Winter 2021

ELECTRIC BOATS INTERACTIVE

FEATURE BOAT

Hynova 40

CRUISE GUIDE

Icehouse to Limehouse

Electric Boat Association

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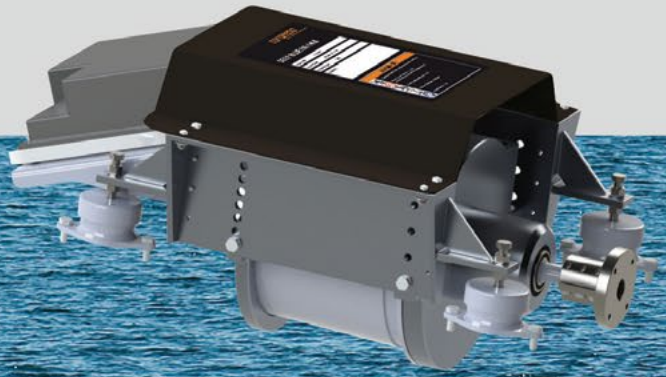
DEEP BLUE i



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ELECTRIC BOATS INTERACTIVE

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Submit

Contributions from readers are welcome although we cannot be held responsible for any damage or loss which may occur to material provided. Items of interest include letters, reports of rallies, events, cruises, articles and advice on building and running electric boats and on items of equipment. We also welcome manufacturers' reports on new equipment and boats.

Copy Deadlines

Material to be considered for inclusion in Electric Boats interactive should be sent to the editor (preferably by email) by the following dates:

Summer	31 May
Winter	31 October

ELECTRIC BOATS INTERACTIVE

Volume 3
Number 2
Winter 2021

The ice house P19

Fresh Air

At the time of writing, the UK government is promoting fresh air "to stop the virus hanging around". Hopefully the 2022 boating season will offer plenty of opportunities to put the government's advice into practice.

The EBA attended the re-arranged 2021 Crick Boat Show in August and managed to have a members rally on the Thames in September (page 14). There are now signs that such events can at last be planned and organised without fear of having to cancel at the last minute.

According to newspaper reports the UK National Grid pays power plant owners to "constrain" output when the network does not have enough capacity to transmit their electricity to where it is needed. It also pays for power plants elswhere to fire up and replace the generation that has been constrained. These "constraint" costs amount to about £500 million a year, but new estimates forecast that they will at least double and could increase five fold to £2.5 billion within five years. Producing hydrogen through electrolysis is one way of utilising and storing energy that would otherwise go to waste at enormous cost. Boats with fuel cell drivetrains turning hydrogen back to electricity are now appearing, from day cruisers (page 6) to ocean going ships (page 16). Japan is building a protype battery storage vessel that can be charged at sea from offshore wind and then carry the power back to land. All of which seems a better way to spend £2.5 billion.

Moving by water in congested big cities is an increasingly attractive alternative. The iconic river ferries run by Thames Clippers has got funding to research more efficient and greener river transport (page 13).

Research by the Canal and River Trust has shown that canals in urban areas can have a noticeable cooling effect during heat waves (page 13). London's historic Regent's canal is a very cool environment in every sense of the word and travelling by boat is probably the best way to explore the waterway (Page 19) if speeding towpath cyclists are to be avoided.

There are 5,000 miles of navigable waterways in the UK (page 12) with their own unique heritage and they are all there to be explored and appreciated.

It is time to get out in the fresh air.

Don Wright

Cover: Hynova 40

Electric Boat Association

Published by Futuremode Limited

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Winter 2021

Chloé Zaied the founder and CEO of French company Hynova Yachts was formerly a manager and professional boat captain at L'Eden Boat which provides tourist boat trips in the Calanques National Park, a series of bays and inlets that have been formed in the limestone cliffs between the city of Marseille and the town of Cassis, in the south of France.
Chloé wanted to continue to enjoy motor boating but in a way that had minimal impact on the environment.

Hybrid Hydrogen Dayboat

Having researched her project, Chloé attended the 2019 Monaco Boat show where she met with the team from Energy Observer Developments (EODev) the R&D subsidiary of the Energy Observer Group that built the *Energy Observer*, a prototype hydrogen-powered vessel launched in April 2017 to voyage around the world in total energy autonomy (featured in the Summer 2020 edition of EB*i*). EODev decided to make Hynova a pilot project for its REXH2 (Range Extender Hydrogen) a modular solution developed around Toyota's latest generation fuel cell and tested on the *Energy Observer*.
Events then moved very quickly. EODev and Hynova formed a consortium of companies and by the middle of the following year the boat was under contruction at the French shipyard at La Ciotat, along Mediterranean coast, with the intention of making its debut at the 2020 Cannes International Yachting Festival. However both the Cannes and Monaco Boat shows in 2020 were cancelled as a result of the Covid-19 pandemic and it was not until the end of September 2020 when the Monaco Yacht Club held a two day congess on theme of "Hydrogen and the yachting of tomorrow" that the world's first electro-hydrogen dayboat made its appearance on the terrace of the third deck of the Monaco Yacht Club in the presence of HSH the Sovereign Prince Albert II .
The Hynova 40 had previously, been awarded a Coup de Coeur (show favourite) at the seventh Monaco Solar and Energy Boat Challenge which was held in July 2020 as an on line event due to the restrictions of the coronavirus pandemic. The Challenge is organized by the Prince Albert II Monaco Foundation and the International Powerboating Federation, both of whom are committed to showcasing clean energy technical and production advances.
Chloé Zaied said 'I'm proud to be the first company in the world to bring to the market pleasure boats equipped with this innovative technology and I am very happy to share this adventure with my partner. Hynova Yachts hopes to be able to contribute to designing boats with the least possible impact on the environment and to promote the use of green hydrogen for tomorrow's world, all of which fits perfectly with my personal values.
Jérémie Lagarrigue, Managing Director, EODev said 'Making boats that are both silent and with zero emissions is a great opportunity to accelerate the development of the hydrogen society.'

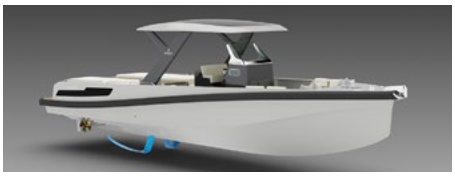
Launched Cannes 2021

The Hynova 40 finally got on to the water at the Cannes Boat show at the beginning of September 2021, where it was the first time that a boat had been refuelled wirth hydrogen in the Port de Cannes. Later in the month the boat travelled to Monaco for the Monaco Show.

The 12-m open boat was designed by Hynova Yachts in collaboration with EODev and naval architects CLYD. The CLYD group has been established in Bordeaux since 2010 where it first specialized in the manufacture of luxury pleasure craft before also moving into yacht design, refit and project consulting. The hull design was optimised with the help of Syroco, whose supercomputers and hydrodynamic engineers improved the efficiency of the whole by nearly 20%, with the addition of foils. Based in Marseilles Syroco is a scientific and technical lab founded in 2019 by Alex Caizergues, world kitespeed champion and holder of multiple speed records on water, and Bertrand Diard, founder of French unicorn Talend and VC fund Serena Data Ventures.

The 12 metre boat has a maximum beam of 4.2 meters and a draft of 08.-0.9 meters. It is intended go into series production from 2021.

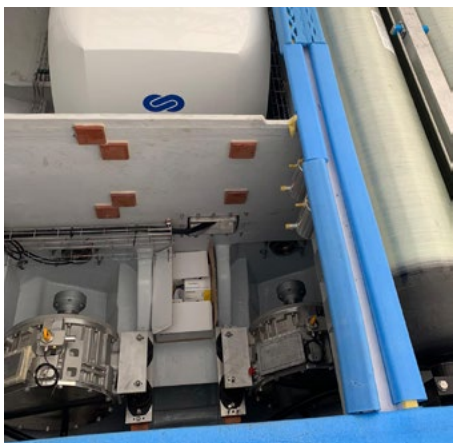
With a capacity of 12 passengers it is the first pleasure boat equipped with REXH2 (Range Extender Hydrogen), a hybrid hydrogen-electric technology. EODev has designed a system for the Hynova based on the latest generation Toyota fuel cells which comprises a REXH2®, which can supply up to 80kW, three LiFePO (Lithium-Iron-Phospate) batteries of 44kW, designed by EVE Systems, and two BorgWarner electric motors providing 184kW



of power each (or approximately 2 x 250HP in diesel equivalent). The design allows the boat, which weighs around 9 tonnes, to reach 25 knots at maximum speed, have a cruising speed of 12 knots, and 20 minutes recharging back at the port. The operating speed limit with the battery alone is 8 knots, and the boat will sail up to 69 nautical miles at 6 knots.

Propulsion: BorgWarner HVH250

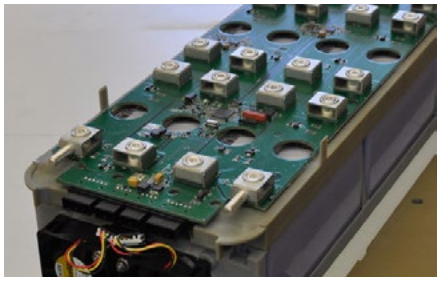
The Hynova 40 is powered by two 184 kW BorgWarner electric motors. BorgWarner is an American multinational automotive supplier based in Michigan. The company maintains production facilities and technical systems on a worldwide basis at 96 sites and in 24 countries.
HVH (High Voltage Hairpin) Series Electric Motors motor are powerful, durable and rugged electric motor/generator for use on and off-highway vehicles, power generation and other special high power demand applications. BorgWarner can draw from a strong background of having its HVH250 in production for more than 10 years. The company's electric motor offers customers peak efficiencies of more than 95% and features patented HVH stator winding technology along with the choice of direct drive, chain drive, belt drive or integrated options. The HVH250 motor is offered fully housed or as rotor/stator assemblies and features an internal permanent magnet rotor and proprietary insulation system for added durability. The motors come in various stack length, cooling and winding configurations.
After 10 years of continuous production and a production capacity of up to 80,000 HPV motors per year there are more than 100,000 motors in service.
BorgWarner has recently boosted its leadership position in commercial vehicle electrification with a German OEM's selection of its HVH250 electric motors to power a heavy-duty truck which will be equipped with two HVH motors per axle, each with industry-leading peak power of 175 kW and 425 Nm of torque at 350 volts.
'We are delighted to provide our electric drive technology for this battery-electric truck for heavy-duty transport. Our proven HVH250 motor delivers the power and durability required for this demanding application,' said Dr. Stefan Demmerle, President and General Manager, BorgWarner PowerDrive Systems.



Energy supply and storage

The Hynova 40 is equipped with a latest-generation Toyota fuel cell, the T-Module, which can deliver up to 80 kW, which supplements three 44 kW LiFePO (Lithium-Iron-Phosphate) batteries designed by EVE Systems and approved for marine use. The REXH2 ® (Range Extender Hydrogen) is an on-board power generator running exclusively on hydrogen, for propulsion and on board systems. The EODev REXH2 fuel cell converts hydrogen into electricity via an electro-chemical reaction. The electricity produced is then fed into the battery bank, which powers the two electric motors. To reach speeds of over 15 knots, the fuel cell and batteries must operate simultaneously. When the batteries are discharged, the fuel cell acts as a super charger. With a footprint of barely one cubic meter and a weight of 400 kilos, the REXH2® is, in relation to the power delivered, the most compact and efficient range extender on the market. The R&D carried out by the EODev teams has adapted it perfectly to the extreme conditions of the marine environment and reach powers of 70kW per unit, up to 1MW when the modules are stacked. For higher output needs, installers can arrange cells in sequence, and since they are small and modular, they can be spread through the hull to fit within various designs. That modularity also means that if any one cell malfunctions, the rest will continue to operate, providing built-in redundancy.

The hydrogen gas that feeds the system is stored in compressed form, at 350 bars, in specially designed tanks installed outside the ship's structure for direct venting. It is this flexibility in the implementation that makes the REXH2® the ideal solution for propulsion and the supply of carbon-free energy at sea. It has been tested over more than 7,000 nm on board *Energy Observer* and can be fitted into all types of boats, from cargo vessels to passenger shuttles to barges and small and large pleasure vessels. Toyota is heavily invested in hydrogen fuel cells, using them in buses, trucks and high-speed ferries.They've sold more than 10,000 Mirai, a fuel-cell equipped car. When engineering the REXH2® Toyota marinized the cell by adding a water-cooling system and filters to keep salt from getting into the internal workings. Compared to petrol or diesel, the REXH2® provides an obvious environmental benefit since it only releases water. There is therefore no release of pollutants into the atmosphere or into the water (CO_2, NOx, greenhouse gases, unburnt hydrocarbons, etc).



Control and monitoring

The benefit of the hydrogen-electric combination in comparison with a full electric system, in addition to significant saving in weight and therefore in energy consumption, is to make it possible to manage power needs according to use, relying on constant fuel cell power in "cruise" mode, while being able to instantly get power from the batteries when extra power is needed. The system is managed by an automated Power Management System specifically developed by EODev, which allows the various systems to be coordinated by the on board computer, calculating the remaining range based on use and expected average speed, like in a car.

Series model in production 2021

After building the Hynova 40 demonstrator to prove the interest and feasibility of an electro-hydrogen propulsion system, and after the promotional campaign during the summer of 2021, the Hynova shipyard in La Ciotat is now going into the series production with the Hyhnova 42 model. The shipyard is aiming for a small series with a production of about 8 boats per year commencing at the end of 2021. Designed by naval architect Gilles Vaton the Hynova 42 is a 8 tonne 12.8 meter dayboat, with 3.8m beam and 0.9m draft, that can accommodate up to 12 passengers. It has a large sunbed on the back, a bowrider lounge on the front and a cockpit protected by a hard-top that can be closed to enjoy a dinner sheltered from the air, or opened for ventilation while sailing. There is a small cabin for changing clothes. The boat will be equipped with the same EODev REXH2 (Range Extender Hydrogen) technology.

The Hynova 42 is available in 3 ranges:

Explorer for more autonomy with a cruising speed of 15kts a maximum speed of 25kts and a range of 150nm

Sport for more speed with a cruising speed of 25kts a maximum speed of 30kts and a range of 90nm

Unique which can be customized for speed and range

The supply of hydrogen remains a major problem and in particular the installation of infrastructures in the ports.

Chloé Zaied is in talks with the various authorities to make things happen. 'Technically, it's pretty easy to be able to fill up with hydrogen. But it's a question of education and supply process. We are in discussion with 8 ports and one of them has agreed to install a mobile solution. There are chargers for electric boats. All that remains is to create areas for hydrogen charging.

We have already taken a first step forward by building a first boat, now the ports will follow us', Chloé Zaied said.

Energy Observer is the name of the first autonomous hydrogen vessel with zero emissions, zero noise, and laboratory and advocate of ecological transition. The Energy Observer project has become an agent of change by creating its land based laboratory, EODev, with the aim of using the expertise and knowledge acquired of from the years of navigation to design, assemble and distribute zero-emission energy systems on an industrial scale. Where the ship tests these technologies in extreme conditions, EODev is responsible for deploying them in various sectors of activity to make these solutions accessible to all.

click on the red dots

In Brief

Miles of waterways

Inland Waterways Association resarch reveals a total of 7,000 miles of waterways in Great Britain. Of these, 5,000 of the miles are navigable today. The other 2,000 miles are either derelict or under restoration.The IWA Waterways Directory details all the inland waterways ever brought into navigation and has been updated with thorough research by IWA experts and local volunteers. The research informs local campaigning and originated out of the need to know who was responsible for what waterway. The new version also lists every local authority responsible for the areas through which each waterway passes.

Inland Heritage Port

The Heritage Harbours scheme has recognised Chester Port as its first inland Heritage Port. The scheme highlights long established but often forgotten ports that played an important role in the maritime and industrial history of the country. The IWA has been working at a local and national level to safeguard inland heritage ports, as part of its wider campaign to protect waterways heritage. IWA Chester & Merseyside Branch submitted a 31 page application alongside partners Chester Civic Trust and Cheshire West and Chester Council to recognise the Roman Port as a heritage asset. Criteria laid down in the heritage harbour designation process included:

- an outline of its unique historical development;
- a catalogue its surviving features;
- an evaluation of its environmental and historical features

The Heritage Harbours scheme is organised by Maritime Heritage Trust, National Historic Ships and European Maritime Heritage, to recognise the great value in sensitively developing the historic buildings; waste land; mooring; and maintenance facilities in the Ports.

Zero Water Witch

Earlier this year, Loch Lomond National Park Authority set the ambitious goal of achieving net-zero emissions by 2030 and the new addtion of an all electric vessel designed and built by Water Witch in Liverpool, to service Loch Lomond will help it get there.. The custom-built 100% electric 8.0m maintenance boat is thought to be the first of its kind in the UK. It will be used as a general multi-purpose support vessel and to maintain hazard buoys across the Loch. The aluminium 'Versi-Cat' vessel is sustainably built from up to 75% recycled content and the hulls are 100% recyclable and it is equipped with a Torqeedo 12-kilowatt motor to easily make the 7 knots required. The motor is powered by the most up to date and safest 'intelligent' Power48 lithium batteries on the market. The vessel's electric controls feature a built-in GPS, an on-board computer and display for information such as speed and input power, state of charge and remaining range, and even an advance communication system that links user's Bluetooth and App technology to the complete system. Unlike the distinctive hum heard from traditional diesel boats, the Versi-Cat is almost silent as it glides through the water. Tests saw it sail the length of the Loch – some 20 miles – on a single charge. The workboat is fitted with a large work deck, recessed storage under deck, and a lifting frame for handling buoys using a pontoon configuration to provide a spacious and well-functioning work platform. With the lifting frame and electric windlass, the vessel is equipped to handle a variety of tasks: maintenance of installations, towing of boats, personnel transport, rescue missions, as well as the possibility to assist in oil spill operations. A customized road trailer was also supplied to allow the vessel to be easily deployed to different sites, and the A frame is removable for transportation

World's most powerdense electric motor

UK company Equipmake is using additive manufacturing to prototype its latest Ampere motor which is projected to weigh less than 10 kg and make 220 kW (295 hp) at a 30,000 rpm, meaning it offers more than 20 kW/kg, making some four times as much power as a similarly sized permanent magnet motor. Equipmake says the 3D printing technology has allowed it to use less metal in its design, combining components into complex shapes that couldn't be achieved with milling or casting while preserving the spoked magnet design's outstanding cooling capabilities

Green River Transport

London's leading River Bus operator, Uber Boat by Thames Clippers, has won Department for Transport (DfT) funding to support three projects to research and develop green river transport for the future. Thames Clippers applied for the funding in collaboration with other partners, via the Innovate UK Clean Maritime Demonstration Competition, to further drive green tech capabilities forward. All of the DfT-funded projects enable research into the future capabilities to design the new generation of river transport; greener, more efficient and advancing the existing technology. The three Clean Maritime projects, which will kickstart the decarbonising of the Thames, are:

- Economical and technical feasibility of decarbonising high-speed public water transport on the River Thames

This study will look at the feasibility of integrating fuel cell electric drive systems into the catamaran platform for new catamarans and, beyond that, retrofitting the existing fleet where possible. The project will analyse three zero carbon fuel types – compressed hydrogen gas, liquid hydrogen and methanol – to allow an informed future choice to power the fleet.

- Cross River Zero Emissions Ferry

This feasibility study will look at the relationship between power demand, duty cycle and vessel optimisation for more efficient vessel operation. It will help to develop a clear plan for a future prototype vessel that provides operational data to show clear economic and technological feasibility to achieve Net Zero by 2050.

- Project HOST (Hydrogen and Oxygen South Thames)

The aim for this project is to enable Thames Clippers to transition from diesel engines to vessels that use hydrogen fuel cell, batteries and electric motors over the next 10 years.

Plymouth charge

Plymouth is set to become the first city in the UK to install a network of shore-side charging facilities for its expanding fleet of electric maritime vessels. Over the past year, the city has become home to the UK's first marine electric passenger ferry and an electric water taxi. However, access to infrastructure is currently a barrier to ensuring further growth in this emerging sector can happen in a coordinated and sustainable way. A consortium of city partners is joining forces to create Plymouth's Marine e-Charging Living Lab, which will provide the pivotal infrastructure required to accelerate innovation and growth.

The project is being led by the University of Plymouth in partnership with Plymouth City Council, Princess Yachts Limited and Aqua SuperPower

In Brief

Boater's report

The Canal & River Trust has published its Boater Report 2021 for the more than 35,000 leisure licence holders who use its waterways. The Report sets out how the Trust generates its income, including the four fifths of income which comes from nonboating sources, and how the money is invested in the network. This year the Report highlights examples of the works the Trust carries out to keep the waterways safe and open for navigation. Despite the coronavirus pandemic, this included the completion of almost 100 major projects, on top of 282 planned repairs and 68 arising and emergency repairs. The Trust replaced 92 lock gates and spent £6.5m on dredging and £8.9m on vegetation management. The Trust's income is derived from a variety of sources, around a quarter coming from the return on its investments, and a quarter from the annual Government grant. Boat licences and income from boating businesses play an important role, contributing around a fifth of the total, while commercial income from utilities and water development accounts for around the same amount.

Cooling waters

Amongst the many modern-day benefits of historic canals, research published by the Canal & River Trust and University of Manchester shows the presence of canal water in urban areas can cool Britain's overheating cities during heatwaves by up to 1.6 degrees celsius in a 100-metre-wide corridor along the waterway. Richard Parry, chief executive at Canal & River Trust, said, 'Our network of canals and river navigations flowing through the hearts of Britain's towns and cities are perfectly placed to help tackle the challenges of climate change'.

Electric Boat Association

Virtual Club House

Give your boating a booster jab.

by Tim Knox
EBA Secretary

It's 2022 and here's to a positive outlook for the year. Personally, I think it's going to be a cracker. However, my new mantra is "don't plan - react". That said, my aim is to have at least three on-water meetings this season. Last year I planned several events only to have to cancel them at the last minute. Lechlade, on the other hand was a last minute event and a great success. More about this fabulous stretch of water later.

Being electric boaters we know about +ves and -ves. Let's talk about the -ves. I have to admit that the Virtual Club House has not as yet been a great success and usage has been very light. We've had more bugs in the VCH than Wuhan. This all lies on my shoulders and I'm doing my best to systematically address the issues. Please have patience and give it another go. Once up and running effectively, it's going to be a huge asset. Any bugs, please let me know so I can fix them.

The Crick Boat Show

This boat show is important to us because it is the largest inland water boatshow. Exhibitors are weighted towards narrowboating but with more narrowboaters going electric it's important we are there. The event is normally held in May but this year it was held in August. You can guess why. Please note I haven't used the 'C' word yet.

Staffing the stand was troublesome so we shared space and staff with DC Batteries and Mothership Marine. Keith Meadowcroft (Ask Keith on the forum) took on the lion share. Not only is he hugely knowledgeable but has the stamina of a marathon runner. He looked like a real guru in our new green T-shirts and deserves a gold medal.

Lechlade.

Our only official outing of the year and indeed the first for a long time. Boats, cakes, sunshine and much bon ami.

Lechlade came about after the cancellation of Windermere. It was a 2 day event and the sun shone. 6 boats and 30 boaters. This is a very picturesque part of the Thames and, if I may speak for us all, it was a most enjoyable event. Special thanks to Jules and Ian Lindsay EBA members and proprietors of the Lechlade Marina for hosting the event, 10/10.

The Virtual Club House and signing in for the first time.

From www.electricboatassociation.org click 'Club House" in the top nav. Use the email address we have for you and click forgot password. You'll be directed on how to get a new one. (There are still some members for whom we don't have email addresses. If that is the case please email me at secretary@electricboatassociation.org and I will make a link to give you access).

Please take a look around the club house and don't be afraid to post. It is a very secure site, your boating secrets are safe with use. You can use it to get in touch with other members and if you see anything interesting elsewhere - please share it with other members.

So let's get boostered up and get on the water. I think there is so much pent up boating energy out there we may not even need batteries. If you do need new batteries, however, check out our online shop in a month or so. We'll have some special discounted offers for you in our shop. See you on the water. Tim.

click on the red dots

Clubs and Associations

As Edward Hawthorne's book (serialised on page 35) reveals boats powered by electric motors were on canals and rivers long before the internal combustion engine took over propulsion and the resurgent interest in electric boats is reflected in the clubs and associations that can be found all over the world.

The UK Electric Boat Association was formed in 1982 and is an international, not-for-profit membership organisation of individuals and businesses promoting electric boating.
The EBA looks to help boat owners with issues such as waterway access, charging points, slipway facilities, licence fees and the Boat Safety Scheme. A Charging Points Forum has been set up in the Virtual Club House to canvas members views and comments on charging infrastructure. The EBA online shop now has a full range of boating apparel

The Electric Boat Association of Greece is a non profit organisation founded in 2016 to promote the development of Electric Boating and to serve the needs of all who have an interest in electric boating.
The Association has a regular news blog and a latest report features the testing of a battery powered and fully autonomous Roboat, as it navigates through Amsterdam's canals using lidar to localize on a pre-existing map along with cameras and ultrasonic sensors for obstacle detection and avoidance. A second boat carrying cargo is planned for the end of 2021.

The Electric Boat Association of Canada is a not for profit Canadian corporation and was formed by a group of boating enthusiasts concerned about the use of fossil fuels for transportation and excited about the possibilities of boats and ships powered by electricity.
Their website has a Canada e-boat news feed from Plugboats.com and a latest post features Transport Canada and Tourism Quebec plans to have up to 15 Vision Marine electric boats available for rent on a waterways system near Montreal known as the Haut-Richelieu (high Richelieu) project

The Frisian Electric & Hybrid Boating Association (SEFF) was founded to promote electric and hybrid boating in the Netherlands Frisian province.
A latest news release reports that residents of Friesland explored the Bûtefjild, the nature reserve between Feanwâlden and Ryptsjerk by canoe, sailing dinghy or in an electric boat. A fossil-free sailing route has been plotted in Bûtefjild's sheltered waters and reed beds, allowing explorers to go in search of kingfishers, great egrets and bitterns.

The Electric Boat Association of America was formed in 1992 with the objective of being:
an educational arm and information source for electric powered boating issues, and a representative of electric boaters in matters of environmental protections and regulations; a planning and organizing agency for meetings, exhibitions and competitions;
a clearing house for ideas and information on electric boat products and services, and a link with similar international associations in the promotion of electric boating.

The French Electric Boat Association was created in 1994 in Bordeaux by partners from different professional backgrounds - academics, researchers, engineers and industrialists - to develop the image and market of the electric boat in France as well as abroad.
Their news section reports that around sixty participants came to the Paris Yacht Marina for the 2021 AFBE technical day (which had been cancelled in 2020), to take stock of the situation and to present the latest technical innovations in the sector.

Attolo's 2030 Project Zero

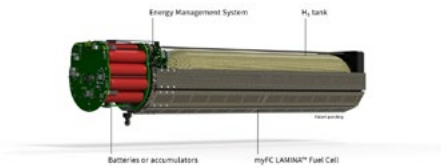
British marine operator Attollo has unveiled designs for $100 million zero emissions autonomous hydrogen vessels, fitted with ultramodern technology and crew facilities, planned to be operational by 2030. The futuristic concepts are part of a multi-generational Research & Development mission known as 'Project Zero' - with the vessels named after the three pillars of the project: *Hope*, *Destiny* and *Progress*.
When offshore, Project Zero's autonomous ships will utilise zero emission hydrogen fuel cells, benefitting from onboard renewable power generation (solar and wind power) and built-in state-of-the-art technology from computer vision to AI. Additional features include advanced sensors, 3D printing capability and hydroponics to increase the vessels ability to operate independently - with drones replacing helicopters to ensure safe transit between assets. Attollo's vessel design has been funded with help of government support and assistance from V&A Dundee 'Design Accelerator' for low carbon technologies. CENEX transport consultancy conducted vital research into the zero-emissions propulsion technologies. Jen Ballie, Design for Business Research Manager at V&A Dundee, said: 'V&A Dundee works with organisations of all sectors and sizes to support their innovation, putting design thinking tools to use and solving complex social and technical problems'. Fergus Worthy, CENX General Manager said, 'Attollo want to use zero emission at point of use propulsion technology for its next generation vessels. Zero emission marine propulsion technology is in its infancy, but Attollo want to demonstrate early leadership and adoption for large scale commercial maritime applications'. Attollo has also signed up to the Science Based Targets Initiative - a net zero standard giving companies science-based certification of their sustainability targets.

Full size fuel cell drivetrain

The Norwegian Kongsberg Maritime has announced the startup of the world's first 'full-scale, full-size' hydrogen fuel cell drivetrain for ships. According to the firm, the shoreside test installation shows that the technology is nearing maturity for vessel operations. The test system is the final section of the EU-funded project "HySeas," which has been running since 2013 and involved participants from Scotland, Denmark, France, Germany, Sweden and England.

Scaleable fuel cell

MyFC, a Swedish fuel cell firm, has signed an agreement to develop fuel cell solutions for autonomous warehouse robots.
MyFC's unique technology for thin, modular, and scalable fuel cells – in contrast to the stacked fuel cells currently on the market – is well suited for applications with limited space and a need for formability, such as autonomous warehouse robots.



Battery storage ship

Japanes startup, PowerX, has formed a capital and business alliance agreement with Imabari Shipbuilding, Japan's largest shipbuilder, where Imabari invests 1 billion yen in PowerX. PowerX and Imabari aim to co-develop and build a Power ARK a protoype battery storage vessel that would be charged at sea from offshore wind and then carry the power back to land. PowerX will develop and manufacture the battery storage system and other battery-related systems to be installed on the prototype ship. The Power ARK will go into full-scale operation after testing with the prototype ship. Even with the smaller prototype at 220MWh capacity, the Power ARK is expected to transport enough electricity for 209,000 Japanese households in just one single trip (assuming average Japanese household electricity consumption is 10 kWh per day). With the Power ARK project, PowerX aims to efficiently distribute renewable energy to regions with high demand, ultimately leading to the greater utilization of clean energy resources. The company also intends to build its own automated gigafactory to assemble batteries in Japan from outsourced battery cells. Annual production capacity of 1GWh is being targeted by 2024, and increasing up to 5GWh by 2028.
Battery systems produced there will serve the marine, EV fast charge and grid-scale storage markets.

Hydrogen battery

LAVO™'s patented metal hydride generates electricity by converting hydrogen into power.

Australian company Lavo has created a system that integrates with solar panels to capture and store renewable energy. It stores some 40 kilowatt-hours worth of energy and uses a fuel cell to deliver the energy when needed, with a 5-kWh lithium buffer battery for instantaneous response, and 5kW is also the system's maximum continuous power output. Conventional batteries store and release energy with minimal losses of around 10%. But the process of generating hydrogen by electrolysis

using a proton exchange membrane is only about 80% efficient, and then there are losses of approximately half of what is stored in the process of converting the hydrogen back into energy through a fuel cell. Lavo say their system's "round-trip efficiency is above 50 percent," which means losing roughly half the energy captured from renewable sources.

Battery Tech

3D solid-state thin film battery

A battery claimed to offer higher energy density, a longer lifespan, and increased safety compared to conventional lithium-ion batteries has been deveoped by Dutch start-up LionVolt BV. The battery is made with a foil covered with billions of pillars with thin layers of functional material that create a 3D structure with a very large surface area and very short distances between both battery electrodes. Through this architecture, the device's lithium-ions have only a short distance to go through, and this, according to the manufacturer, reduces charging and discharging time LionVolt claims this approach enables the product to overcome two major hurdles to bring this technology to commercial production, which are the conformal coating of the full battery stack and the development of scaleable manufacturing tools.

Recycled materials for batteries

Panasonic, Tesla's main battery partner plans to use recycled materials supplied by a startup led by the electric-car maker's former tech chief to produce lithium-ion cells in a more sustainable, fashion. Redwood Materials, which already collects and recycles scrap and used battery components from Panasonic, is to begin supplying it with copper foil this year for use in making new lithium-ion cells at Tesla's Gigafactory in Sparks, Nevada,

Solid Power pouch

Solid Power, a battery developer backed by Ford and BMW, is expanding its Colorado based factory footprint as it prepares pilot production of its solid state batteries early next year. The new production facility will be dedicated to manufacturing one of the company's flagship products, a sulfide-based solid electrolyte material, by up to 25 times its current output. The new facility will also make room for the first pilot production line of its commercial-grade, 100ampere battery cells. Those pouch cells are expected to go for automotive testing in early 2022.

ELECTRIC BOATS INTERACTIVE

Cruise Guide

Icehouse to Limehouse

Cruise Guide

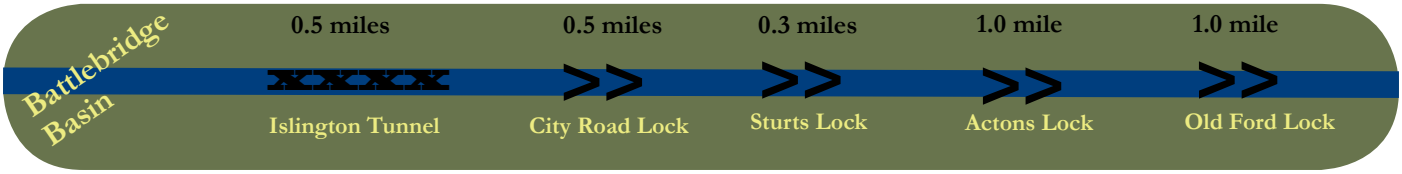
Our winter cruise is only 4.5 miles along the Regent's canal, but with a tunnel and eight locks to navigate as we drop down to the Thames it is a peaceful world of its own to enjoy away from central London's teeming congestion.

The Regent's Canal Company was formed in 1812 to cut a new canal from the Grand Junction's Paddington Arm around London to Limehouse where a Thames dock was planned. The canal was opened in 1820 adding to the UK's wider network of 4,000 miles of canal and river navigations which by the 1830's were an essential component of the world's first industrial revolution. Much early industrial archaeology has disappeared but the canals remain as part of this unique heritage and our cruise starts at the Canal Museum which is based in a former icehouse and one of the few surviving industrial buildings from the canal age. The canal carried coal, timber and agricultural products as well as ice imported from Norway.

Icehouse to Limehouse

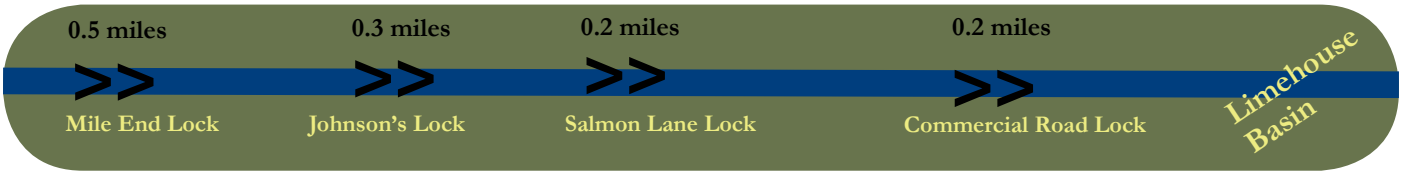
The Canal Museum based at Battlebridge Basin has two brick-lined ice wells thirty feet in diameter, and approximately 42 feet deep built around 1857. Ice packed into these wells could be stored for months, losing only about a quarter of its weight between Norway and the customer in London whose supply was delivered by horse and cart with the "iceman" chipping off a block of ice to the required size. Battlebridge Basin was originally known as Horsefall Basin after the original landowner, William Horsefall made an agreement with the canal company that when they dug out the nearby Islington Tunnel they could dump the spoil on his land to form the basin. He ensured supply of water from the canal to fill the basin by way of an Act of Parliament. By 1822 the basin was surrounded by industrial buildings. Its current name comes fromt the former name for the King's Cross area, named after an ancient bridge over the River Fleet. The basin is now home to Battlebridge Moorings part of a community of almost fifty narrow boats, with Ice Wharf Moorings and

Cruise Location



the London Canal Museum's moorings along the eastern side of the basin. Temporary moorings are available over the summer for narrowboats only. Leaving Battlebridge basin we are soon at the entrance of the tunnel that supplied the basin groundworks. Islington tunnel is 960 yards long and can only be used by powered vessels. There is no ventilation, and is only wide enough for one boat, so needs getting through as quickly as possible. The Canal and River Trust and Islington Council are trialing electric charging points for visiting boats on both approaches to the tunnel. Having cleared the tunnel the canal starts to become more peaceful as we pass Victoria Park but we are soon into the locks and have to clear City Road Lock, Sturt's Lock and Actons Lock before passing the 300 acre Victoria Park on the approach to Old Ford Lock. The park was laid out in the 1840's and the west lake is visble from the canal. The Hartford Union Canal linking to the River Lee Navigation runs along another side of the Park before joining the Regent Canal just after the Old Ford Lock. The canal was once so busy that a second lock chamber was built alongside the original locks but these have long since closed and now allowed to cascade. There are now four more locks to navigate and the canal gets quieter and quieter as we travel on to Limehouse Basin. After Mile End Lock we reach Johnson's Lock and pass examples of original canalside warehouse buildings now repurposed as the Ragged School Museum. Next is Salmon Lane Lock and the finally Commercial Road Lock takes us into Limehouse Basin.

Old Ford Lock
The lock cottage and stables are Grade II listed buildings. Thames lighters using the canal would have horses provided by the operators of the canal.



Info

Launching

Craneage and slipway facilities on the UK canals are few and far betweeen. Websites such as *www.londonboaters org* provide listings of the nearest sites to Regent's Canal

Licences

Short term licences can be obtained from the Canal and River Trust Boat Licensing Team. There is a 25% discount for electric propulsion.
T: 0303 040 4040
Mon to Fri, 8am to 6pm.
Email: customer.services@canalrivertrust.org.uk
www.canalrivertrust.org.uk/licensing

Pubs

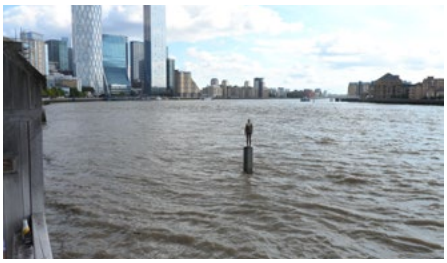
The Grapes
76 Narrow Street
Limehouse
E14 8BP
Tel: 020 7987 4396
Real ales
Riverside deck
Lunchtime and evening meals

The Craft Beer Co
576 Commercial Road
Limehouse
E14 7JD
Tel: 020 7790 2726
Real ales
Roof Terrace
Lunchtime (Sat and Sun) and evening meals (not Mon)
Wifi

TheQueens Head
8 Flamborough Street
Limehouse
E14 7LS
Tel: 020 7265 8979
Real ales
Beer garden
Wifi

Tourist Information

www.visitlondon.com



Limehouse Basin

Limehouse Basin opened in 1820 as the Regent's Canal Dock connecting the Thames with the canal system. Cargoes could be transferred from larger ships to shallow draught canal boats. Limehouse Basin is now a marina and dockside housing development but this mix of vessels can still be seen in the Basin, narrowboats rubbing shoulders with seagoing yachts
The name derives from Old English "lime-oast" and relates to lime kilns located by the river. The earliest reference is to Les Lymhostes in 1356. In the earliest times Limehouse, had better links with the river than the land, the land route being across a marsh. Limehouse became a significant port in late medieval times, with extensive docks and wharves. Although most cargoes were discharged in the Pool of London industries such as shipbuilding, ship chandlering and ropemaking were established in Limehouse.
The Basin marina has overnight moorings, long term moorings, pump out, showers, toilet and laundry facilities, as well as providing BW licences, windlasses and lock keys.

The Grapes

A superb riverside pub with a balcony that overlooks the river. Originally named The Bunch of Grapes, it has stood on the Limehouse Reach, for nearly 500 years. Limehouse was first settled as one of the few healthy areas of dry land among the riverside marshes. By Queen Elizabeth I's time, it was at the centre of world trade and her explorer Sir Humphrey Gilbert lived there. From directly below The Grapes, Sir Walter Raleigh set sail on his third voyage to the New World. In 1661, Samuel Pepys' diary records his trip to lime kilns at the jetty just along from The Grapes.

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EBi International

Electric Edorado

Netherlands

Edorado Marine, a new Netherlands start up company has now announced development of its latest model, the 8S. The company intends the boat to be the first in a fleet of designs that aim to make electric boats a faster, more reliable and more cost-effective option for consumers – echoing similar efforts around the development of electric cars and aeroplanes.

"Current fast electric boats are too expensive and inadequate," says Edorado Marine. "We at Edorado are certain that only foil-electric boats will achieve the goal of affordable fast electric boats with good range. Range and power have been the biggest challenges for electric speedboat designers. But Edorado Marine believes its "electro-foil" combination will help it overcome these issues. It has created its own unique hydrofoil arrangement as part of its design, with a blade that wraps around the side of the hull towards the prow. This also gives the boat a wider profile, making it more stable. At slower speeds, it will move along with its carbon fiber hull sitting in the water, just like a regular power boat. Upon reaching open water and speeding up, however, its retractable hydrofoil system will be deployed, lifting the hull up and out of the water The 8S should then be able to reach a top speed of 38 knots (43 mph or 70 km/h), with an Automatic Control System adjusting the foil angles 100 times per second in order to deliver optimum performance and safety. An onboard 80-kWh battery pack will power two 50-kW electric propeller drives, in both planing-hull and hydrofoil modes.

At its cruising speed of 25 knots (29 mph or 46 km/h), it should have a battery range of 40 nautical miles (46 mi/74 km) per charge. And once it needs to be trailered or docked, its foils will simply be retracted back into the hull. Some of the 8S' other features include a pilot interface incorporating three 15-inch touchscreens; integrated mood lighting; a Bluetooth sound system; a built-in picnic set with a wine cooler; and a rear "leisure pad" for lounging and sunbathing. The pilot will additionally be able to check stats such as the charge level via an app. Prospective buyers can preorder an 8S via the Edorado website and the boat is priced at €350,000 (around US$413,404)

Specification

Top Speed	38 knots
Range at 25 knots	40 nm
Battery electric drivetrain	
Carbon fiber hull	
Fully retractable hydrofoil system	
IP67 electric safety standard	
Twin propeller drive	
Dual redundancy drivetrain	
Patented Collision Impact Safety System (CISS)	
CE-C certification	
User Interface 3 x 15-inch touch screen	
Wifi software update	
LOA	8.40m (27.5 ft)
Beam	2.50m (8.2 ft)
Draft foils retracted	45cm (1.2 ft)
Draft foils deployed	135cm (4.4 ft)
Displacement	1950 kg (4300 lbs)
Motors	2 x 50 kW
Battery	80 kWh

Torqeedo Giga Factory

Germany

Torqeedo became an independent subsidiary of Deutz AG in 2017 and last year delivered its 100,000th electric boat motor. The company is now preparing to move into a purpose built facility on the Munich Air Tech Campus (ATC) where it has been based since 2012. The new headquarters project consists of 3720 square metres of office space, and 4800 square metres of warehouse, production, and research

and development area. Construction is expected to be completed in the 1st quarter of 2022. The new facilities will allow direct contact and exchange between various departments and on the production side the consolidation of the three current manufacturing locations into one will increase manufacturing capacity. The Air Tech Campus is home to a number of forward-thinking companies and organisations and there are many possibilities for cooperation on topics like lithium-ion battery technology, electric motor development and advanced composite manufacturing. The groundbreaking ceremony for the new Torqeedo headquarters was attended by Bavaria's State Minister for Housing, Construction and Transport, Ms. Kerstin Schreyer, who said 'I'm very pleased that the world market leader in electric motors for boats is investing in their new headquarters and production facilities in Oberpfaffenhofen. Innovative and eco-friendly technologies are crucial to achieving our ambitious climate targets in Europe. The ATC offers a great ecosystem for technology leaders like Torqeedo.'

click on the red dots

EBi International


Germany

Electric Fire Fighting

Damen, an international shipyard group with 35 shipyards across 5 continents, has supplied twin Fire-Fighting vessels to Flotte Hamburg, a subsidiary of the Hamburg Port Authority (HPA). With 315 kWh of battery capacity, the state-of-the-art, plug-in hybrid vessels are capable of extended, fully-electric, emissions-free operations in and around the Port of Hamburg. One ship will be operated by Hamburg's fire service while the other will support the HPA, the fire service and other third parties. The vessels, classed as Damen Fire-Fighting Vessels 3508, are completely new designs fitted out to the latest standards. 35.5 metres in length and with a maximum speed of 12 knots, they are equipped to not just fight fires in the port and within the city itself. Their compact size also enables them to undertake other activities including water supply, rescue and recovery, technical assistance and environmental protection. And with their ability to lower their wheelhouses and a draught of just 1.5 metres they can also undertake bridge inspections and maintenance within the city, as well as serve locations that larger vessels would be unable to reach.

Norway

Hydrogen ship of the year

The Norwegian maritime magazine Skipsrevyen has awarded MF *Hydra*, the world's first hydrogen powered ferry, Ship of the Year 2021. The prize is awarded annually to a Norwegian-built ship at a Norwegian shipyard. *Hydra* was built for Norled at Westcon Yard and designed by LMG Marin.
This recognition means a lot to Norled,' said CEO, Heidi Wolden. '*Hydra* marks the start of the hydrogen adventure. It is a milestone for the industry and for Norled. In 2014 we were honored to win Ship of the Year for MF *Ampere*. It was also the start of an electric revolution in the ferry industry. Six years later we have won the award with a hydrogen vessel, MF *Hydra*.'

World's first liquified hydrogen carrier

Japan

The classification society ClassNK has added the world's first liquefied hydrogen carrier built by Japanese corporation Kawasaki Heavy Industries (KHI) to its register. *Suiso Frontier* is the world's first liquefied hydrogen carrier built by KHI, a member of the CO2-free Hydrogen Energy Supply-chain Technology Research Association (HySTRA). HySTRA was formed by KHI, Iwatani Corporation, Shell Japan Limited, and ElectricPower Development in 2016, with the aim of promoting hydrogen as a fuel source. The ship started trading in 2021 and

is expected to be the first of many more hydrogen carriers Kawasaki wants to build in the future. The use of hydrogen is expected to expand worldwide, and efforts are being made to build a supply chain. Hydrogen is liquefied at an extremely low temperature of -253 degrees Celsius and has hazards such as flammability, permeability, and more. ClassNK added the world's first liquefied hydrogen carrier to its register to contribute to the safe seaborne transportation of hydrogen. ClassNK published the "Guidelines for Liquefied Hydrogen Carriers" in 2017 describing the safety requirements based on the IMO's Interim Recommendations for Carriage of Liquefied Hydrogen in Bulk. ClassNK completed the prescribed surveys on *Suiso Frontier* and added the vessel to its register in December 2021. ClassNK said it will continuously support the safe operation of the vessel through surveys in service, and utilize the knowledge and experience gained to keep its guidelines up to date.

Solar Boats and Boating

New name for world's largest solar boat

After Turanor Planet Solar's record breaking solar powered voyage around the world, the boat became a laboratory for the Swiss foundation Race for Water in 2017 and went on a four year mission to investigate plastic pollution in the world's oceans. Marco Simeoni the CEO of the Race for Water Foundation has now announced that the Swiss association Porrima, under the leadership of Professor Gunter Pauli, has become the new owner of the boat which will be renamed *Porrima,* the Roman goddess of the future and protector of pregnant women.

The Race for Water Foundation is continuing its fight against the pollution of the oceans by plastics and at the same time it will contribute to the development of the Porrima project, which looks to accelerate the implementation of renewable energies such as solar, powerkite technologies and hydrogen mobility already initiated by Race for Water, while adding biomimetics to clean the oceans' nanoparticles and many other new technologies to its portfolio. Marco Simeoni said, 'During these past four years, this incredible vessel has allowed us to be ashore on the ground, and to travel the seas, and to take concrete action against plastic pollution of the oceans. This Odyssey is an essential mission at the focus of our concerns. Today, I am honoured to hand over this unique vessel to Porrima and its partners so that this fabulous time machine can continue its journey to raise awareness, demonstrate and inspire'.

Solar to Alaska

Wayward Sun, a 27-ft wooden hull solar boat propelled by a Torqeedo Cruise 4.0 electric poddrive with six Torqeedo Power 24-3500 lithium batteries, has sailed from Washinton to Alaska using only solar power. There is a separate 12-volt system for lights, electronics and other DC-powered systems and an inverter for occasional AC loads. The batteries are charged from a 1700-Watt array of solar cells on the boat's rooftop. The boat averaged 32 nautical miles per day at an average speed of 3.7 knots. and there were only two full days when it didn't travel at all due to high winds or dense fog. Even on a completely overcast day the boat could make 2-3 knots during daylight hours without drawing on the batteries. With direct sunlight the boat could make 5 knots or more all day without any battery use, but most of the trip was overcast and it rained a lot, so some days it travelled slowly because it had to and on other days it travelled slowly to charge the batteries while under way.

click on the red dots

Solar Boats and Boating

Future energy solutions

At the end of 2021 Groupe BPCE, a cooperative bank with 9 million cooperative shareholders and currently the second-largest banking group in France, became main partner of *Energy Observer*. As Groupe BPCE has made the fight against climate change a core feature of its strategic plan for 2024, the partnership with Energy Observer is perfectly consistent with its ambition to be a major player in driving the energy transition. In 2021 *Energy Observer* attended a host of events in the South of France: the UICN's World Conservation Congress in Marseille, the Cannes Yachting Festival, the French leg of the Sail Grand Prix in Saint-Tropez, an international sailing championship targeting a climate-positive impact and finally Les Assises del'Économie de la Mer (Forum of the Economy of the Sea). While *Energy Observer* is the name of the first hydrogen-powered vessel to circumnavigate the world entirely self-sufficiently and with zero emissions, it is also an organisation which groups together both expeditions and innovations, and its primary mission is to explore and develop future energy solutions both at sea and on land.

Solar powered into a storm

Saildrone makes autonomous ocean vessels to study the environment. This summer, the Silicon Valley startup sent five of its vessels directly into the path of hurricanes in the Atlantic. Saildrone's vessels are 23-feet long and have four cameras on them and measure wind, the temperature of the ocean and the air.

Solar powered into weeds

The Waterbug is a remote controlled aquatic lake weed harvester featuring a camera that shows what the Waterbug sees on the remote screen. It is designed for managing aquatic vegetation and floating debris in lakes, ponds, and water bodies of all sizes. It fits on a compact trailer and it floats in as little as 4" of water. Its lithium batteries can be solar charged and give around four hours operating time.

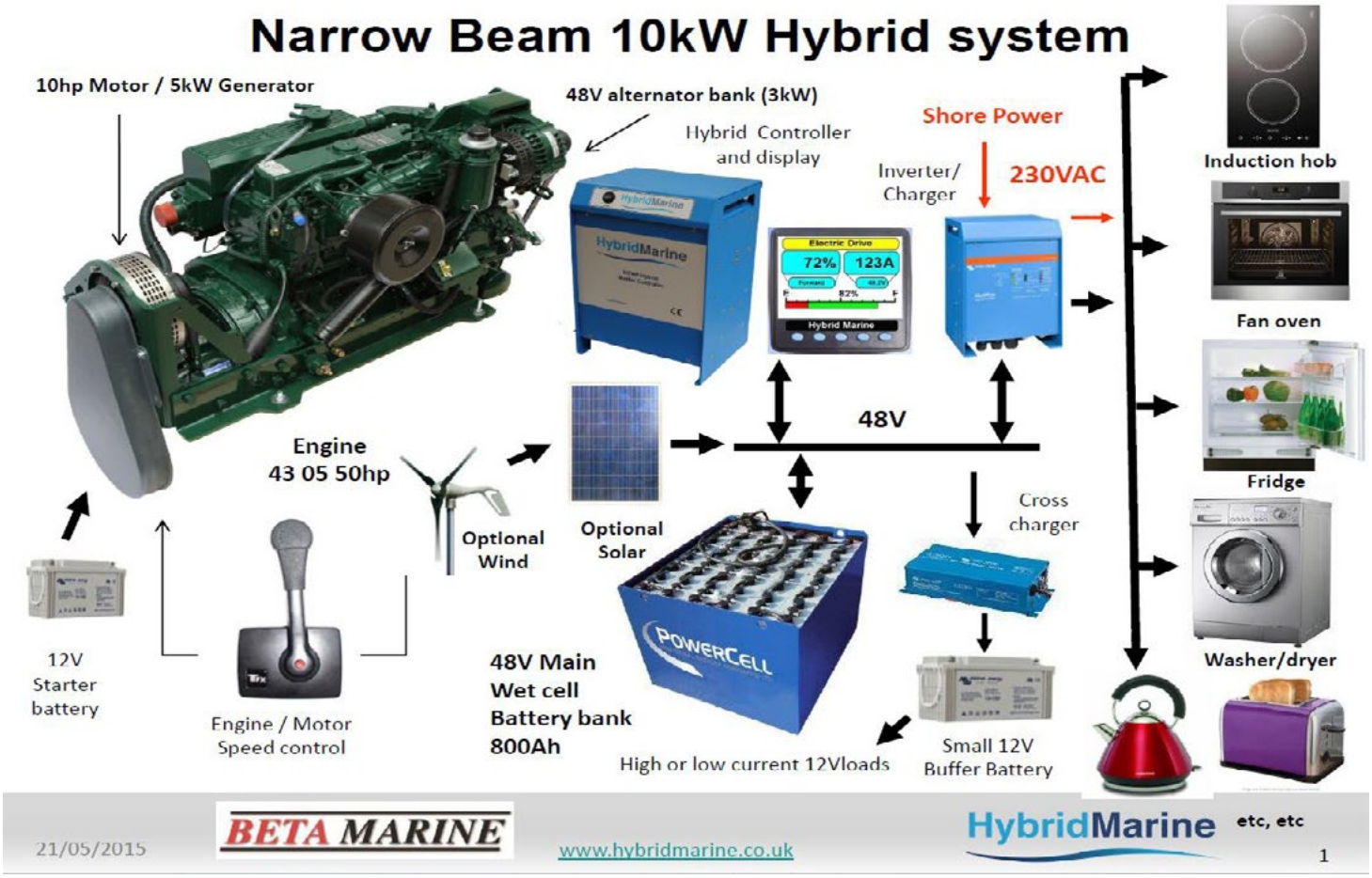
Solar Tech

Thin solar cells

Perovskites are compounds that have cube like crystal lattices and are highly efficient light harvesters. Their potential has been known for years, but they present a problem.
While they are good at converting sunlight into energy, they are degraded by sunlight and moisture.
US researchers have now achieved a new benchmark in the design of atomically thin solar cells made of semiconducting perovskites, boosting their efficiency while retaining their ability to stand up to the environment.
They discovered that sunlight itself contracts the space between atomic layers in 2D perovskites enough to improve the material's photovoltaic efficiency by up to 18%.
An astounding leap in afield where progress is often measured in fractions of a percent.

Ultra efficent low cost solar cells

Norwegian resarchers have developed a method for making an ultra-high material efficient solar cell using semiconductor nanowires. If this is placed on top of a traditional silicon-based solar cell, it could potentially double the efficiency of today's silicon solar cells at low cost.
Gallium arsenide (GaAs) is the best material for making high efficiency solar cells because of its extraordinary light absorption and electrical characteristics.
It is commonly used to make solar panels mainly for use in space.
However, high-quality GaAs solar cell components are quite expensive to make, which has driven a demand for techniques that can cut the use of the material. The Norwegian researchers have found a new way to make an ultra high power-per-weight ratio solar cell that is more than 10 times more efficient than any other solar cell, by using GaAs in a nanowire structure, making solar cells much more efficient while only using a tiny fraction of the material that is normally used.



Electric narrowboating

Malcolm and Barbara Bridge were already experienced narrowboaters when they took delivery of their all electric boat at the Crick Boat Show in 2015 where Ampere was voted one of the show's favourite boats on display. Since then Ampere has travelled extensively and in the fourth of a series on electric narrowboating Malcolm gives his personal assessment of the relevant technologies.

Free Power

As previously I should emphasise that these are my personal views on the present state of the technologies relevant to the design of an electric narrowboat, based on my involvement in the design and construction of all-electric narrowboat Ampère over the period 2011-15 and its subsequent use, now totalling about 3,500 miles of cruising.

Solar panels are an obvious source of 'free' power, though their cost effectiveness is questionable. Our experience suggests that with semi-flexible panels you can expect to get about 0.5 kWh/day per 100W of installed panels on the best few days in summer with a total of 50-60 kWh over a year, significantly less than the theoretical prediction of about 90. At 25 p/kWh (assumed marginal cost of power from a generator) this works out at only £12-15 worth of power per 100W panel per annum, giving an 7-8-year payback for the cheapest, £100 flexible panels and a 20-25 year one for 'superior' ones at £300. The economics of rigid panels are much better as they are much cheaper and slightly more efficient than flexible ones and appear to have longer lives. Taken together, these suggest that the cost of power from such panels will be comparable with domestic rates (before the large increase expected in Spring, 2022). As it is unlikely that any panels will work for long enough to repay their capital cost, we decided not to replace our original panels when they failed.

There is clearly a place for solar panels to support systems with lower power requirements such as security devices or starter batteries – or even leisure batteries on boats whose only other means of charging is the alternator on a propulsion engine, the marginal cost of charging with which while moored could easily exceed £2 per kWh. For all these a bank of solar panels may be the best option available. However, for bulk charging an installation with large system losses on an all-electric boat (typically about 2 kWh per day on Ampère) they are simply not worthwhile.

Some boats carry wind turbines but it is generally considered that these are not cost effective. A rough calculation for a typical 1.5 metre unit, the largest I believe could reasonably be carried on a narrowboat, suggests a pay-back time of 10-20 years, though I concede that this involves considerable guesswork as wind power is even less predictable than solar because it is so location dependent.

Not strictly 'free' but likely to offer a much better rate of return than either of the above is to fit a water source heat pump. Essentially a fridge working backwards, these take heat from the canal and discharge it into the boat either as warm air or warm water for use in an underfloor heating system. As one will provide 3 to 4 kW of heat for each 1 kW of power used in running its compressor this is a very efficient use of power. A quick Internet search suggests that a standard, warm air unit would be easy to fit, if rather bulky, and that hot water units (heat pumps mounted directly onto hot water tanks) are also available but might need modification (an extra coil in the tank) to make them compatible with heat recovery from the generator engine. Nevertheless, costs looks to have the potential to be comparable with those of a conventional c/h system. A small, electric heater should then be all that is needed to top up during periods of particularly cold weather. I understand that there was a broad-beam fitted with a water-source heat pump at the 2019 Crick show but didn't get to see it.

I will be looking at "Domestic Use" in the next **Electric Boats** *interactive*

Electric narrowboats on test

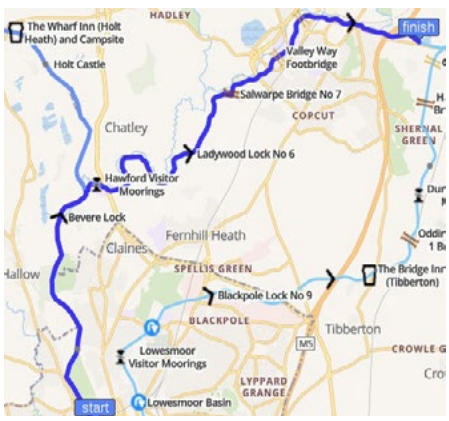
Paul Sumpner Nb *Old Nick* reports on the Ortomarine electric narrowboat trial on the River Severn

SATURDAY 29th MAY 2021

The river Severn Visitor Moorings at Worcester just north of Worcester Bridge (A44)

Eight Ortomarine-built narrow boats of varying shapes, specs and sizes, began to gather at 08.00 in time for the breakfast briefing. For many of the owners, this was the first time they had met each other and they had all come together to help Ortomarine carry out the first ever series of electric narrow boat performance trials. The main goal of the day, was to record how each of the boats would perform during a typical day of cruising on a river and canal. Each boat would follow the same route, in as close to identical conditions as possible, with owners encouraged to cruise at their normal pace and style. This unique event was the first of its kind, to our knowledge, and was the brainchild of Ortomarine owners, CarolineBadger and Rob Howdle. The propulsion trials would attempt to record real life data on power consumption, electric engine performance, propeller thrust, generator usage/efficiency, solar yield and sound levels. In addition, two of the diesel boats would compare traditional red diesel performance against the latest Hydrotreated Vegetable Oil (HVO) fuel. There were 3 diesel boats. The first *Here We Go Again* (58.5 ft, Beta Marine 43) was the benchmark boat. Another diesel engined boat *Oyster Moon* (58.5 ft, Beta Marine 43 HP Greenline) was helmed by Ortomarine's Paul Weaver, running with HVO in the fuel tank and the third, *Mokoro* (60.5 ft, Beta Marine 43 keel-cooled) was required to cruise as conservatively as possible – switching off the engine in locks and so forth. Next were the "parallel" hybrid boats. These boats have both a diesel and an electric engine, either of which can propel the boat. The first of these was *Stannator* (58.5 ft, Beta Marine 50, Hybrid Marine 10kW WC/EM and the other was *Mordiford Dragon* (60 Beta Marine 50, Hybrid Marine 10kW WC/EM). And finally the "serial" hybrids *Hunky Dory* (61 ft) with its Bellmarine 10kW WC/EM engine, *Perseverance* with its Tema 12kW AC/EM engine (the most recently launched boat in the flotilla -just two weeks before the event). And last, but by no means least, *Old Nick* with its brand new Vetus E-Line 10kW WC/EM.

It was a dramatic sight as the eight boats cast off and motored up river in formation and despite the grey and drizzly conditions, everyone was in good spirits as they made their way up river to the first lock (Bevere). It soon became clear that the electric engined craft were happy to set a slower pace



Narrowboat test: Key Results

• All the boats in the trial completed the day's cruise without incident. All the electric boats were able to travel upstream on the Severn using electric power only, when conditions were "Amber".

• Two boats, *Oyster Moon* and *Perseverance*, used HVO fuel, with no impact on their operation. Within the accuracy of the trial measurements, the diesel and HVO trial boats burned the same volume of fuel. The experienced helmsman driving *Oyster Moon* on HVO was very impressed with the clean burn of the fuel, the performance and the lack of diesel fumes in locks.

• Hybrid boats using electricity from solar panels and battery storage needed 9.7kWh to complete the cruise.

• A 12-panel solar array generated 2.9 kWh during the trial, even though the conditions were overcast for most of the day. Boats with smaller arrays generated proportionally smaller amounts of energy, so the energy gathered from solar panels was, at best, one third of that required for the cruise.

• Non-hybrid boats operated at an efficiency of less than 10%, well below the maximum efficiency of a diesel engine (typically 25-30%).

• Hybrid systems using diesel generation to complement solar generation have an efficiency between that of non-hybrid boats and pure electric power.

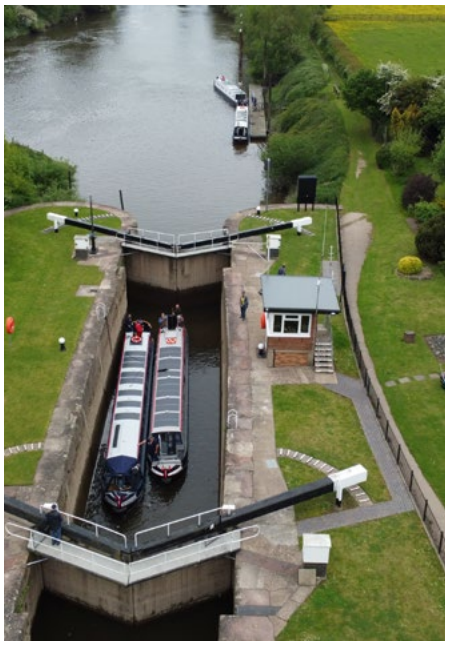
in the interest of efficiency, while a couple of the diesels set a fast pace at the front of the pack. Only two boats at a time could go through the river lock and also the double locks on the Droitwich Barge Canal, so the boats naturally paired up and stayed together for the first half of the day. The Droitwich canal was only re-opened in 2011 and consists of two canals; the wide Barge canal and the narrower Junction canal that meet in the very attractive Vines Park in Droitwich Spa. The electric narrow boat owners had been asked to carry out a series of speed tests whilst on the Barge canal; measuring motor current and voltage at various speeds and then towards the end of the day, as they exited the last "staircase" lock, they performed an acceleration test, immediately followed by an "Emergency Stop" test.

On arrival at Droitwich Spa Marina a sound engineer from Warwick University was on hand to measure the engine volume and generator volume experienced by the helmsman for each of the boats and the following morning a "bollard pulling" test was carried out to measure the amount of thrust the engine/propeller combination could generate. Accurate measurements were taken of the State of Charge (SOC) of each boat's battery bank, at the start and end of the day, plus the amount of diesel used by the electric boats that ran their generators during the event. Throughout the day itself, detailed electrical measurements were constantly recorded and uploaded to the cloud by the Victron systems on board each boat.

All of this data, along with the test results, has now been analysed and published by Ortomarine, so that other boat owners, boat builders and the industry in general can see how the latest electric propulsion systems perform and show case that electric narrow boats are a realistic and desirable alternative to traditional diesel vessels.

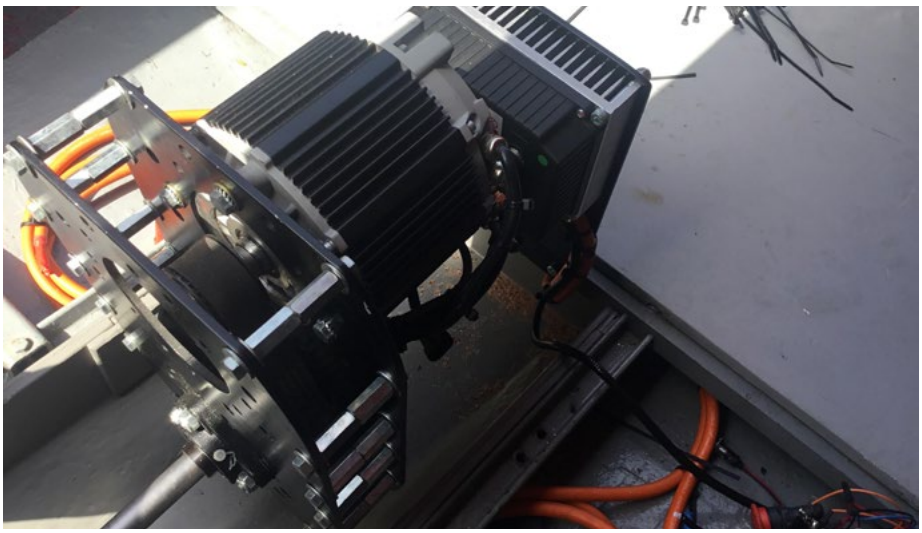
It was a great day and the boats were helped on their way through all the locks by a succession of Ortomarine customers old and new.

That evening at Droitwich Spa Marina, a suitably socially distanced get together to collect the test results, share the day's stories, and for everyone to get to know each other, was a very pleasant and fun end to a great event.



Swapping diesel for electric

Peter Hooper is a marine engineer, who after working for the Royal National Lifeboat Association sailed his 22 ft Colin Archer to Spain some 20 years ago. Now based at a marina in Mallorca Pete spends his time getting other owners' boats ready for use when they arrive for another season's sailing. He is also working to finish his diploma in Marine Surveying.



He has finally found the time to swap out the old diesel engine in his boat for an electric motor. After some research he chose a 4kw drive from Evea Carting in France, an online company which supply electric conversion kits of varying sizes.

He is very pleased with the result and says that the unit is neat, and at 48v performs very well with surprisingly little draw, while giving him the speeds and control he wants.

The pleasure craft electrification pack (P06 48V 6kW)

Contents

Qty	*Description*	*Included*
1	Motor Motenergy ME1115 PMSM Brushless 6kW	Power cable 35mm² - long.1m
1	Controller ZAPI BLE-2 48V 500A	Standard program
1	Security system	Power contactor
	Fuse 320A	
	Fork circuit breaker	
1	Power cables pack	Power cable 35mm² - length.5m
14	eyelet pods	
11	orange terminal covers	
1	Transmission pack Reduction ratio 1:2	
	Belt transmission - ep.30mm	
1	Engine support pack Stainless steel	
	No-dust pallet	
	Fixing rod	
1	User interface pack Voltage display	
	On/Off button	
	Accelerator potentiometer	
1	Drive assembly and parameterization package	Control harness - length.2m
	Standard program	
1	Power cabling assembly package	Power harness/td

Technical description

The performances are given for a nominal voltage of 48Vdc.
The nominal performances are given for a controller in Standard program.
The maximum performances announced require reprogramming/changing the controller,

Motor characteristics

Description	*Minimum*	*Nominal*	*Maximum*	*Unit*
Voltage		36	48 60	Vdc
Current	-	150	420	Amps
Power	-	6	16	kW
Torque	-	22	60	Nm
RPM	-	2000	4000	RPM
Temperature		-20	+30 +50	°C

Transmission characteristics

Description	*Minimum*	*Nominal*	*Maximum*	*Unit*
Torque	-	50	140	Nm
RPM	-	1000	2000	RPM
Weight	-	30	-	kg

The pleasure craft electrification pack (P06 48V 6kW)

Typical use:

The pleasure craft electrification pack (P06 48V 6kW) is intended to be used when converting pleasure craft categories C - D and sailboats up to 10 meters to electric.
The motor / transmission support is mounted directly on the propeller shaft.
It is strongly recommended to add a force bearing at the end of the shaft fixed to a partition.
The engine / transmission unit must be mounted close to the force bearing in order to avoid excessive stress on the stuffing box.
The motor / transmission block is available for propeller shafts with diameters:
20mm, 22mm, 22.22mm (7/8 "), 25mm, 25.4mm (1"), 30mm, 35mm.

evea
Équipement Véhicules Électriques de l'Anjou

Boat electrification pack

P06 48V 6kW - inboard
Model 719-051
The pleasure craft electrification pack (P06 48V 6kW) is intended to be used when converting pleasure craft categories C - D and sailboats up to 10 meters to electric.

Description	
Voltage	48Vdc
Power	6kW
RPM 1	000RPM
Cooler	AIR

Jeff Butler Editor of Plugboats has kindly allowed EBi to reproduce the Gussie awards copy and pictures.

The Gustave Trouvé Awards were started in 2020 as an initiative by electric boat website Plugboats to recognize the inventors, designers, manufacturers, entrepreneurs and visionaries who are making advances every day to develop clean, quiet, zero emission technologies and designs to reduce reliance on fossil fuel for marine propulsion. It is the only international boating award that focuses exclusively on electricboats and boating. The awards are named to honour one of the first visionaries of electric boating, French inventor Gustave Trouvé, who in 1881, created the world's first electric outboard boat motor - the world's first outboard boat motor of any technology.

Electric Boats Up To 8 metres/26 ft In Production

e-Commuter, Cantiere (Boatyard) Ernesto Riva, Italy

The Cantiere Ernesto Riva was established in 1771 and this year celebrated the anniversary of two and a half centuries of wooden boat building in Italy's lake district.

Electric Boats Up To 8 metres/26 ft In Development

Freepower Solar Boat, Bjurtech, Norway

The Freepower is the creation of Martin Bjurmalm, who named it after his goal of an autonomous boat with the freedom to go whenever and wherever without fuel stops.

Electric Boats Over 8m/26 ft In Production

Silent 60, Silent Yachts, Austria

The Silent 60 is the most popular model, and not just with Gussies voters. The company added a second production line in early 2021 to meet demand and now has the capacity to build 15 Silent 60s a year

Electric Boats Over 8 metres/26 ft In Development

Aquon One, Swiss Sustainable Yachts, Switzerland

The Aquon One is the first Gustave Trouvé winner to incorporate hydrogen into its energy storage and propulsion system, producung hydrogen from desalinated sea water

Electric Boats Designed for Paying Passengers In Operation

The Maid of the Mist, USA

Maid of the Mist ferries can carry up to 600 people right up to, and then pull away from, Niagara Falls and the suction power created by 600,000 gallons (2.25M litres) of water falling each second.

Electric Boats Designed for Paying Passengers In Development

Zero Emission Double Ended Ferry, Lamarca Engenharia, Brazil

A 38m / 125ft double ended ferry with electric motors and thrusters designed to carry commuters and to use floating docking stations roofed with solar panels

Customized / DIY Electric Boats

IRON, ecomarine, Bangladesh

The first project by Ecomarine of Dhaka, Bangladesh, IRON is a 20.5m / 67 ft wood fibre composite solar catamaran custom built with 6 passengers cabins and used for tourism

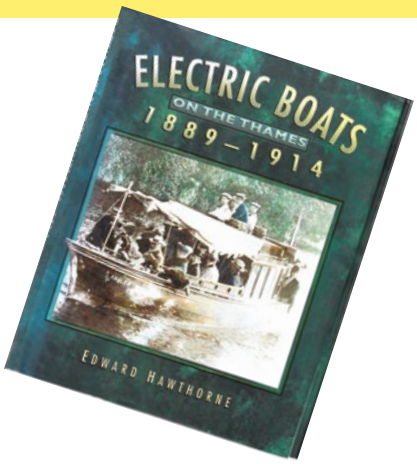
Electric Sailboats

Sunreef 60E, Sunreef Yachts, Poland

Electric propulsion became a big part of Sunreef's portfolio with the unveiling of its Eco models and the Sunreef 60 E during the 2019 Cannes Yachting Festival.

The Gussies were decided through online voting augmented with weighted ballots from a panel of representatives from national electric boat associations and other related organizations. The 2021 Gussies has been a great success, and the International Panel is already discussing ways to make it even bigger and better for 2022, which will be the 120th anniversary of the death of Gustave Trouvé, inventor of the world's first outboard boat motor.

Edward Hawthorne was a mechanical engineer by training and a past chairman of the Electric Boat Association User's Group. His superb and fascinating book is no longer in print and his family have kindly permitted EBi to serialise extracts

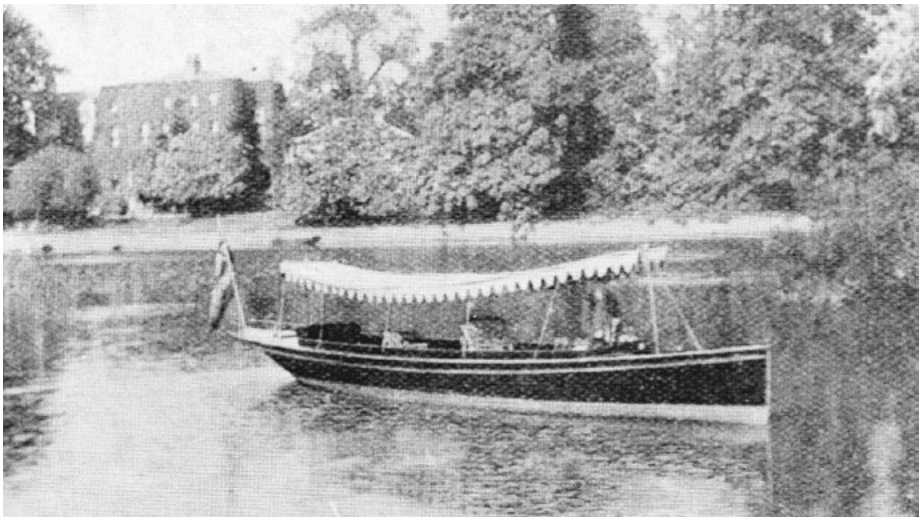


Immisch Electric Launch Company

Moritz Immisch's General Electric Power & Traction Co went into voluntary liquidation in November 1893. However, the launch business was considered to be viable and the Immisch Electric Launch Co was set up in May 1894 to take over the launch department of the liquidated holding company. Soon after its formation the launch business had opened a depot at Riverside, just below Boulter's Lock at Maidenhead, and by 1898 had depots at Platt's Eyot, Bray, Maidenhead, and at Henley during the regatta week. It had land based charging stations at these depots and charging arrangements at other boatyards up the river. From its first years the company also had three steam floating charging stations. In 1904 the company was reformed as the Immisch Launch and Boat Co Ltd and at this time had a fleet of 26 electric launches on the Thames. By this time small motor boats with petrol engines had started to appear and the reformed company stated that it intended to develop the petrol launch branch of the business and that it had become the sole agent in the Thames district for the Scout motor. The 1904 new brochure for the company lists 23 electric launches, the ten passenger steam launch *Viola* and three petrol launches, seating eight, six and four passengers respectively. The brochure also contained a short guide to the chief places of interest between Oxford and Richmond, including detailed maps, and a list of recommended riverside hotels. The brochure noted that the "Company is now building Standard Electric and Petrol Launches of the very latest design ...with regard to Electric Launches the company have a large fleet any of which they are prepared to dispose of on reasonable terms". In 1905 the company announced that, "owing to the nature of the electric launch business having considerable changed during the past few years, due largely to the competition of motor cars and lately of motor boats, the future policy of the company will be to change the existing electric into a petrol launch selling and electric business. Although the petrol launch is not yet as noiseless as the electric it has many advantages with it in the matter of speed and economy in working." The company took a stand at the Olympia Motor Show in November 1905 where it exhibited petreol marine motors of 3, 6 and 12 hp. The demand for new electric launches was falling rapidly, but the existing fleet was kept going as long as possible. During Ascot week in 1934 the Immisch Maidenhead depot hired out the old electric launches *Delta, Eta, Lambda, Zeta and Rolalind*. The construction of petrol commercial craft became a flourishing side of the business until its sale to Thorneycroft in 1914. Thorneycroft took over the Platt's Eyot yard, changed the company's name to Hampton Launch Co and turned the business over to the construction of petrol engined boats for the war effort. In addition the company's fleet and letting business at Maidenhead was aquired by Mr George Bond

What happened to the remaing electric launches is not clear, but they were probably stored or used for war service with their electrics stripped out and replaced by petrol engines. Only the *Viscountess Bury* and *Lady Lena* are known to have survived

Moritz Immisch did not live to see the collapse of the electric boat building business, although he would have been aware that it was imminent. He died suddenly on 20 September 1903 aged sixty six. He was a trailblazer who overcame many obstacles and set a pattern of design and operation which, over the twenty six years that the business lasted, was followed by most other builders and hirers.



Immisch *Delta* from Immisch 1904 Brochure
One of the first five electric hire launches operated by the Immisch Launch Co - buit in 1889 - LOA 33' Beam 6' - motor average 23 amps at 78 volts producing 1.8kW - battery 44 cells weighing 2,520 lbs

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