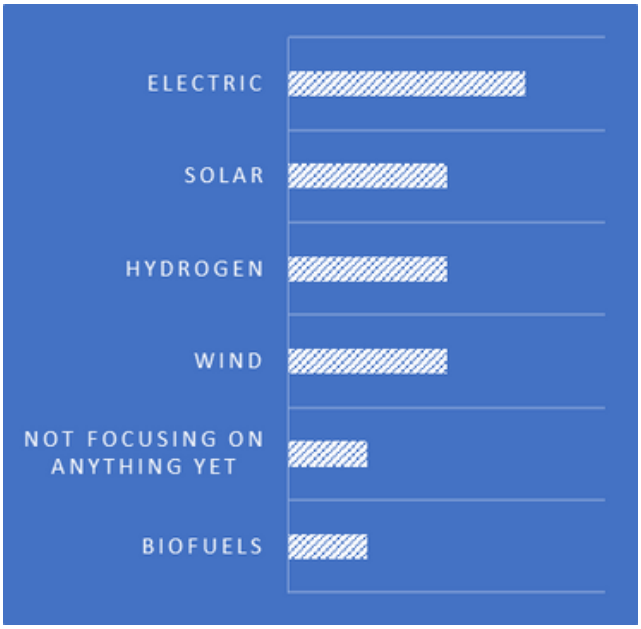


Figure 12. Results by potentital of green technologies

c) Improvements in hull efficiency

Asked about higher efficiency targets through hull improvement, some companies answered that they are working together with research centres, others are conducting their own studies to reduce weight, whilst a few are of the opinion that they already have an efficient hull design *(Figure 13)*.

Figure 13. Answers to the question "Is your company planning to change/improve hull design to give higher hull efficiency?"

d) On-board energy generation

When asked about alternative on-board energy generation, most companies answered that solar is the preferred new on-board energy, but that it is only playing a minor role for supplying energy to electronic devices such as plotters, VHF, lights or pumps.

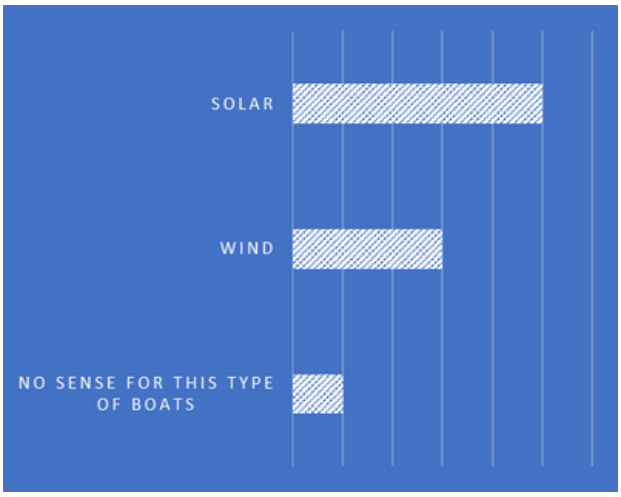


Figure 14. Results by on-board energy generation

e) Barriers to the implementation of alternative drives

The lack of regulations that support the develoment of alternative drives is the main identified barrier to their implementation. This statement is followed by identifying a lack of innovation, not enough infrastructure (regarding electricity charging opportunities and hydrogen supply stations) and a lack of grants or governmental support (*figure 21*).

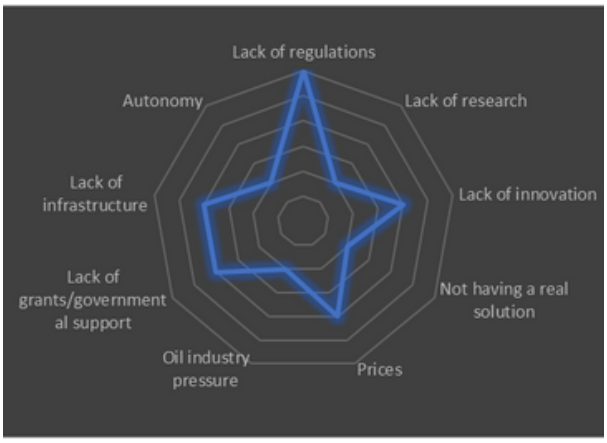


Figure 15. Results by barriers to the implementation of alternative drives

f) Customer demand

When asking companies "What do you expect in terms of customer demand? and how will it develop? The majority stated that "there will be more environmental awareness and customers will require circularity of the materials", whilst some said "if the price is high, the customer won't be interested in sustainable solutions".

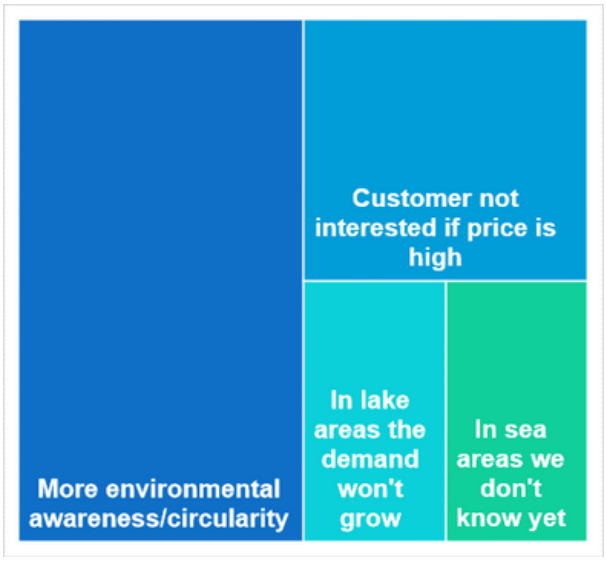


Figure 16. Results by customer demand

g) Use of life-cycle analysis

Half of the interviewed companies are implementing a life-cycle analysis (LCA) approach by using materials such as recycled plastic or hemp fibre. Others stated life-cycle analysis is not needed as boats are constantly being re-furbished and re-built.

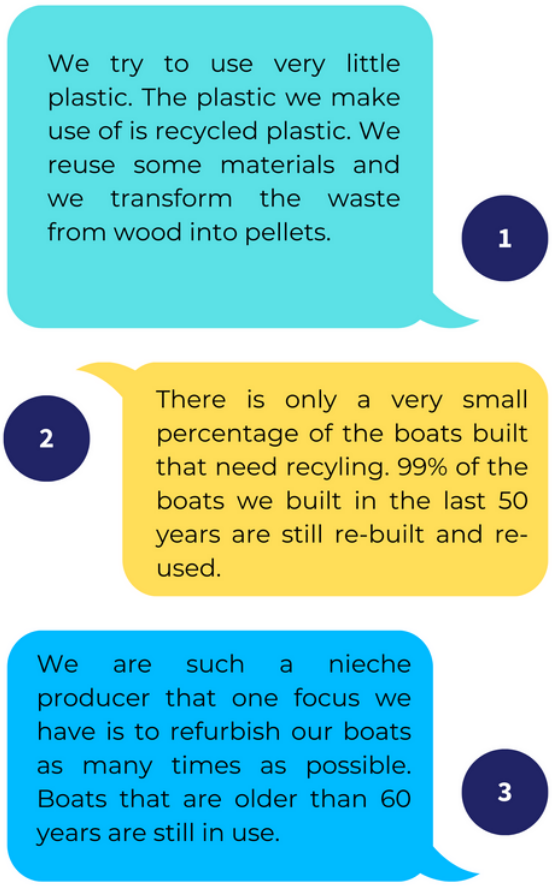


Figure 17. Answers to the question "Are there plans to use life-cycle analysis for a more comprehensive approach, for example to materials?"

h) Date by which combustion engines will no longer be offered

When asking companies if they have set a date by which combustion engines will no longer be offered, some pioneering companies stated that it is already now their business philosophy to not produce boats with combustion engines and only offer electric engine solutions. On the other hand, over half of the companies said that they had no plans yet to move away from combustion engines.

i) Benefits from the automotive industry

Those companies who are producing electric boats stated that they are using electric batteries produced by car manufacturers and are capitalizing on the fact that customers are more aware of the electric engines because of the car industry.

On the other hand, companies stated that the boating sector is very small compared to the car industry, and that they are expecting for marine engine manufacturers to offer solutions and for the automotive sector to develop smaller batteries with longer life and longer autonomy *(see figure 18).*

UP TO 10 METRES AND OUTBOARD

1 We are using electric batteries produced by car manufacturers. The automotive sector also help increasing the customer environmental awareness.

2 I think is too early, but I guess we will get small batteries with long autonomy and long life from the automotive industry.

3 The boat industry is waiting for the leading engine manufacturers to develop new products.

Figure 18 Answers to the question "To what extent can the industry benefit from the developments in the automotive industry?"

j) Factors that accelerate the implementation of alternative propulsion systems

When asking companies about the factors that could accelerate the implementation of alternative propulsion systems, social pressure was the most mentioned option, followed by customer demand, customer's environmental awareness and subventions/ grants from the government.

Other factors that were mentioned included; the need to do more research from the boating industry, political pressure through new laws and to have a common real solution to shift away from combustion engines.

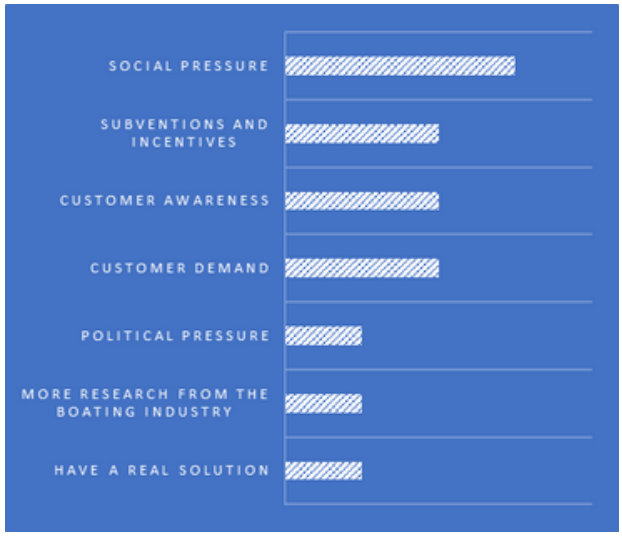


Figure 19. Results by factors that accelerate the implementation of alternative propulsion systems

UP TO 10 METRES AND OUTBOARD

k) Development goals of companies

The economic growth of the company is currently the most important development goal of these companies, as they are still dealing with the effects of the COVID-19 crisis such as supply chain issues. Sustainability was named by two thirds of the interviewees, followed by the plan for a circular economy model. More individual development goals can be seen in the following figure.

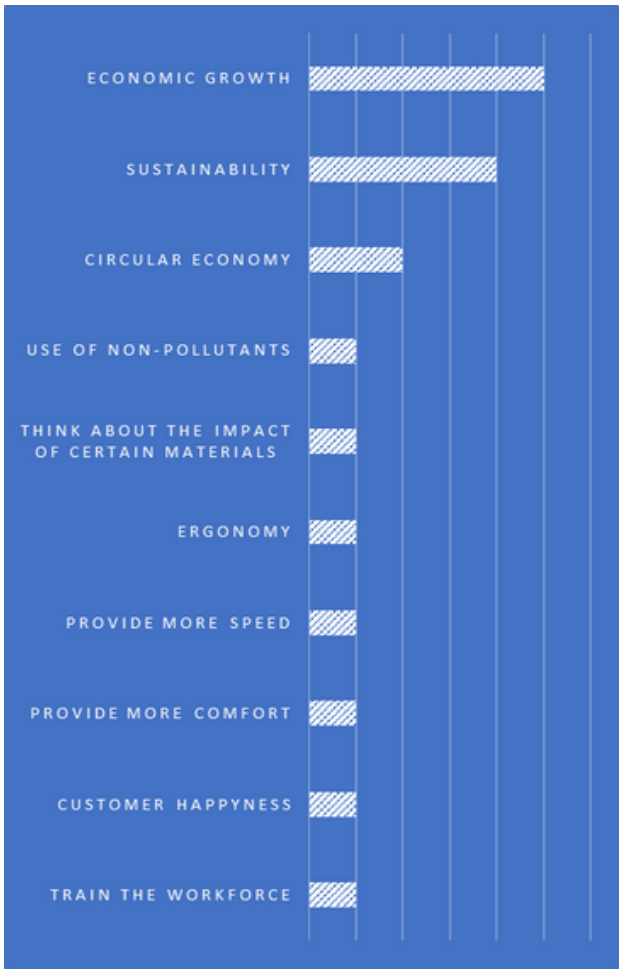


Figure 20. Results by development goals

OVER 10 METRES AND INBOARD

Interview sample

Face-to-face interviews were conducted with leading companies that produce boats over 10 metres with inboard engines.

The type of boats these companies manufacture include: yachts with traditional engines, companies that offer boats with diesel, hybrid and electric engines, or companies that produce both, motor and sailing boats.

a) Actions for the implementation of EU environmental targets for 2030 and 2050

When asking companies about the actions they are implementing to meet with EU environmental targets for 2030 and 2050, the majority admitted that they do not have a clear strategy yet.

The reasons given included that the boating industry is waiting for the engine manufacturers to develop alternative options to combustion engines, and also for new innovations from the car manufacturing industry.

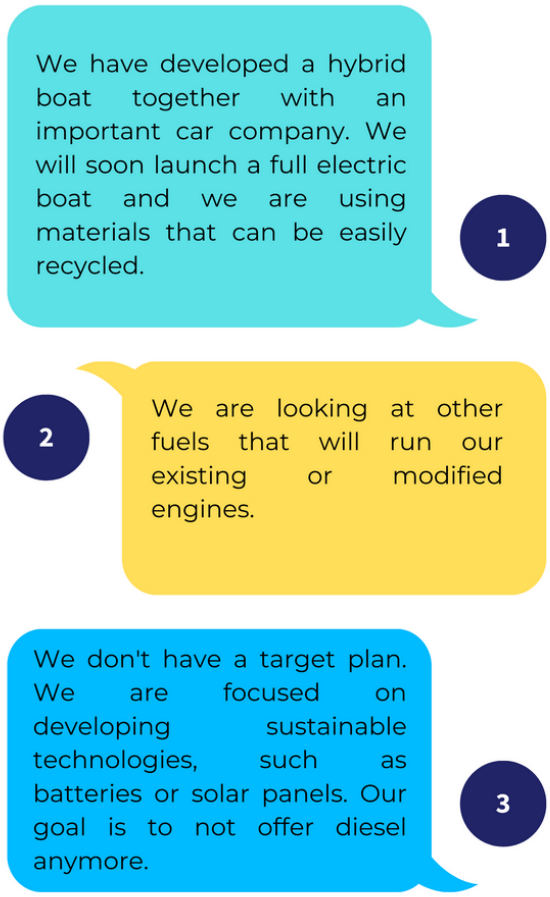


Figure 21 Answers to the question "What is your company doing regarding the implementation of the EU targets for 2030 and 2050 respectively?"

OVER 10 METRES AND INBOARD

b) Potential of green technologies

When asking companies to produce boats of generally more than 10 metres and with inboard engines to identify which green technology has more potential, a hybrid solution of diesel and electric was favored by a majority, followed by electric drives. Biofuels and hydrogen were also mentioned, but only in correlation with the user experience.

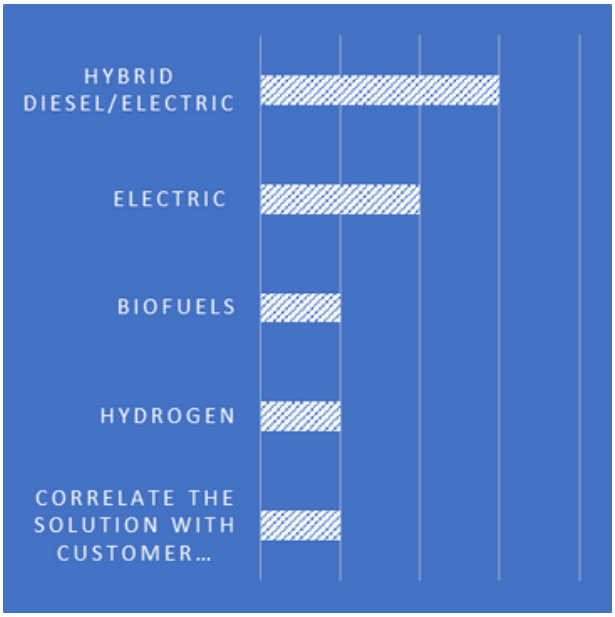


Figure 22. Results by potential of green technologies

c) Improvements in hull efficiency

All companies stated that hull efficiency is a constant topic for them. Whilst about half of the interviewees stated that this is achieved by reducing the engine size, the weight and the fuel consumption, the other half stated that they reduce the weight by reducing the amount of material used in boat building (see figure 23).

Figure 23. Answers to the question "Is your company planning to change/improve hull design to give higher hull efficiency?"

OVER 10 METRES AND INBOARD

d) On-board energy generation

All companies mentioned solar energy as the main type of on-board energy, but only as a supplement to the main engine. It's main purpose is as an alternative to generators and for general services on board such as fridges, ice-makers, air-conditioning, etc.

e) Barriers to the implementation of alternative drives

When asking companies about the barriers to the implementation of alternative drives, the results vary from the previous group of boat builders, as in this group the main barrier is a wrong expectation from the consumer as well as the price/cost factor.

Companies mentioned that their customers are now interested in electric solutions because they hear about famous car brands producing electric drives. They then expect the same on boats which is often technically not possible.

On the other hand, the lack of innovation, the fact of being a small sector and the autonomy of the vessel were also mentioned.

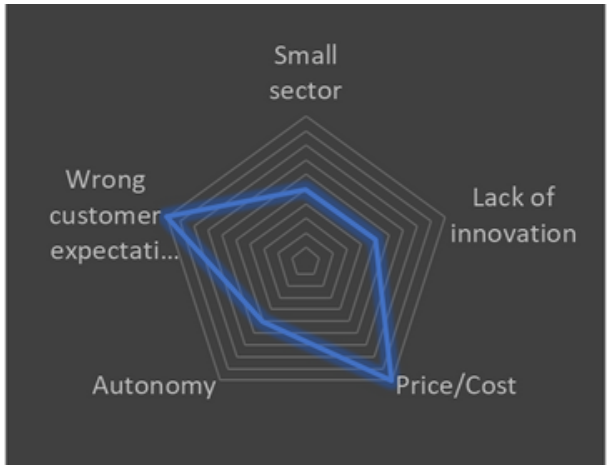


Figure 24. Results by barriers to the implementation of alternative drives

f) Customer demand

Most companies stated that price is and will always be the driver for customers to make their choice.

On the other hand, it was stated that customers think about being greener but there is no evidence to indicate that they are being greener looking at the current market situation, and that the big change in customer demand will come when the generation Z will be over 40.

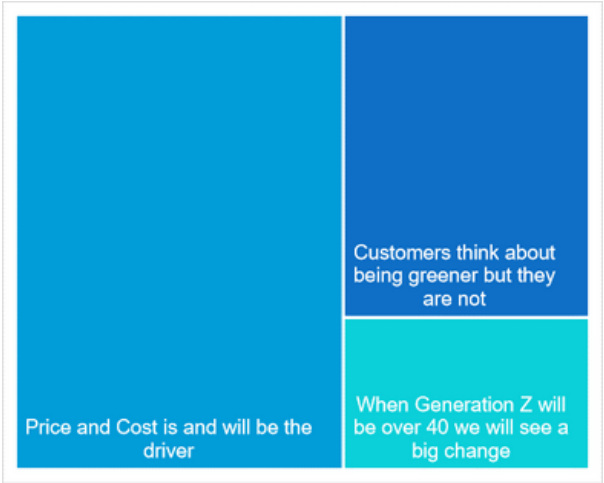


Figure 25. Results by customer demand

OVER 10 METRES AND INBOARD

g) Use of life-cycle analysis

When asking companies about their use of a life-cycle analysis approach, nearly half of them stated that they are implementing relevant actions such as using cork or recycled plastics. Others are in the process of preparing initial plans or do not have it as their priority right now.

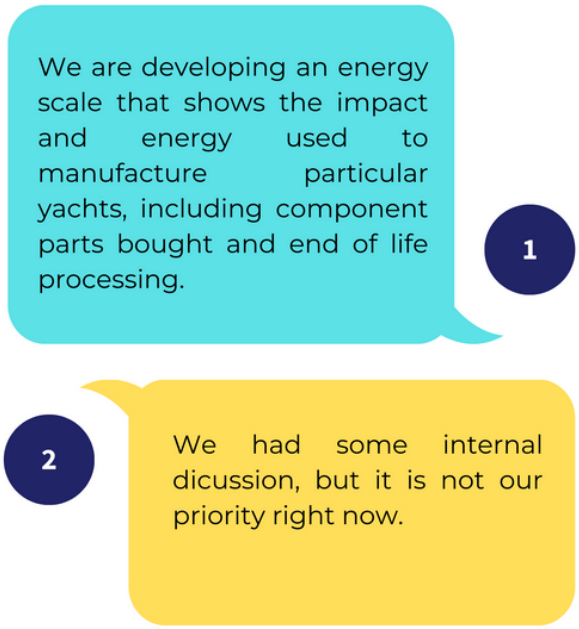


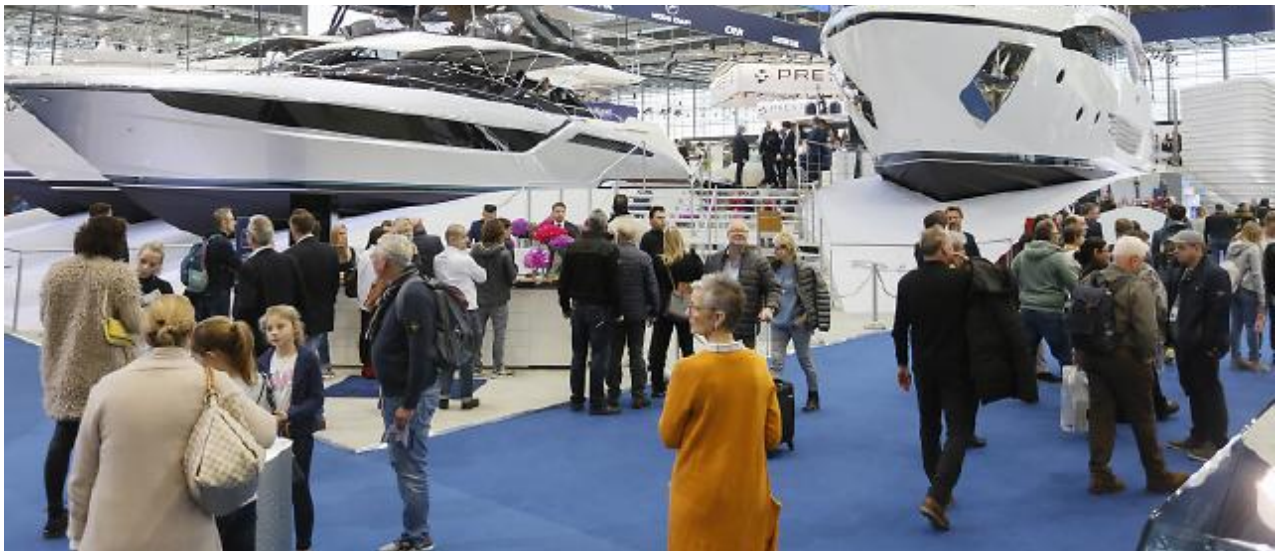
Figure 26. Answers to the question "Are there plans to use life-cycle analysis for a more comprehensive approach, for example to materials?"

h) Date by which combustion engines will no longer be offered

All companies stated to not yet have a fixed date by which combustion engines will no longer be offered.

As reasons for not having a fixed date it was stated that the industry is waiting for the engine manufacturers to come up with new propulsion solutions which will then be fitted into the boats, and that there is not a fixed date but that it will be a progressive change over the next 15 years.

Only a minority claimed that they are already set up and can offer electric boats. But they do not have a date yet to stop offering combustion engines as it will mean that the customer needs to sacrifice more to obtain less, which needs a mindset change.



OVER 10 METRES AND INBOARD

i) Benefits from the automotive industry

Whilst it is clear that the boating industry has always benefited from the automotive developments, the interviewed companies also stated that these two industries can not be compared, because the car industry is much bigger.

1

We believe the current options offered are not comparable and will not be used for the short term as the infrastructure for both boating and automotive sector is based on fuel provision.

2

We cannot compare these two industries. The energy infrastructure for cars is extremely mature and robust. You can find a service station every 50 km. Therefore, you can reload your car easily with an alternative propulsion.

Figure 27. Answers to the question "To what extent can the industry benefit from the developments in the automotive industry?"

j) Factors that accelerate the implementation of alternative propulsion systems

When asking companies which are the factors that accelerate the implementation of alternative propulsion systems, price/cost and more infrastructure were receiving the highest votes.

Other factors mentioned were: different fuel options, more regulations, competition between companies, customers ready to pay more and green taxonomy. *(see figure 28)*

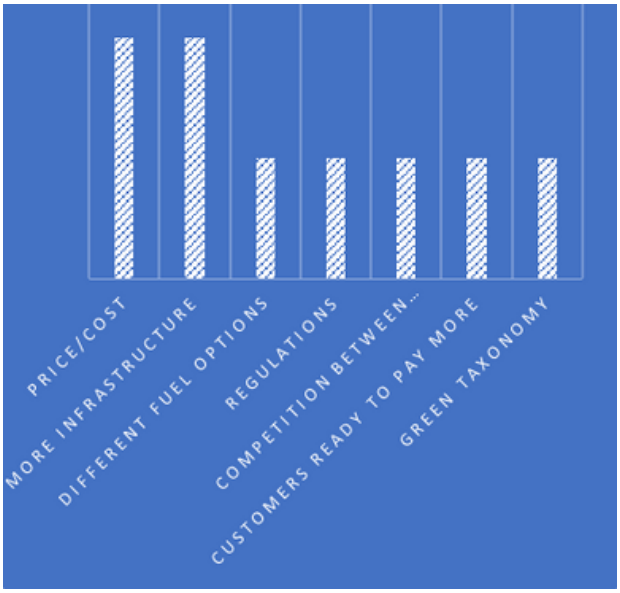
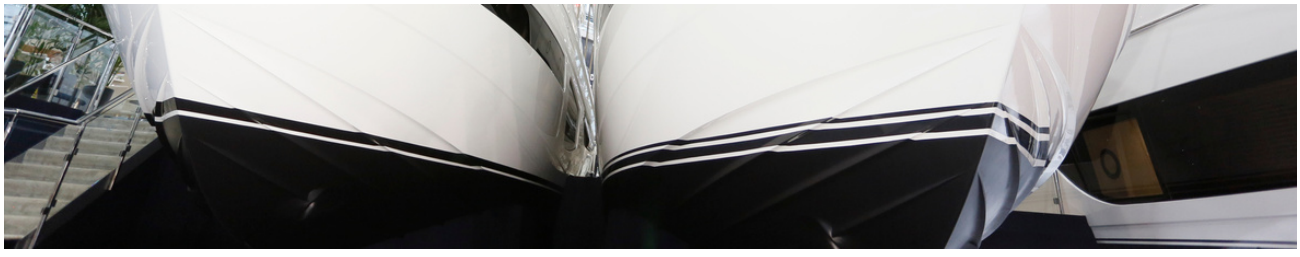


Figure 28. Results by factors that accelerate the implementation of alternative propulsion systems.



OVER 10 METRES AND INBOARD

k) Development goals of the companies

To grow or maintain the business was the most repeated development goal, followed by the aim to offer more product options.

Identify and reduce components with strong CO2 emissions, produce hybrid systems, reach other markets, new technological advances and transition from fossil to clean fuels were other goals.

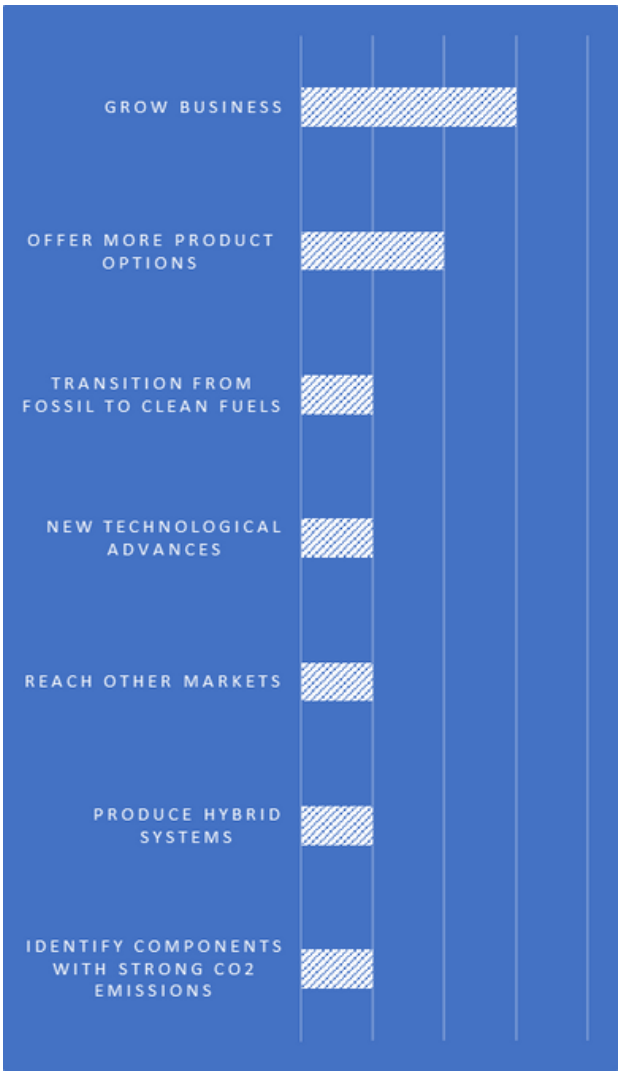


Figure 29. Results by development goals

SAILING BOATS

Interview sample

Face-to-face interviews were conducted with leading European manufacturers of sailing boats .

a) Actions for the implementation of EU environmental targets for 2030 and 2050

The interviewed sailing boat producers stated to not yet having a date, as they are in the process of defining targets and investigating innovation options.

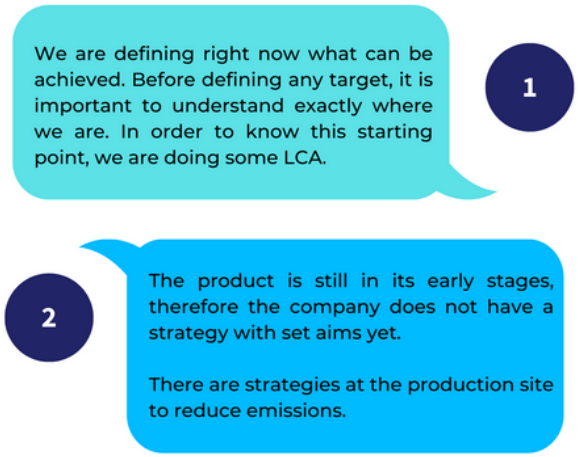


Figure 30. Answers to the question What is your company doing regarding the implementation of the EU targets for 2030 and 2050 respectively?

b) Potential of green technologies

As the sailing boat manufacturers are still in the process of assessing options, no decisions have been made which green technology could have the highest potential. As for motorboats, this sector also mentioned its dependency on engine manufacturers and the need to find solutions that correlate with the user experience".

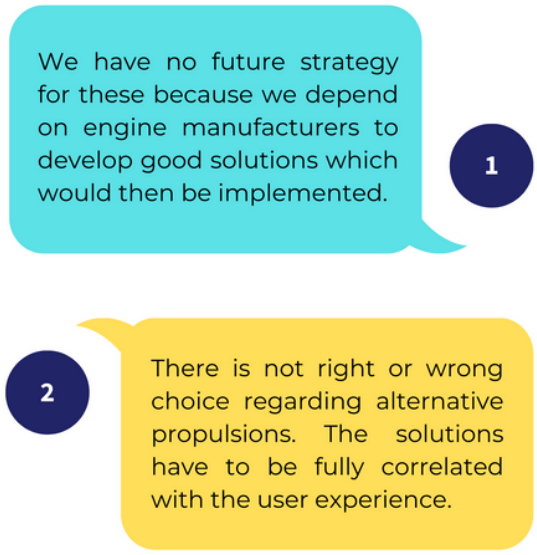


Figure 31. Answers to the question which green technology has the mote potential?

c) Improvements in hull efficiency

Being asked which measures the companies are implementing to improve the hull efficiency, the respondents showed different approaches which include the constant drive to improve the hull efficiency and also the prioritising of other factors over hull performance.

SAILING BOATS

d) On-board energy generation

When asking companies about on-board energy generation the measures named were as follows: manufacturers are implementing energy management on board through LED lights and energy efficiency of other commodities, the use of lithium batteries, and are installing photovoltaic cells on Bimini covers.

e) Barriers to the implementation of alternative drives

The four main factors named as barriers to the implementation of alternative drives are:

- the price of electric motors,
- the range required by the customers,
- the energy source, and
- the unavailability of products in bulk.

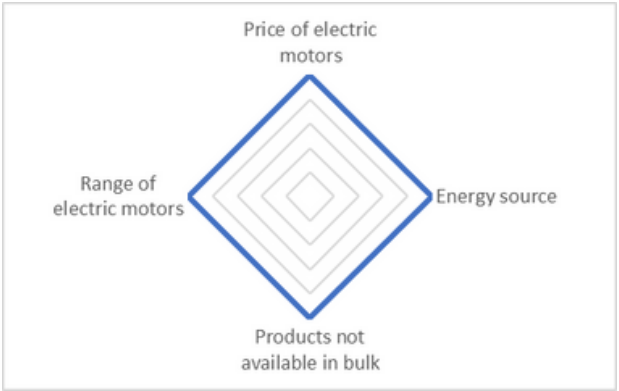


Figure 32. Results by barriers to the implementation of alternative drives

f) Customer demand

Companies experience a lot of interest from the customers, but not much demand for alternative drives. As reason for this some state that the average age of their customers with around 50-60 years is responsible and others claim that the subject of sustainability is on everyone's mind, but is not matched by the real demand.

g) Use of life-cycle analysis

The interviewed companies had mixed approaches on this subject: whilst some are implementing some measures, others stated that boats are an emotional purchase and that the customers do not buy them with the thought of how to dispose of them at the end of their life and that boats are generally easy to recycle.

h) Date by which combustion engines will no longer be offered

The responses drew a varied picture: whilst some have no date fixed yet, others say that there are first changes in the engine manufacturing industry, but a complete change in the boating industry by 2035 seems to be unlikely.

SAILING BOATS

i) Benefits from the automotive industry

Sailing boat companies are in quite strong agreement that there will be options to benefit from the automotive industry, but that the two industries can not be compared, as the automotive industry is so much bigger and has more resources.

1 We cannot compare these two industries. The energy infrastructure for cars is extremely mature and robust. Moreover, the motor speed is not consistent in a car and so it is easier to imagine alternative solution.

2 The boating industry is generally 10 years behind the automotive industry in its development. Some pioneering companies will build up pressure for the other boat manufacturers to follow.

Figure 33. Answers to the question "To what extent can the industry benefit from the developments in the automotive industry?"

j) Factors accelerating the implementation of alternative propulsion systems.

Customer demand is the main driver for implementing alternative propulsion systems on sailing boats. Another accelerator might be the value depreciation of boats, should stricter phase-out limits be put in place for boats too.

k) Development goals of the companies

The current development goals of these companies are focused on identifying alternatives and solutions to to high emission components, and at the same time maintaining the company's position in the market. To building a strategy in the next years is another important goal.

ENGINE MANUFACTURERS

Interview sample

Face-to-face interviews were conducted with leading companies that manufacture engines for the boating industry. The interviewees included multinationals and SMEs to give the study a wider view on the engines side.

a) Actions for the implementation of EU environmental targets for 2030 and 2050

When asking companies about the actions they are implementing to reach the EU environmental targets for 2030 and 2050, most companies confirmed to be committed to the targets, more specifically to the reduction of engine's CO2 footprint. This was accompanied by others who hold a more cautious attitude towards the EU targets and are trying to follow the market and how the electric solution is developing, whilst trying to find the best solutions to reduce greenhouse gas emissions.

A limiting factor is that the boating industry is just a very small part of combustion engine production, it requires specific measures and investment in innovation therefore needs longer to become profitable.

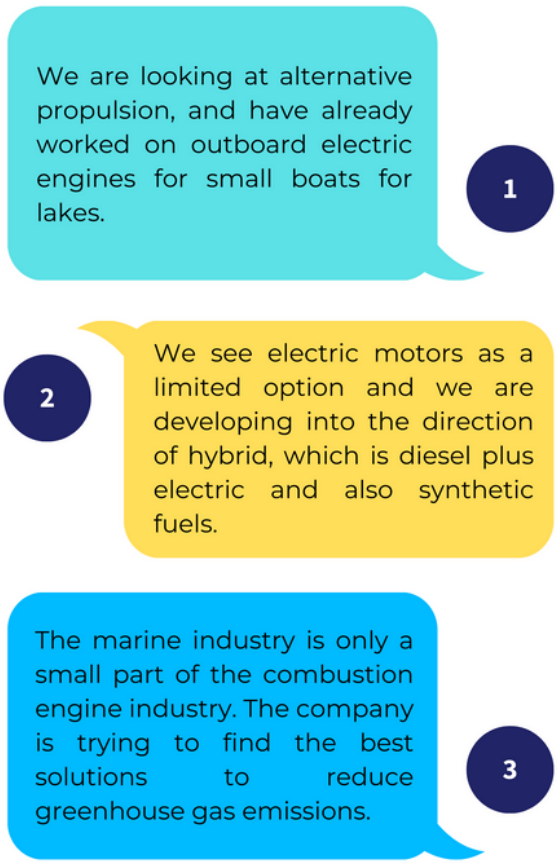


Figure 34. Answers to the question What is your company doing regarding the implementation of the EU targets for 2030 and 2050 respectively?

ENGINE MANUFACTURERS

b) Potential of green technologies

Most engine manufacturers declared that electric propulsion is the technology with most potential, followed by hydrogen and the use of alternative fuels (synthetics and biofuels).

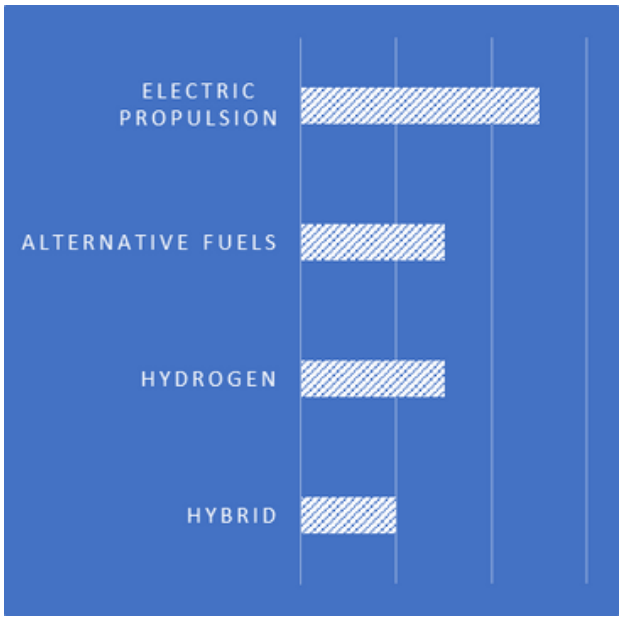


Figure 35. Results by potential of green technologies

c) Improvements in hull efficiency

Whilst hull efficiency is not a subject that directly concerns engine manufacturers, some stated that they are working with boat builders to reduce the friction of the hulls as well as friction of engine propellers. The hull design is also of importance to the inboard engine producing companies as some alternative propulsion systems require more room than current engines.

ENGINE MANUFACTURERS

d) On-board energy generation

Solar is the favoured on-board energy, but only as supply for small electric outboards. Engine manufacturers also list hydrogeneration, air filter systems and AdBlue systems as additional systems to reduce emissions.

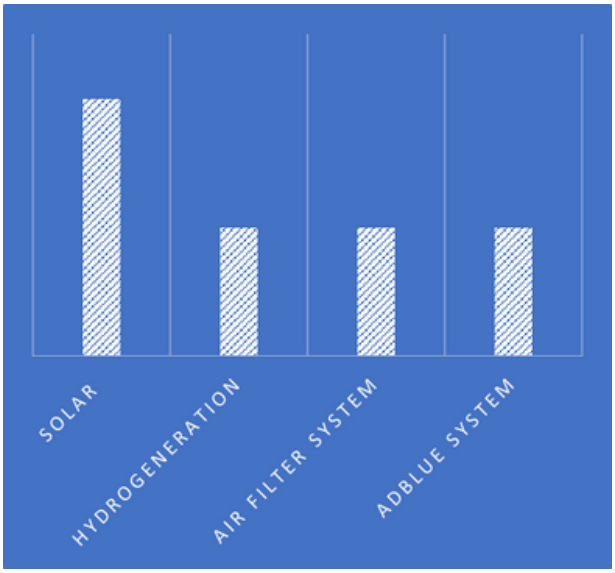


Figure 36. Results by on-board energy generation

e) Barriers to the implementation of alternative drives

The fact of being a small sector compared to the automotive or shipping sector and the lack of infrastructure are the main barriers to the implementation of alternative drives. In third position, companies see a lack of regulation as another restricting barrier. Other barriers include price, not having a clear guidance, limited range of batteries, not having big investments or the energy consumption.

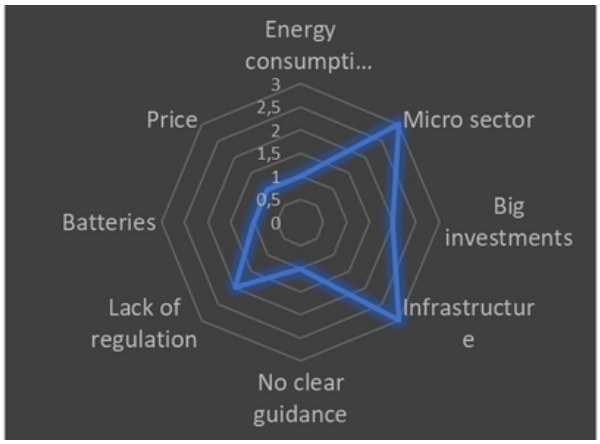


Figure 37. Results by barriers to the implementation of alternative drives

f) Customer demand

When asking engine manufacturers about how will the customer demand develop, fairly diverse responses were given, depending on the type of engine/ boat they referred to. While some think that demand in Europe will be high for electric boats, others are worried that customers are not willing to pay higher prices for a new electric boat" *(see figure 38)*.

Figure 38. Results by customer demand

ENGINE MANUFACTURERS

g) Use of life-cycle analysis

Life-cycle analysis seems to be not relevant for engine manufacturers and at most they are collaborating in reseach studies but are not contributing with any actions.

h) Date by which combustion engines will no longer be offered

When asking engine manufacturers about a possible fixed date by which combustion engines will no longer be offered, the answer was clear as all of them said "no". The reasons for not having this date set are diverse and stem from the companies being in the process of developing different approaches and strategies that include adding electric motors to their production line, looking into biofuels or improving the combustion engines.

i) Benefits from the automotive industry

Half of the interviewed engine manufacturers mentioned how the car industry is conducting studies on mass production, batteries development and even how the boating industry takes the workforce from the automotive industry, others did not want to answer this question.

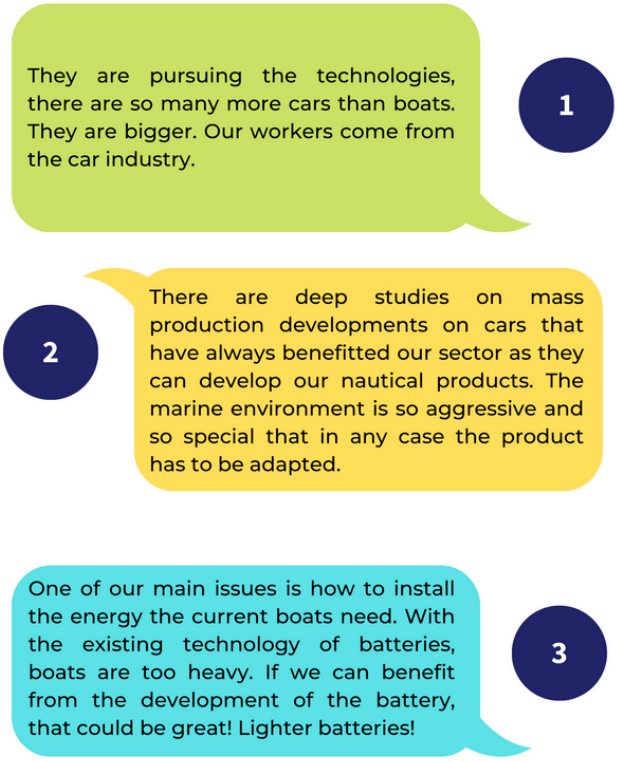


Figure 39. Answers to the question "To what extent can the industry benefit from the developments in the automotive industry?"

j) Factors accelerating the implementation of alternative propulsion systems

When asking engine manufacturers about the factors that could accelerate the implementation of alternative drives, more regulations and better infrastructure were the most mentioned factors, followed by stopping the development of combustion engines, more developments of green technologies, investment pressure and more customer interest.

ENGINE MANUFACTURERS

k) Development goals of the companies

The development of hybrid solutions (diesel plus electric), more market research and sustainability are the major development goals of the interviewed companies.

Pairing electric with combustion engines, more technology, improvements in electricity and connectivity and a better autonomy were also mentioned as development goals.

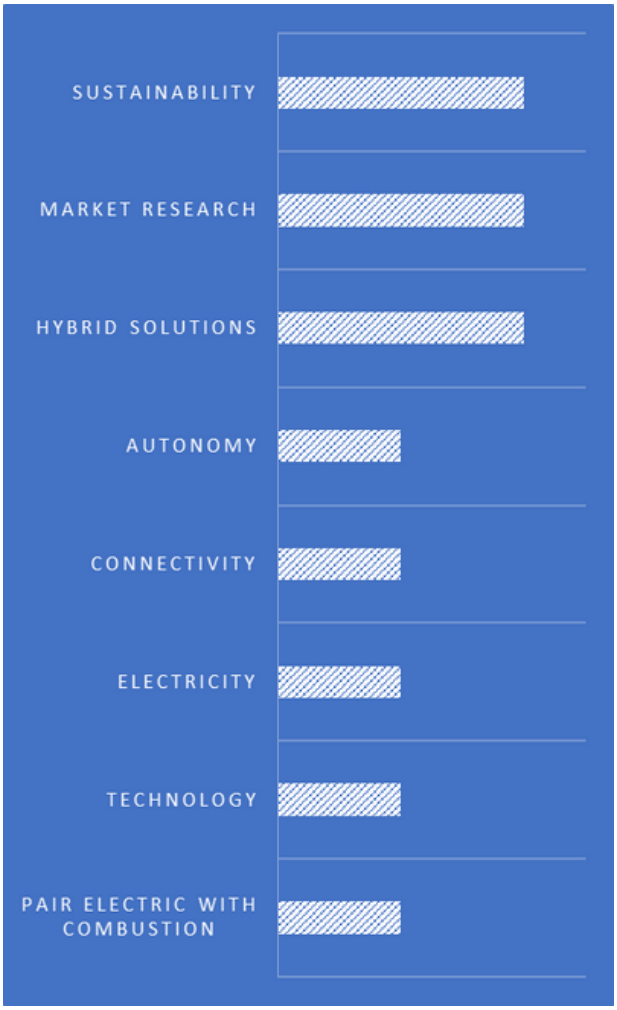


Figure 40. Results by development goals

ASSOCIATIONS

Interview Sample

Face-to-face interviews were conducted with the boating industry associations from Finland, France, Germany, Greece, Ireland, Italy, Lithuania, Norway and Spain. The answers from the national Associations give this study a wider and more general perspective on how the nautical industry is developing and the requests through the customer demand. They also ensure an even higher representation of the industry.

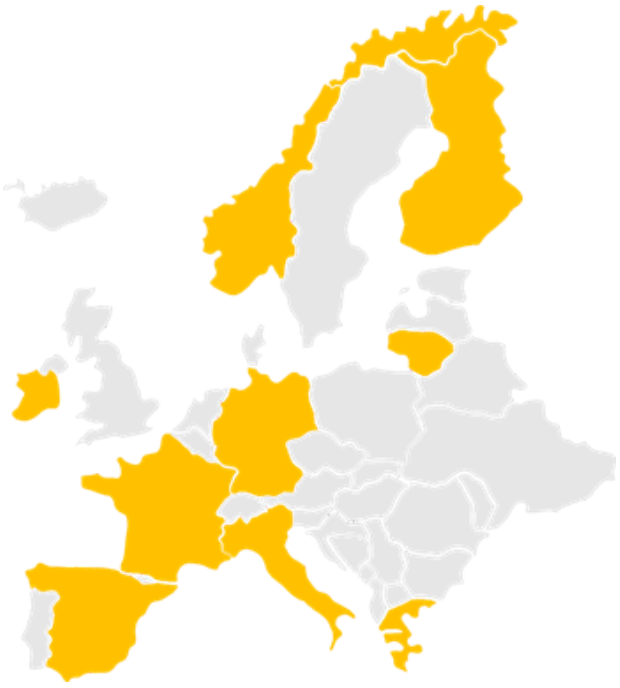


Figure 41. Nationality of the Associations

a) Actions for the implementation of EU targets for 2030 and 2050

The associations are accompanying the boating industry through this time of change. As no clear milestones and regulations are set yet and companies are testing and implementing what the market is offering, clear strategies can not be set at this moment in time.

1. The marine industry is a small sector and it is now making a strategy and building an approach for concrete changes.
2. We are ready to offer assistance to reach these targets and giving them the possibility to understand the problems.
3. Companies are trying to adapt but the performance of electric propusion is not developed enough. Other companies are working together with the car industry.

Figure 42. Answers to the question "What are companies doing regarding the implementation of the EU targets for 2030 and 2050 respectively?"

ASSOCIATIONS

b) Potential of green technologies

Hydrogen is the favoured technology, followed by green methanol (for superyachts) and electric propulsion for small boats. Biofuels were mentioned as a positive alternative if the resources are produced in Europe, while others see the combination of hydrogen and electric propulsion as the most suitable option.

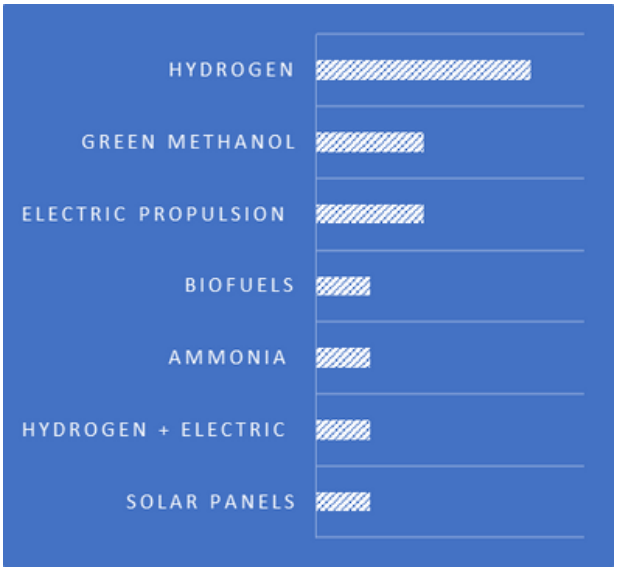


Figure 43. Results by potential of green technologies

c) Improvements in hull efficiency

The associations generally focus on the industry in their countries, therefore it depends on the profile of their companies in how far hull efficiency is an energy-saving option. Generally they are stating that the industry is working to find global long-term solutions and are giving suggestions to companies.

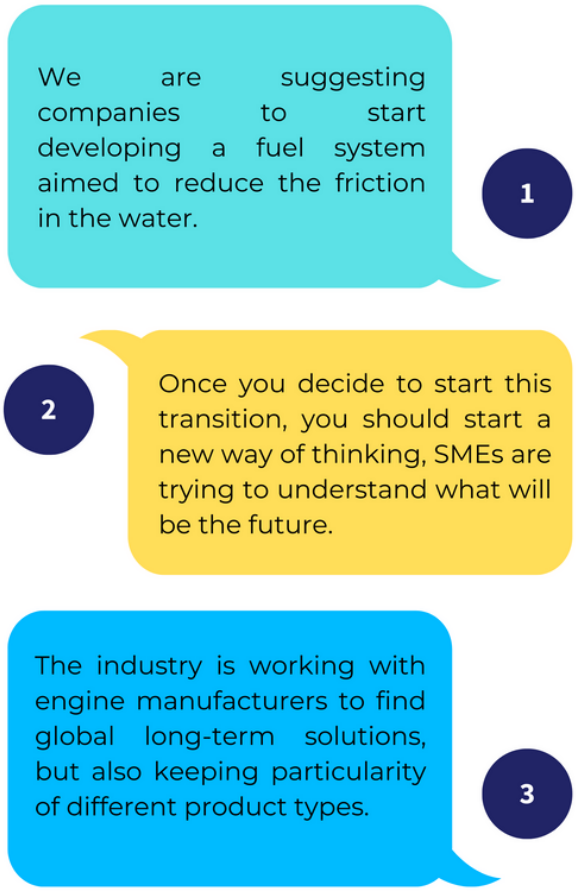


Figure 44. Answers to the question "Are companies planning to change/improve hull design to give higher hull efficiency?"

d) On-board energy generation

Solar energy as an add-on technology in the system was most named, with extra comments: "it has been working on for years but now it is gaining more importance". Solar energy was also mentioned as the main energy source for on-board applications, but only for lakes (not for coastal areas).

Other more-specific alternative options included electrolyzers and the use of sodium as the “new oil”.

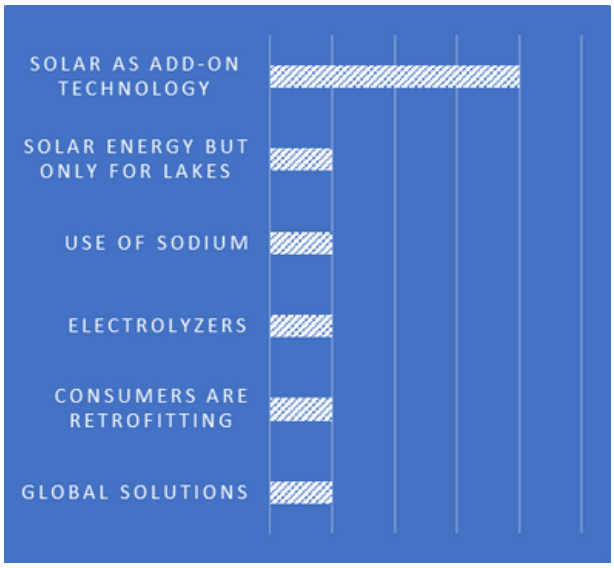


Figure 45. Results by on-board energy generation

e) Barriers to the implementation of alternative drives

Market maturity and the need of clear regulations (e.g. in the EU Recreational Craft Directive), are the main barriers identified by the boating associations. Price, technology, more infrastructure and the lack of support programs or grants are also relevant.

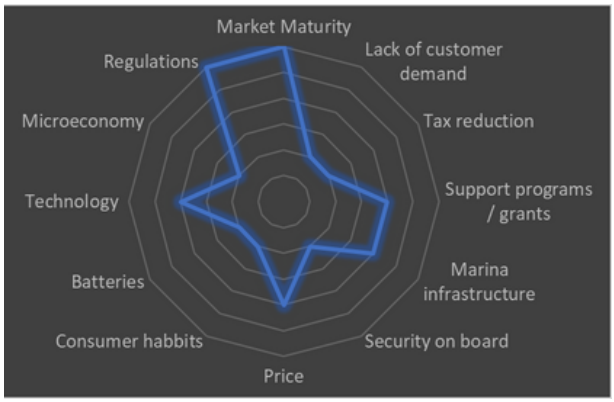


Figure 46. Results by barriers to the implementation of alternative drives

f) Customer demand

Many associations having analysed the customer demand in their countries, point out that the price of alternative drives is a problem. Other typical characteristics of customers are that they are either looking for 100% sustainable options vs. those who see sustainability as a supplement.
Customers also wish to see more than only prototypes and demand better autonomy and more safety.

Figure 47. Results by customer demand

ASSOCIATIONS

g) Use of life-cycle analysis

Most of the associations stated that more developments are needed but they confirmed that some companies are working on life-cycle analysis solutions whilst others are not planning LCA yet.

Figure 48. Answers to the question "Are there plans to use life-cycle analysis for a more comprehensive approach, for example to materials?"

h) Date by which combustion engines will no longer be offered

When asking associations about a set date by which combustion engines will no longer be offered, they all said "no" and commented:

- The boat industry is depending on the automotive industry and if the automotive industry stops producing combustion engines, this will largely affect the boating industry.
- Our companies build their boats and they buy their engines. Except the startups.
- The investment is enormous, we are trying to bring in the tourism development body to establish a tourism investment fund to help the e-boating sector.
- There are no dates from our companies on when they will be totally decarbonized.
- At the moment you can not say it's a fixed date because the technology is not there.
- The move to electric is just a move away from thermic solutions, but it will not be the only and final solution.

ASSOCIATIONS

i) Benefits from the automotive industry

The associations are aware of the immense influence from the automotive industry and that the boating industry needs to be aware of any developments in this much bigger industry that can benefit the boating industry. But they also warn of attempts to try to transfer technology between the industries without taking into account the differences.

Figure 49. Answers to the question "To what extent can the industry benefit from the developments in the automotive industry?"

j) Factors that accelerate the implementation of alternative propulsion systems

When asking associations about which factors could accelerate the implementation of alternative propulsion systems, governmental grants were the most mentioned measure, followed by customer demand.

Other relevant factors include the need to develop more charging infrastructure in ports and marinas, social pressure, reducing the prices/ costs and more developments with regard to green technologies and sustainable materials *(see figure 50)*.

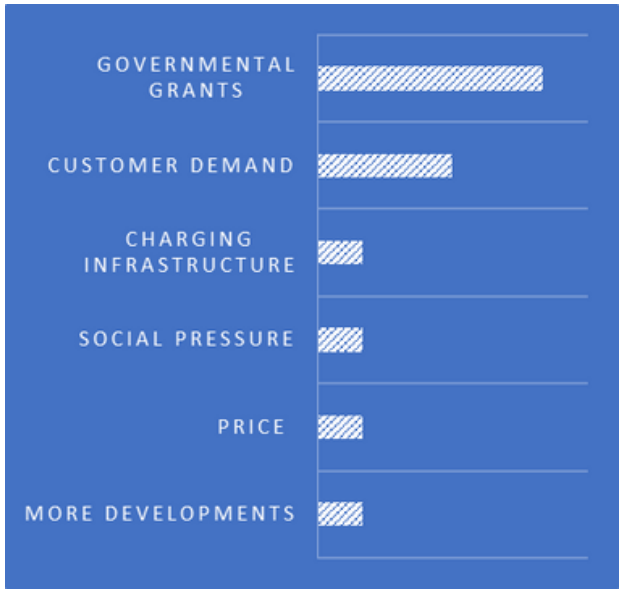


Figure 50. Factors that accelerate the implementation of alternative propulsion systems

ASSOCIATIONS

k) Development goals

"Keep the business going" was the most relevant development goal for the associations, as the sector has suffered 2 major crisis (the financial crisis and the COVID crisis) and is still recovering from the last one. To bring the industry together in a task force, meet with legal requirements, incorporate alternative propulsion, understand customer behaviour, sustainability and the use of end of life materials were also mentioned but not with the same relevance.

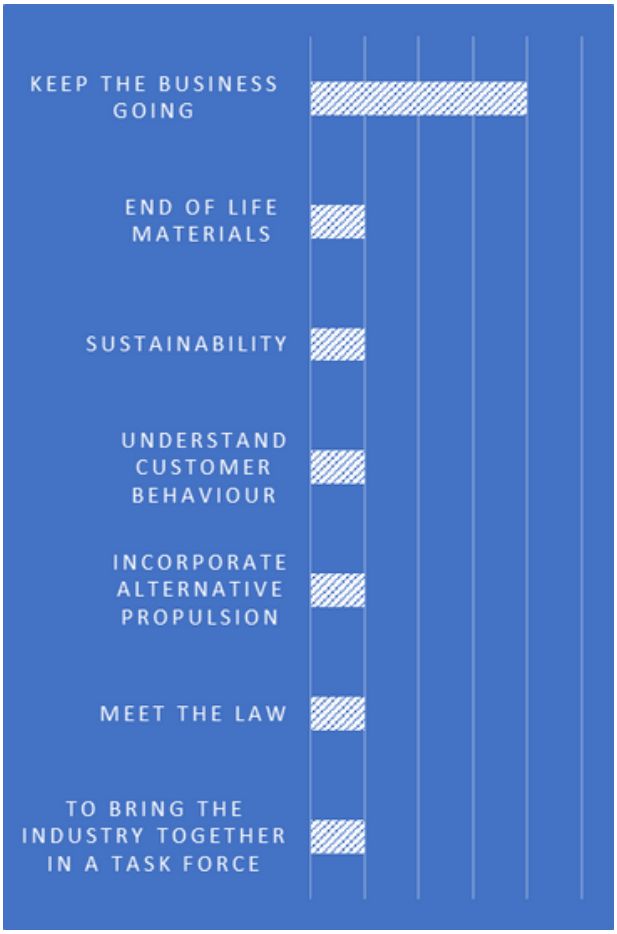


Figure 51. Results by development goals

CONCLUSIONS

CONCLUSIONS

The obtained results from the research phase show how the industry finds itself in a paradox situation: governments and policy-makers are making a shift towards sustainability and zero-emissions targets and are requesting companies to reach their milestones, but on the other hand, customers are not 100% willing to purchase boats which have sustainable propulsion systems, due to factors such as higher prices, perceived lack of safety or lack of knowledge on latest developments.

The challenge of decarbonising boat propulsion is one of the most challenging aspects of the overall journey to environmental sustainability. Infrastructural problems, a lack of innovation due to the comparably small market size and a not yet pressing demand from customers have led to a cautious approach of the industry: Different segments of the boating industry are waiting for the other segments to take first steps and see which technology works and fits better with the various use requirements and customer demands.
In this current situation it is therefore essential that boat builders and engine manufacturers cooperate to design boats that have sustainability in-built to enhance the green transition, but keep the factors demanded by the customers (price, comfort, range, etc.) in the foreground. This also needs to include looking into the materials used and considerations for end-of-life dismantling and recycling.

Companies producing smaller boats (up to 10 metres) equipped with outboard engines are more positive in the use of electric propulsion, and some of them are taking advantage of it by making e-boats their company philosophy.

On the other hand, companies that produce boats that are mostly over 10 metres with inboard engines are working on hybrid solutions of diesel and electric, because pure electric propulsion is not an effective solution for their boats. They are expecting transferable hydrogen developments from the car industry, as they see electric propulsion rather as a stepping stone than the future solution. This is mostly explained with limited ranges from batteries and missing charging infrastructure in marinas. It will be an important future factor for these companies to better manage expectations of customers and policy makers by explaining clearly why the boating industry is not comparable to the car industry and that it has to find specialised solutions.

CONCLUSIONS

Companies producing sailing boats are less concerned about the future of propulsion, as they only use the engine as an auxiliary form of propulsion. This will potentially allow the use of electric propulsion due to lower range requirements.

Overall, issues are however still identified for electric propulsion that inhibit their adoption, such as range, infrastructure and price.

Engine manufacturers are at the starting point of creating sustainable plans alternative propulsion systems. They highlight that it has to be a global solution rather than a regional solution that will only be used by a subset of their customers. They are also waiting for boat manufacturers to improve hull efficiency and address spatial concerns.

Associations are trying to guide the companies by participating in different research studies, pilot projects and monitoring how new start-ups are developing new prototypes, so the best models can be replicated on bigger vessels. Having analysed the customer demand in their countries, associations recognize that customers either are part of a small group that is looking for 100% sustainable options vs. those in the larger group, who see sustainability only as a supplement.

Customers focus firstly on factors such as price, comfort and range as a decision-making factor when buying a boat, sustainability was only raised as an important factor when suggested the interviewer. The quantitative survey painted a slightly different picture where customers stated that sustainability is an important factor, although their deciding factors for buying a boat are price, comfort and security. Electric propulsion is seen by many customers as the best future propulsion solution, but not by a majority.

The boating industry anticipates the mindset of consumer to change drastically when the customer profile changes. Especially the Generation Z (born between 1997 and 2012) is anticipated to make a major difference in expectation of sustainability.

In conclusion: the industry as well as the customers have started implementing sustainability and currently changing their offers and demands in small segments. But both sides of the market are becoming increasingly aware of sustainability necessities and whilst the industry is developing new concepts, the customers are becoming more interested and demanding.

Acknowledgements

We acknowlede the contributions of all companies, associations and customers who participated in this study,

Those responsible for **concept and coordination,**

The group of researchers,

The **writers** behind the study report,

The **designers** of the study report,

And all the contributors who facilitated contacts and facilitated the arrangements of the interviews.