



Inland Waterways International
campaigning for inland waterways worldwide since 1995

Alternative Fuels Committee Zero-emission passenger fleets CASE HISTORIES AND PROJECTS



The following case histories intend to demonstrate the progress made in transitioning fleets of fossil-fuel ships in various inland waterways venues around the world towards zero emission alternative fuels. They begin with concrete histories and are followed by promising projects.

The Netherlands: Amsterdam



In 1993, an initial fleet of electric dayboats in Giethoorn attracted a visit from a fact-finding delegation of councillors from Amsterdam to see how electric boating could be used on their city's canals. By 1998, Anton Brands of the Rondvaart Delft cruising company had one of his Amsterdam luxury tourist saloon launches equipped with diesel-electric propulsion, the first of an e-fleet.

Before long tourists were asking explicitly for this silent electric boat for their city tour. During the next ten years, Amsterdam's electric fleet grew. In 2011, a photo of a fossil fuel tour boat belching out fumes used by the SVUVA (Foundation for pollution free boating Amsterdam), via the Media to persuade that city's authorities to force the 5 tourist boat-operating companies to convert their diesel fleet to electric.

By the Fall of 2013 a Zero emission status declared requiring all private and smaller sighting boats to go electric by 2020, and the larger 20 meter (65ft.) ones to be emission free by 2025 at the latest.

In June 2015, more than 150 exhibitors were on display at the Electric & Hybrid Marine World Expo 23-25 June 2015 at Amsterdam RAI. Each showcased the very latest ideas, concepts, technologies and components for electric and hybrid marine applications.

This resulted in the City of Amsterdam deciding to ban 2-stroke engines on private boats from 2017 and for commercial vessels operating in the city (530 canal boats yearly transporting some 3 million passengers for sightseeing) achieve "zero emission" target on its 60 miles of canals by 2020. The City License will not be renewed unless the boat is electric. This included retrofitting historic vessels. To help push along the move to electricity among

smaller boat owners, the city is also working with contractors to install 100 boat charging stations by the end of 2021.

Concerning the regulations and cost for Amsterdam (pleasure craft) for mooring in the canals, a 'Groen Vignet' (green license) is about 0.3 times the cost of a red license. Green is for pleasure craft with an electric motor, or no motor. Red is for petrol or diesel engines. They calculate length x width to get to m².

The average cost is about 60 euro per m² per year for a red license so for a launch of 7 x 2.5 m = 17.5 m², the license fee is 1050 euro per year, while electric boats of the same size pay only 315 euro per year, or in other words a 67% discount.

In September 2020, Corvus Energy announced that it had been selected by Holland Ship Electric to supply lithium-ion battery-based energy storage systems (ESS) for five new all-electric ferries being built by the shipyard group for Amsterdam's municipal public transport provider, GVB. The first, 41 m LOA by 13.9 meters Beam and able to carry 20 cars, four trucks and 400 passengers, will enter service by 2021. It will feature a superstructure and aluminium railings instead of steel to reduce maintenance.

This and its sisters will operate on three of the North Sea Canal routes, replacing the current fleet built in the 1930s. The routes in the North Sea Canal are among the busiest routes, transporting more than 350,000 cars each year. The replacement of the ferries is in line with the sustainability goals set by GVB and the Municipality of Amsterdam to provide zero-emission public transportation in the Municipality of Amsterdam and surroundings.

The aim of GVB's extensive new building and retrofit program is that the entire fleet will be hybrid or fully electric by 2025.

Amsterdam is not alone. In Loosdrechtse, south Holland Wetterwille BV have 2 rental 'sloepen' whose hirers enjoy a list of charging points at the Loosdrechtse Plassen and along the river Vecht just in case they need to recharge.

Norway



As atonement for the oil industry that made Norway into a very rich country, since 2014 this Scandinavian nation has been aiming for a fossil-free transport system. Based on operational data, Siemens concluded in a life cycle analysis that 61 of Norway's 112 diesel ferry routes could be replaced by electric ferries with a payback time of 5 years.

The analysis included auxiliary costs such as chargers, grid, and so on. In June 2015, Norled one of the country's major ferry companies launched the Ampere, the world's first fully electric battery powered car ferry which in its first two years sailed a distance equivalent to 4 times around the Equator, racking it up 6 km at a time by shuttling back and forth between two little ports called Lavik and Oppedal.

In 2018, a 400-passenger electric carbon-fibre catamaran Future of the Fjords began cruising the waters of the country's famously majestic fjords. The Norwegian Parliament accept a resolution which would see emissions banned on the world heritage fjords "as soon as technically possible and no later than 2026."

This means fjords with a world heritage designation, such as the west Norwegian Geirangerfjord or Nærøyfjord can only be crossed by electric ships. In response to this, ferry operator Fjord 1 which runs one of the largest regional transport networks in Norway has been electrifying its entire fleet.

It signed an agreement with the Havyard Group for the construction of another seven battery-electric ferries. Five of them will be built in the company-owned shipyard in Leirvåg, and two more will be built in the Turkish Cemre shipyard.

Their names are Vision of The Fjords, Legacy of the Fjords etc. The battery specialists who have been focusing on making this possible include PBES Energy Storage and Siemens.

On the Oslofjord, at the northern end of which lies the Norwegian capital Oslo, these ferries will be put into operation by 2022 – the first of these as early as 2021. The transport authority Ruter has awarded the contract to operate the electric ferries to the Norwegian provider Boreal Sjø. So far it is clear that the ferries, each 35 metres long and eight metres wide, can carry 350 passengers.

In addition, in June 2020, Wärtsilä was commissioned to design and equip two battery-powered ferries for Norwegian operator Boreal Sjø at Holland Shipyards in the Netherlands. The following month in New Delhi, India, Cochin Shipyard Ltd (CSL) also received a commission to construct and supply of two autonomous electric ferries to Norway-based ASKO Maritime, with an option to build two more identical vessels.

The 67 meter-long vessels will initially be delivered as a full-electric transport ferry, powered by 1,846 kWh capacity battery. After commissioning autonomous equipment and field trials in Norway, it will operate as a fully autonomous ferry of ASKO that can transport 16 fully loaded Standard EU trailers in one go across the fjords.

ASKO Maritime AS, Norway's largest grocery wholesaler has commissioned the Cochin Shipyard (CSL) in India to build two 67m autonomous RoRo ships, Designed by Naval Dynamics, their Schottel EcoPellers will give them full manoeuvrability to transport 16 fully loaded standard EU trailers at a time, which can be stowed on the open deck with a loading ramp at the stern

In August 2020, propulsion specialist Schottel announced that Festøya, the first of four hybrid ferries for Norwegian ferry operator Norled equipped with its electric drive systems, had recently entered operation. According to the company, each of the four double-ended ro-pax ferries, built at the Remontowa shipyard in Poland, feature two of its SRE 340 EcoPellers, powered by a diesel-electric hybrid system and operated by battery power during transit.

Another Turkish boat builder Sefine Shipyard has won a prestigious order to supply Norwegian operator Boreal with five electric ferries – each supported by two Volvo Penta D13 MG IMO III generator sets (gensets). The ferries will operate to-and-from the islands in the inner Oslo fjord and run scheduled

services throughout the day. The Multi Maritime-designed vessels will each have a length of 35 metres, a beam of eight metres, and two passenger decks capable of accommodating up to 350 passengers.

Norway also has its own smaller sized electric engine builders: EVOY in Norway make drivetrains for boat systems at 74-671 kW, 100-900hp, for new and used fast planing boats from 20 to 30ft (6 to 9 m.).

In July 2019, Evoy I, a 28ft (8.6 m.) Polarcircle 860 workboat, was timed at a speed of 50 knots across Ranafjorden. In 2020, Evoy teamed up with two other Norwegian marine companies, Frydenbo and Hurtigruten to make a 150hp electric outboard – which will be the world's most powerful to-date.

At the same time, the Port of Oslo is working to make an 85% reduction from 1990 levels in its emissions of carbon dioxide, sulphur oxide, nitrogen oxide, and particulate matter, with the goal of becoming the world's first zero-emissions port by 2030.

This is a decree that spares no person nor industry. The port's 17-point climate action plan includes refitting ferry boats, implementing a low-carbon contracting process, and installing shore power, which would allow boats to cut their engines and plug into the grid when docked. This began with an electric harbour boat for the collection of liquid rubbish.

Oslo joins a handful of other ports around the world in aiming for carbon-neutral and zero-emission.

In October 2019, the Port of Los Angeles unveiled two new battery-electric top loaders. Rotterdam, which is Europe's biggest port, is using zero-emission port equipment.

In December 2020, Slovenia's Greenline Yachts has teamed up with Canal Boats Telemark AS in Norway, W-Yachts and Torqeedo to create what it describes as the "first 100% electric charter fleet in the world". Canal Boats Telemark will operate six new Greenlines - two 33s and four 39s - all fitted with the shipyard's revolutionary EDrive system, which was launched at Boot Düsseldorf in 2019.

Since then, full electric Greenlines have been sold all over the world including to the USA, Germany and Russia. Thanks to their bank of lithium batteries and electric motors, the Greenline 33 and 39 can cruise at a speed of 7 knots and to a top speed of 11 knots. With their battery capacity of 80kWh, they have a range of up to 40nm on a single charge.

India: Kochi



In 2012, AltFuels Committee President Hartmut Ginnow-Merkert from Berlin, Germany, and supervised by Dr Frue Cheng of Taiwan, focussed on envisioning the use of solar power in the area of eco-tourism, by means of designing solar-powered houseboats for three different countries, one of which was based on the traditional Kerala rice boat.

In 2013, Sandith Thandassery, a naval architect who graduated from IIT-Madras founded NavAlt Solar & Electric Boats Pvt. Ltd headquartered at Kochi, (also known as Cochin), a city in southwest India's coastal Kerala state. His vision was to transform marine transport more efficient by drastically reducing the energy for its operation.

Having built a 20-seater solar boat for a tourism operator in Bhatinda in Punjab, Thandasherry collaborated with Alternative Energies of La Rochelle, France to make a 40 kW, 75-pax solar ferry for Kerala State Water Transport Department (KSWTD) for operation on Lake Vembanad between Vaikom and Thavanakdavu.

In November 2013, after attending the trial run of the Aditya, India's Transport Minister A.K Saseendrank said the Government was planning to operate at least one solar-powered boat each in every district, eventually a fleet of up to 50 vessels.

Aditya, used in the singular means the Sun God, Surya. By 2020, Aditya had transported over 110,000 passengers and a totted up a distance of 70,000 km (22 daily trips, carrying a maximum of 75 passenger per trip), without relying on a single drop of fossil fuel. It thus saved KSWTD over 100,000 litres of

diesel, worth approximately ₹75 lakh. Aditya uses a meagre ₹180 per day as energy cost, as opposed to approximately ₹8,000 that would be required for a diesel-run ferry of similar size.

Thus encouraged, Kochi Metro Rail Limited (KMRL), the Government of Kerala, and German funding agency KfW signed an agreement with the Cochin Shipyard to build twenty-three 100 pax hybrid-electric ferries and the remaining fifty-five ferries to have 50 seats, several of them double-deckers.

Siemens will equip the boats with electric propulsion drive train, safer and more fast-charging LTO (Lithium-Titanate) batteries developed by Echandia of Sweden and vessel automation technologies. With 78 units, the city will have the world's largest fleet of electric ferries.

The vessels will run for up to one hour on fully electric mode courtesy of a propulsion system equipped with a lithium titanium oxide battery, which can be fully recharged in as little as 15 minutes' time.

The project will cover 16 routes in the Greater Kochi area, connecting 38 terminals across 10 island communities, across a 78-km channel length. The first batch of ferries are slated to operate on Vyttila-Kakkanad route from 2021. Aditya was a game changer in Kerala's water transport sector, so much so that ambassadors and officials of over 40 countries flew down to check it out.

One delegation from the Andaman and Nicobar Islands in the Bay of Bengal has commissioned two 1,200 pax electric ferries to operate between mainland India and the islands.

The 1,200-passenger ferries is part of a four-vessel order that also includes two 500-passenger ferries.

When, in July 2020, Aditaya won a Gustave Trouvé medal in the Plugboats.com online voting contest, its success was published across the Indian Media and read about by over 5.5 million readers across the India Continent.

Kerala is also an example of how an AltFuel marine success can have a knock-on effect: Steps are also being taken to increase the number of electric vehicles in the State to bring down pollution. Efforts are being made to roll out 6,000 electric buses by 2025. E-autos too will be introduced on a larger scale (a dozen of them operate in Kochi now).

Denmark: Copenhagen



In June 2020, a coalition of left-wing parties led by Mette Frederiksen Social Democrats in Denmark's parliament adopted "Klimaloven", committing to reach 70% below its 1990 emissions by 2030. Whichever elected government must provide an annual global report on the international effects of Danish climate action, as well as the effects of Danish imports and consumption.

It will also need to provide a strategy for how its foreign, development and trade policy is driving international climate action. The law targets carbon neutrality by 2050 and includes a robust monitoring system. New legally-binding targets will be set every five years, with a ten-year perspective. The first of these will be set in 2020. A Danish government could lose its majority if it fails to meet its climate target.

In July 2018, Damen Shipyards Group signed a contract with leading multinational public transport company Arriva Danmark for seven fully-electric ferries for use in Copenhagen Harbour. Arriva would operate these ferries for its client, Danish public transport agency Movia.

One crucial requirement was that the new vessels be able to fit into the existing framework – including use of current timetables and infrastructure, as well as capacity to carry at least 60 passengers.

Propulsion was a major factor in the design of the vessels. Movia requested a cleaner, greener use of energy from its ferry service, and Damen had a number of options available. Engineers considered biodiesel engines, hybrid vessels with generators on board, and full electric solutions, ultimately deciding full electric was the optimal choice for the twelve year operation of the ferries, based on several factors.

This zero emissions, fully electric solution is quiet in operation and is much more maintenance-friendly than a diesel option. Combustion engines contain a lot more mechanical parts that can fail, and the oil used for lubrication of these moving parts makes the system very dirty in comparison with an electric motor.

The next decision to make was how often the vessels could charge their power supply – how could the ferries operate all day on a minimal battery pack and recharge without disrupting their schedule?

To answer this question, Damen Civil – another branch of Damen’s complete service provision – investigated full civil solutions such as accessibility to the local grid, the regulations surrounding civil power supply, and the practical limitations of the jetties as potential charging points.

The ferry route takes one hour to complete, and at each end there is a small window in which to prepare for the beginning of another route. Damen saw this as a window of opportunity to take advantage of a fast-charging system.

To fulfil this, Echandia Marine of Stockholm (with its DNV-GL certified LTO battery systems), Eekels, Heliox and Staubli, together with Damen developed their 23.3 meter x 5.6 meter, E-Ferry 2306 design with a capacity for 50 passengers, tailored so that the vessels can auto-dock – bow first – at the existing jetties and fast recharge in only seven minutes.

The first 5 yellow ferries were delivered in July 2020 in the presence of Copenhagen’s Lord Mayor Frank Jensen. The remaining 2 followed in the autumn.

According to Damen, the ferries reduce Copenhagen’s public transport NOX emissions by 2.5%, CO2 emissions by 10% and particulate emissions by 66%. As well as a positive environmental impact, there will be a noticeable improvement in efficiency and experience.

The ferries are silent, making for a beautiful ride - and need to be charged for just 7-minutes after each journey – negating the need for longer charging periods which take the ferries out of service.

Given the demands of its operation, each ferry carries two drivetrains to provide a good level of redundancy should any unexpected problems occur.

The ferries cover passenger routes in the central metropolitan area of Copenhagen as well as to the port area and serve as a blueprint for future sustainability projects in cities around the world.

Although coastal, in its first year of operation on a 22 nautical mile route, the pioneering Danish all-electric ferry Ellen has notched up some noteworthy milestones.

Operating between the Danish islands of Ærø and Fynshav, the vessel was designed by Jens Kristensen Consulting Naval Architects and built by the Søby Værft shipyard. Just under 60 meters long and with a breadth of approximately 13 meters, the ferry travels at speeds of 12-12.5 knots, and is capable of carrying 198 passengers in summer months, with this capacity dropping to 147 during winter.

It can also carry 31 cars or five trucks on its open deck. With a 4.3 MWh capacity battery pack, the largest currently installed for maritime use, it is the first electric ferry to have no emergency back-up generator on board. Compared to a similar modern diesel-powered ferry, making some 1,800 trips, Ellen annually saves around 2,520 tons of CO₂, 14.3 tons of NO_x, 1.5 tons of SO₂, 1.8 tons of CO and half a ton of particulate matter.

The E-ferry is charged from the local grid on the island of Ærø, whose electricity demand is entirely powered by wind. Even if Ellen were to use electricity from the usual Danish grid mix, it would still save around 2,010 tons of CO₂ annually.

In August 2020, Ferry operator Stena Line announced it was planning to add a 1,000kWh battery system to its Stena Jutlandica ferry, which operates between the cities of Gothenburg, Sweden and Frederikshavn, Denmark. The project began in 2018 and is made up of three phases, the first of which is the battery installation.

Phase two involves the installation of a 20,000kWh battery park, which will create ten miles of pure electric range, while phase three will focus on getting the battery capacity to 50,000kWh. The amount of energy will enable the ferry to travel the distance between the two cities.

Six months' later: To speed up the transition to fossil-free fuels in the transport sector, Stena Line, Volvo Group, Scania, and the Swedish Port of Gothenburg have joined forces to bring about a significant reduction in carbon emissions linked to the largest port in Scandinavia.

The aim is to cut emissions by 70 percent by 2030, including a commitment from Stena to proceed with an all-electric ferry.

Named the “Tranzero Initiative,” the initiative includes the electrification of sea transport as one of its goals. The focus is also on the one million truck transports and the 55,000 tons of carbon emissions generated from road transports to and from the Port of Gothenburg each year.

As the largest ferry operator, Stena Line plans introduce two 200m high tensile steel, battery-powered ferries called Stena Elektra to service the 50 nautical-mile Gothenburg-Frederikshavn route by 2030. Capacity will be similar to the Stena E-Flexer series with 1,000 passengers and 3000 linear metres of vehicles able to be accommodated.

As part of the overall project, the Gothenburg Port Authority will produce the necessary infrastructure and access to fossil-free fuels for heavy vehicles, including electric power, HVO, biogas, and hydrogen gas. Volvo and Scania will put commercial offerings in place for their heavy truck customers, ensuring that in time land transport becomes fossil-free following the goals laid down by the port.

Although Stena ships are for offshore ferries, the technology developed for the Stena Electric is bound to benefit indirectly inshore ferryboats.

In December 2020, it was announced that a Danish-Norwegian project aimed at building what will be the world’s largest and most powerful hydrogen-fuelled ferry had applied for EU funding. The plan is to start operating a Copenhagen-Oslo service by 2027.

Several shipping and energy firms have banded together to build a ferry capable of transporting 1,800 passengers between the two Scandinavian capitals. The vessel, which will be named Europa Seaways, will be powered by zero-emission hydrogen fuel cells

The hydrogen will be produced in Denmark using offshore wind power, meaning it will be ‘green hydrogen’ rather than grey or blue, which involves using fossil fuels in the production process.

According to the project’s initial calculations, the ferry would avoid 64,000 tonnes of CO2 emissions every year, the same as taking more than 13,000 passenger cars off the road.

Europa Seaways will also be able to carry vehicles, either 380 cars or 120 trucks, on the roughly 48 hour-long roundtrip. To achieve this feat it will be powered by a 23-megawatt fuel cell, which will dwarf all existing propulsion systems.

France



In May 1881, French electrical engineer, Gustave Trouvé, tested the world's first rechargeable battery electric outboard engined boat on the River Seine in Paris.

In 1994, the University of Bordeaux, in conjunction with the French electric utility company EDF and the former Chairman of the Electric Boat Association (UK), set up the French Electric Boat Association (AFBE).

Following a demonstrator boat, an electrified Arcachon pinasse called Egretta, work began to promote electric boats around the waterways of the Hexagon. To do this, AFBE gradually built up an important corpus of 50 active and professional members. With pioneer companies such as Ruban Bleu of Nantes, by 2020 the total number of small pleasure boats, privately owned or for rental, has grown to 9,000.

As part of Paris Plages, the yearly transformation of sections of the Seine into man-made beaches, moviegoers on Saturday were able to board 38 electric boats for a free showing of the 2018 French comedy "Le Grand Bain". Jul 19, 2020 The event is sponsored by movie theater chain M2 and Häagen-Dazs. use boats from the Marin D'eau DOuce rental company whose fleet is manufactured by Ruban Bleu, Europe's leading producer of licence-free electric boats.

Meanwhile Alternative Energies of La Rochelle, founded in 1996 by Philippe Palu de la Barrière, starting with a 35PAX solar-powered ferry, have progressed to 15 such boats for various cities in France (Paris, Bordeaux, Marseille, Rouen, Strasbourg, Ajaccio, Calais, la Rochelle, Lorient, Nantes and Toulon), In 2009

ODC marine introduced the first passenger ferry powered by lithium batteries and in 2012 first hybrid passenger vessel.

These are part of a 70-strong nationwide fleet of hydrogen fuel and all-electric passenger boats, built by other shipyards such as the Chantier Naval Franco Suisse, Transfluid, Torqeedo, Fisher Panda and Naviwatt, Mayday, ABB, ODC Marine with capacities from 12 to 200 passengers.

In 2017 AE developed a fuel-cell sea ferry called Galilee. They also worked with NavAlt in India to create their first solar-electric ferry Aditaya (see Kochi Case History below).

AFBE, led by their President Xavier de Montgros, are also the interlocutors of professional organizations and public authorities, asked to participate in various working groups, such as the ISO standard on electric propulsion through AFNOR or the PAMI (Modernization and Innovation Assistance Plan) system of VNF for a cleaner river fleet.

AFBE is also part of the Federation of Nautical Industries, the EcoNav network and the Groupement des Industries de Construction et Activités Navales (GICAN) and the Maritime Cluster. While those wishing to build or retrofit electric boats in France can obtain financial aid, recent legislation passed by the French Government requires any harbour with more than 200 berths to set aside 1% for electricity complete with recharging points. This will create 2000 berths by the end of 2021.

Jean-Marc Roué, CEO of Brittany Ferries claimed to begin greening his fleet with an LNG-electric propulsion vessel, the Honfleur, to operate from Portsmouth to Caen.

Powered by LNG, Honfleur's four main engines feed electric generators and two electric shaft propulsion motors with two fixed pitch efficient propellers. Honfleur was promoted as the most environmentally friendly ship regularly operating in UK waters when she took to the seas in a post-COVID/Brexit era. Brittany ferries announced a follow-up with another three 215 metre 42,200-tonne E-Flexer class ships Galicia, Salamanca and Santana, built at the CMJL shipyard in Weihai, China.

They should be in regular operation by 2022 and 2023 with a caveat as to whether, at most, with modest gains of the order of 10-15% in operation, LNG should be considered as a decarbonizing energy of any importance.

USA: California



Since 1970, The Duffy Boat Company of Newport Beach, Orange County, California, USA, has built and sold more than 30,000 of luxuriously appointed 16 – 22 ft electric dayboats, of which more than 3,500 locally, but exported to customers around the world.

In 2000 alone, Duffy delivered over 15,000 boats. For a number of years they organised “The Great Electric Boat Race” around Newport Harbour.

Duffys are primarily for harbours, bays, rivers and small lakes, so their boats are very capable of handling winds up to 40 mph in protected waters. While not designed for use in heavy seas, the Duffy 22 completed a 100 mile trip in southern California seas around Catalina Island on April 19, 2013 in 25 knot winds. Their sales brochure states “A Duffy is not just a boat, it's a lifestyle..

Once you experience your first Duffy cruise you'll understand exactly what that really means. Our motto - Unplug, Untie and Unwind...it's that simple.” In 2008, the Duffy 22 Cuddy was launched, Over 9 feet wide, the boat has the largest interior of any previous Duffy by 50%, so designed to give more space to the elegantly upholstered seats and tables for “sunset meals” afloat.

In 2020, Duffy celebrated its 50th Anniversary. Marshall Duffield's contribution to Newport Beach has gone further than just boat production. In 2014 he was elected the City's Mayor and implanted 20 new EV charging stations alongside the existing infrastructure for marinas of hundreds of Duffy boats. Duffy Electric Boats Worldwide Fleets: Eleven venues in the USA, the ones in Mexico, Copenhagen, Dubai, Qatar, and Singapore.

More recently he has invented fiberglass SafeHuts for the homeless sleeping on the local piers

Alongside Torqeedo electric outboards (100,000 sold since 2006), the Duffy Case History exemplifies the great potential of inland waterways fleet transition.

Some 425 miles northwards along the Californian coastline, at San Francisco, one boards the Enhydra, (a tribute to the California sea otter), a 128-foot-long hybrid ferry operated by Red & White Fleet, a tour guide company that's one of San Francisco Bay Area's oldest businesses.

The boat can shuttle up to 600 passengers for over an hour using lithium-ion batteries developed by Corvus Energy, a company that makes energy storage solutions for the maritime industry.

BAE Systems integrated some of the technology, which also includes gear from Cummins Red & White Fleet plans to have a 4-strong zero-emissions fleet by 2025. the first aluminum hulled, lithium-Ion battery plug-in hybrid vessel built from the keel up under US Coast Guard regulations.

The Enhydra can cruise in all electric-mode at 7 knots for 2+ hours, consuming less than 8 gallons per hour. With near silent operation, the Enhydra comes equipped with elegant interior finishes, clear handrails for maximum viewing capacity, a state-of-the art sound system and personal audio headsets for audio tours in 16 languages.

In 2021 R&W are planning their first hydrogen fuel cell powered vessel. The 84-passenger e-ferry was under construction at the All American Marine shipyard in Bellingham, WA using private funding from SWITCH and a \$3 million grant from the California Air Resources Board (CARB).

While Hornblower Group's Vessel Construction Management Team was overseeing and ensuring the successful construction of this innovative vessel, the project was leveraging technology from partners including Golden Gate Zero Emission Marine, BAE Systems, and Hydrogenics.

Scaling this zero-emission technology will only be possible with significant investment in new fueling infrastructure. SWITCH is partnering with Clean Marine Energy (CME) to develop electric charging and hydrogen fueling infrastructure onshore.

Backed by the same founders, CME plans to make clean fueling infrastructure available in multiple ports across the US.

Sweden



In 2014, the Swedish companies Echandia and Green City Ferries launched the retrofitted all-electric passenger ferry Movitz. With a 200-kWh battery and a diesel engine for back-up, Movitz could operate as a commuter in Stockholm for 1 ½ hours and recharge in 15 minutes.

Two years later, Green City Ferries launched the BB Green prototype, a 20 m high-speed carbon-fibre all-electric vessel using ASV (Air Supported Vessel) technique. With a 200-kWh battery the vessel operates for 15 minutes at a speed of 30 knots.

Four years later, the Transport Authority is still not interested. Green City Ferries along with former Minister of Finance, Allan Larsson, then took the initiative to develop a plan for the transition to an emission-free archipelago fleet. Of today's 60 vessels 30 of them should be retrofitted with batteries or fuel cells. 30 of should be discontinued and 30 new vessels should be invested in.

The plan for the fleet has until now been to change from fossil diesel to biodiesel which is claimed to be carbon-neutral, which is questioned. Furthermore, any diesel emits nitrogen-oxides and particulate matter which are harmful to people and waters.

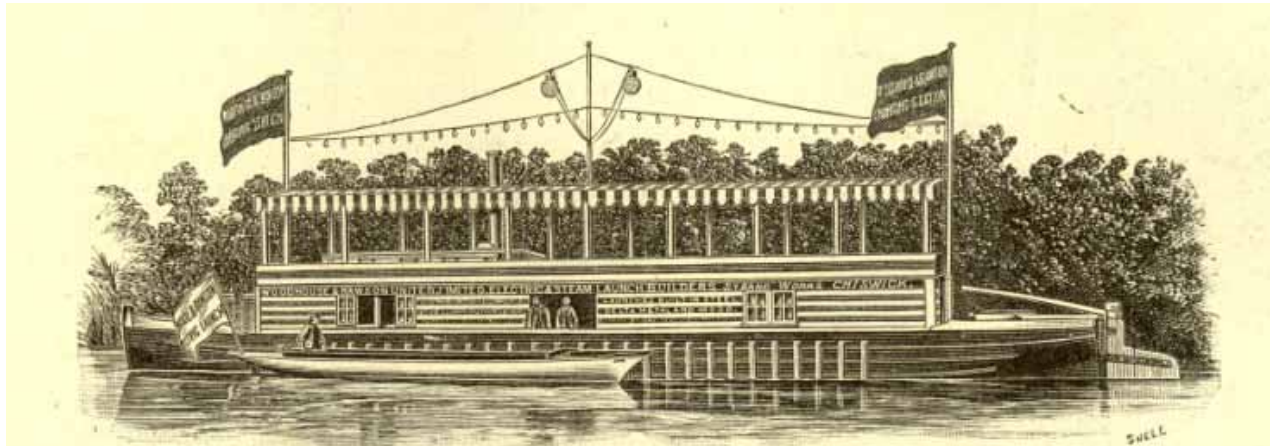
Vessel by vessel and route by route was investigated and while present fleet emits 40 000 tons of carbon-dioxide every year the new fleet emits almost nothing, and the total cost is less than if one had continued with the existing fleet and biodiesel.

Furthermore, the total investment for new vessels and retrofitting of existing vessels will amount € 150 M and can be financed from pension funds. The

charging infrastructure will be financed from an electricity supplier. This will leave the Stockholm County budget untouched and hopefully the politicians will take this as an offer they cannot refuse.

There is also a European initiative called Viable cities who held a meeting last week where the mayors of nine Swedish cities (among them the three largest) officially signed a climate contract where they made a commitment to have their cities climate neutral by 2030

UK: Thames River



Unlike Duffy Boats in California, the development of electric boats on the Upper Thames, UK was in fact a revival of the popularity that electric boating had enjoyed during the 1890s and 1900s – during which era there were fleets of electric hireboats and even floating barges for recharging.

During 1898, the Immisch Electric Launch Co. and the Thames Valley Launch Co. each had about sixty electric launches for hire, there were about the same number in private ownership and most of the large boatbuilders had experience in building, fitting out and hiring electric boats.

Of the several Thames builders, one of the most prolific were Messums of Richmond, but also Hobbs of Henley and Salters of Oxford and these were of the electric canoe design. More recently Freebody's of Hurley have built several on that original 'double ender' design concept. The first sailboat with electric auxiliary and the first hybrid-electric cabin cruiser were launched from Upper Thames yards.

In the early 1980s, following the setting up of the world's first Electric Boat Association, a key player was Rupert Latham of the Steam and Electric Launch Company which built, sold and exported some 200 Frolic and Mystic dayboats.

A close second was Emrhys Barrell of the Thames Electric Launch Company who sold new boats and developed and installed electric and hybrid systems into existing boats. Their electric systems enabled two 29 foot cruisers to break records by covering more than 100 miles in 24 hours on one single battery charge.

Encouraged by a special rate licensing fee from the local navigation authority, during mid-1980s there was a boom in the popularity of Thameside electric dayboats, either in private ownership or as rental fleets. To this were added two electric river patrol boats for the then National Rivers Authority which were hybrid models, keeping their diesels but able to cruise range permitting on electric.

The EBA arranged regular electric boat social gatherings and, with its publication "Electric Boat News" was also behind the setting up of electric boat associations in the USA, The Netherlands, France and Norway.

The Upper Thames has waterside charging points at every 15 miles along the river provided and maintained by the Environment Agency, plus those in many marinas, and remains a strong region for electric boats, be they privately owned (American film star George Clooney has one) while E-Boatique's "Pure Boating" runs a fleet of chauffeured and self-drive elegant electric 15 rental boats from Wallingford and Goring & Streatley on the upper River Thames with a capacity of up to 11 people.

This has recently expanded to the Beetle and Wedge in Moulsoford and in 2021 will be inside Beale Park too with mini port of kiddy electric boats (you have to get them young!). GoBoat's 16-strong fleet at the Grand Union and Regent's Canals and Kingston-on-Thames.

For 2021, Hobbs of Henley on Thames have ordered 5 x new electric day boats from Alumax from Holland, which arrive in May. It's the start of Hobbs returning to electric a century later and investing in the future!

Currently. More recently Boat Showroom has been the importer 'Alfastreet' range of electric launches mainly to private houses around the middle and lower Thames.

Interestingly enough there is no doubt that electric powered craft would be even more popular if the current navigation authority – the Environment Agency – were to encourage growth in electric longer-range cruising boats if it invested in more charging points at their locks and other key wharf/mooring areas.

The Canal and River Trust (CRT) manage over 2,000 miles of Canals and Rivers in England and Wales. The CRT WATERWAYS AND WELLBEING Initiative and the Inland Waterways Association (IWA) Webinar on future powering of recreational canal boats will all assist in growth in the numbers of Electric and Hybrid vessels on UK Waterways and the facilities to support them..

There are plans for AltFuels ferryboats further down river on the Tidal Thames:

Thames Clippers, which operates a fleet of 20 vessels connecting passenger to their homes, places of work and river-side attractions, is involved in several initiatives to develop battery-operated ferries.

One of these is a pedestrian and cycle ferry between Rotherhithe and Canary Wharf. It would offer a 10-minute frequency at peak times change to a three-boat operation of electric ferries delivering a three to four-minute headway at peak times. While Thames Clippers would operate the service, it would be provided by TfL. The London Mayor's ambition is to achieve this by 2023.

Thames Clippers is also working on another electric ferry project. It is working with One2Three Naval Architects and Wight Shipyard on the concept and delivery of a 220-seat high-speed hybrid vessel.

The battery would be charged by the boat's own engines when the vessel is operating further down river at high speeds, but also use overnight shore power. This is part of a of a 2020 EU funded Horizons research and development project, which also takes in a similar vessel for the inland waterways of Belgium

UK: Plymouth



The cruising, ferry and fishing company Plymouth Boat Trips (PBT), the boatbuilder Voyager Marine in partnership with the University of Plymouth, the University of Exeter, the manufacturer Teignbridge Propellers and the engineering technology company EV Parts have developed an electric ferry called the e-Voyager.

It uses repurposed, Nissan Leaf batteries and an advanced electric motor, which replaces the traditional diesel engine. The green ferry will undergo rigorous running trials, before carrying passengers on ferry routes from April 2021

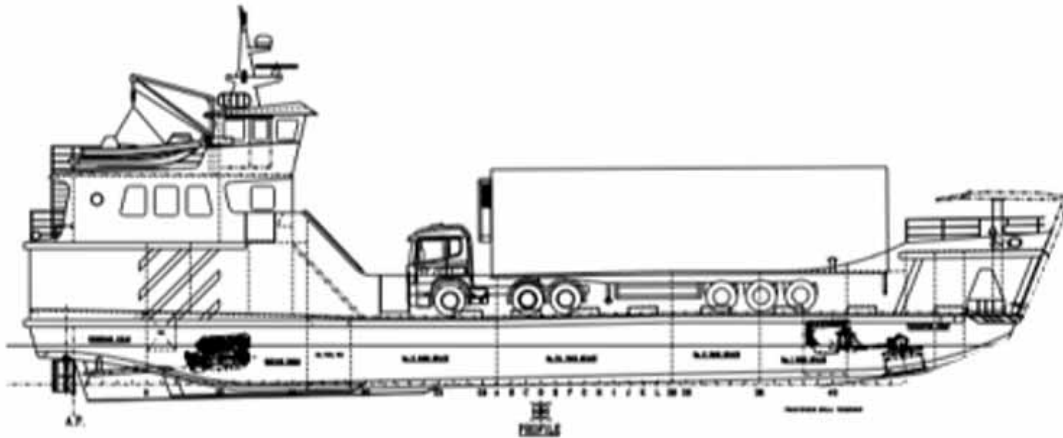
Plymouth City Council plans to install three 22kWh chargers, a development that would allow the vessel to achieve a full charge in under three hours.

The project is funded through the £1.4 million Clean Maritime Call, a Maritime Research and Innovation UK initiative supported by the Department for Transport, launched to support the UK's goal of zero emission shipping.

Partners note the e-Voyager will be the first vessel to be recognised by both the Maritime and Coastguard Agency and a Classification Society. The partnership will now aim to convert larger passenger vessels. Scientists from the University of Plymouth carried out research during the build, measuring emissions including noise pollution, air pollution and fuel consumption and argue the process could be transferable to commercial vessels less than 24 metres long.

Prior to crippling COVID, Connor Johnson of Patriot Yachts in Appledore, Devon was planning to build two hydrogen-fuelled ferries, 19m and 12m in length, to transport 52 and 42 people respectively across the Severn Estuary between Bristol and Cardiff.

UK: Orkney



MV Shapinsay, the first hydrogen fuel cell ferryboat in the world obtaining its energy from renewables such as wind and tidal power is undergoing trials between the Orkney Islands in Scotland. The HyDIME project is made up of a consortium of partners being led by Ferguson Marine. Partners include Ballard, ULEMCo, Lloyd's Register, HSSMI and Orkney Islands Council and is funded by the EU project HySeas III. The ferry has initially been trialled using hydrogen to fuel its auxiliary power while docked before undergoing sea tests.

The Alps: Austria, Italy, Germany, Switzerland



Eleven significant European lakes, fringing the great mountainous mass of the Alps, are located in four different countries – Germany, Austria, Switzerland and Italy.

The Königssee, a natural lake in the extreme southeast Berchtesgadener Land district of the German state of Bavaria, near the Austrian border, is noted for its clear water and is advertised as the cleanest lake in Germany. For this reason, only electric-powered passenger boats, rowing, and pedal boats have been permitted on the lake since 1909 – over a century ago.

The first of these the 38-pax Siemens-engined Akkumulator already reached a maximum speed of 10 km/h or 5.4 knots per hour and had a range of 100 kilometres. The engine output was 15 hp. It was followed by the electric ferryboat Godesberg.

Today's 18-strong fleet is maintained and run by the Bayerische Seenschifffahrt company. Recently two of these boats were re-batteried with Hoppecke units. An Austro-Swiss collaboration between Boesch (Lake Zürich, Switzerland), Schmalzl and Krautler (on the River Rhine) created the Elektro, a 25 kW 180 volt speedboat that could tow a waterskier called – before long they had developed the 560 powered by an 80kW motor giving it a top speed of 60 kmh (38 mph)

In Switzerland, in 1995, at Yverdon-les-Bains beside Lake Lemman,, two 8m50 12 PAX solar-powered passenger boats, Solifleur and Chlorophylle, built by MW-Line were in regular service. When not cruising, their surplus electrical energy was supplied to the town's grid.

In 1997 MW-Line's Aquarel went into service on the same lake with three boats added to the fleet by 1999. The 20m 65ft Becassine, also running on Lake Geneva had a range of 90 m 65 mi at 10 knots. In 2019, the fleet received its 5th vessel in the 25 PAX Aquabus Greta, taking visitors to the foot of the city's famous Jet d'Eau fountain using 100% solar power and electric motors.

More recently electric boats have arrived on the Italian Alpine Lakes. Lake Como has been name "The Electric Lake" by Judith Wade, CEO of I Grandi Giardini Italiani. Como is the birthplace of Alessandro Volta, the electricity physicist who invented the electric battery some 200 years ago.

Eco-conscious travellers can now enjoy the lake by e-bike or e-boat. Along points of interest, 17 charging stations are being fitted around 170 kilometres of the Lake Como. Most of the stations are installed by the Tesla Destination Charging Programme, with the idea that many will become global chargers to fit any electric car.

Taking advantage of these e-vehicle chargers, the Ernesto Riva shipyard of Laglio has produced the 12 PAX 100 kW Vaporina Elettra passenger yacht, The ecovolta lithium-ion batteries used in the Elettra provide a total capacity of 180kWh and enable five hours of autonomous operation at a speed of 13 knots. Thanks to their high energy density of 480Wh per litre, the batteries offer a high capacity without taking up too much space.

Further along the lake, Nautico Matteri Shipyard and the Econoleggio Como Lake are planning a fleet of zero-emission boats. On neighbouring Lake Maggiore in Cittiglio, Vita Yachts have not only developed a 40 knot electric runabout but also a fast-recharging system.

Italy: Venice



The 1,800-strong fossil-fuel motorboat fleet (private and commercial) which used the canals and Lagoon of Venice, Italy was urgently in need of transition to Alternative Fuels considering the harmful effect it was having on both the canalside palaces and the people of the city (CO² and foundation-eroding stern waves).

With the help of Andreas Apostolopoulos of the Greek Electric Boat Association, Kevin Desmond, electric boat historian and President of the UK Electric Boat Association, set up an ngo VeniceAgenda2028 complete with a .org website and change.org petition (target 1500 signatures) He asked the IWI for help.

They in turn delegated the mission to their man in Venice, Francesco Calzolaio, President of the Venetian association Venti di Cultura, dedicated to cultural cabotages, associated to IWI since 10 years. He then linked to Assonautica Venezia.

The foundations for this had already been laid by Commandant Piero Tosi of Venice who had been building and demonstrating electric boats around Italy for the past 25 years. All three organizations working together organized a joint stand at the 2019 Venice International Boat Show, where fifteen electric boat and marine electric engine manufacturers exhibited and speeches were given.

In officially opening the Show, Venice Mayor Luigi Brugnaro announced that the future of his city would be “green”. Meanwhile Desmond had contacted Prince Albert II of Monaco who had agreed to become Patron of

VeniceAGenda2028.org with its impressive Committee. A Facebook page “Electric Venice” was also set up.

During the winter, a full international e-regatta (31 boats from 17 nations), electric boat parade and Electric Village and international seminar was prepared for the 2020 Show. Although this was postponed by the COVID-19 pandemic, in June 2020, Mayor Brugnaro announced his Municipality's decision to invest €1.5 million into the conversion of the Venice fleet to using AltFuels, 300K of which to encourage private boat owners to change their fossil fuel outboards for an electric equivalent.

With 131 million Euros from both the Veneto Region and Azienda Veneziana della Mobilità (AVM)/ACTV, as approved by the City Council, during the next few years, Venice's fleet of vaporetti will be replaced or retro-fitted to diesel-electric serial hybrid propulsion.

According to in-depth researches, the Venice infrastructure is not suitable for pure electric propulsion. Therefore 35 vehicles will be converted to diesel-electric and 28 new ones will be purchased. To this will be added a further investment of 154 million euros. According to Renato Boraso, Assessore for Mobility and Transport of Venice and Mestre, “In 2 or 3 years all the boats in the Grand Canal will be green.”

To this will be added the construction of 116 floating pontoons (equipped with gangways) equipped with mooring systems for ferries, while on the land, electric buses and rental electric scooters will circulate in Lido and Pellestrina.

To this may be added a similar conversion for Bureau Veritas workboats. With this transition, the production of pollutants and the acoustic impact of the vehicles decrease considerably.

These contributions derive from specific national funds destined for the Regions in the two-year period 2018-2019 (DM n. 52/2018 and DM n. 397/2019) then attributed to the Municipality of Venice with a resolution of the Regional Council in March 2020.

With the blessing of the UIM and FIM, an open-source Rulebook for e-regattas has been published enabling such an event to be performed anywhere in the world. The e-regatta, parade and electric village have been re scheduled during the Salone Nautico in early June 2021. This mission continues.

While the Alilaguna transport company with Vizianallo shipyard of Venice have developed a 16m hydrogen fuel cell passenger ferry Hepic which is still

waiting for approval by the Italian Navigation Authorities, AltFuel for some of Venice's fleet will be provided by algae.

Currently research and development work is being carried out at the Green Propulsion Lab or "Test Field" in Fusina created by Veritas as part of the agreement for Porto Marghera between the Municipality of Venice and the Ministry of the Environment. Its solar-paneled roof supplies electricity to the equipment below.

By February 2020, for this sustainable initiative, Veritas, Enea, the universities of Venice and Padua and some Venetian companies joined forces to arrive at alternative solutions and zero emissions. And not only with algae: four large areas are being explored microbiology, energy from renewable sources, electrochemical storage and sustainable mobility.

Microorganisms will be used in environmental biotechnology processes, microalgae will be produced to capture gases from industrial emissions and to generate advanced biofuels, organic waste and industrial derivatives will be transformed into biodegradable plastics or biogas, biomethane and hydromethane. A 12 m hybrid prototype for the collection and transportation of waste has already been trialed. Both innovation systems, of course, require electricity.

An Italian company The GRIMALDI Group, a private shipping company owned by Gianluca and Emanuele Grimaldi and based in Naples, Italy, has come up with a solution whereby cruise ships briefly mooring at beautiful destinations, SUCH AS VENICE, do not pollute in the port.

Grimaldi's green fleet, Grimaldi Green 5th Generation (GG5G), will be made up of 12 hybrid units (9 in the Mediterranean and 3 with Finnlines in northern Europe) commissioned from the Chinese Jinling shipyard in Nanjing. equipped with an exhaust gas purification system for the abatement of sulphur and particulate emissions.

The first are Eco Valencia and Eco Barcelona (length 238 meters and width 34, gross tonnage of 67,311 tons and a cruising speed of 20.8 knots) Each ro-ro can carry 7,800 linear meters of rolling goods.

Also worth mentioning are the 2,790 pax cruise ships Roma and Barcelona which have already been operating a Zero Emission system since 2019 where a system of mega lithium batteries has been installed, in total 976, with a capacity of over 5 MWh to power the ship during stops in ports without the

need to put diesel generators into operation. These have been recharged during navigation with the shaft generator and 350 x 600 m² of solar panels

However the batteries do not guarantee zero emissions during long stops for 24 hours. Required must be electric docks, not only built but also functioning, which allow us to overcome the limits of batteries.

China



Xi Jinping, President of the People's Republic of China has stated that going electric is a National strategy.

With more than 2,500 years of history and its ancient stone bridges, the Chinese city between rivers and canals, nicknamed "The Venice of the East", and especially the eponymous river, was in the grip of serious pollution.

In 2018, the Suzhou municipality launched a fleet of boats equipped with Torqeedo electric motors to free the channels of waste. As part of its cleanup program, the river management authority built 177 boats to collect floating waste and opted for modern electric boats powered by Torqeedo engines.

The China Ship Scientific Research Center (CSSRC) designed and built the boats that are owned by the Suzhou River administration, but run by private companies. The fleet consists of 18 nine-meter catamarans equipped with Twin-Cruise outboards, 22 seven-meter steel catamarans with double Cruise 2.0 engines, and 137 wooden boats of five to six meters driven by outboards Cruise 2.0.

All boats have special devices for "fishing" and collecting litter floating in the water. Alongside the ubiquitous Torqeedo, Chinese companies such as Caroute of Zhejiang Province are now manufacturing a N400-48V 180LB brushless E-Boat trolling motor

Smaller boats are going electric in China:

1. For aquaculture in lakes, reservoirs and offshore, boats are going electric. One reason is that in some area is gas motor forbidden,

another reason is the eclectic boat average using cost is much cheaper than gas boat.

2. For fishing from boats. City-based Chinese families do not have a large backyard or storehouse. So an inflatable boat and electric motor are a good choice.
3. For urban rivers and scenic lake parts, only electric pleasure boats and smaller ferries are permitted.

Scaling up the vessel, in China, ferry boats, sightseeing boats, inland water freight ships, and work boats in coastal cities along the river are expected to be partially electrified using lithium-iron-phosphate (LiFePO₄) batteries. The total number of ships on the Yangtze River and Beijing-Hangzhou Canal (estimated at 60,000) present a tremendous potential but is still in its infancy.

Despite this, the large-scale promotion and application of electric ships is still subject to lack of relevant standards, imperfect charging facilities, limited power supply capacity of the power grid, and unclear business models, etc. problem.

To rectify this, in January 2019, CATL the Chinese battery manufacturer signed a strategic cooperation agreement with China Classification Society (CCS) Wuhan Institute of Standards in Fujian.

The two parties are carrying out strategic cooperation in various aspects such as promoting the research and marine application of battery system ship technical standards, accelerating the recognition and inspection of related battery products, and further deepen all-round cooperation and exchanges such as resource sharing, technical cooperation, and service upgrades.

On June 19th, CATL revealed that the company had signed cooperation agreements with many parties in the field of electric ships. Among them, the first purely electric official ship in the Yangtze River Basin, the "Hai Xun 12909" of the Yangtze Three Gorges Navigation Administration, is equipped with a lithium iron phosphate battery from the CATL with a capacity of 0.68MWh and a maximum speed of 21 km/h.

In June 2019, Yiwei Lithium Energy signed a cooperation agreement with Shanghai Hansun Shipping Co., Ltd., which will provide power batteries for 18 5000-ton new energy bulk carriers of Shanghai Hansun Shipping; in December of the same year, the company and CSSC The Power Research

Institute signed the "New Energy Power System Battery Product Cooperation Agreement" to jointly deploy the electric ship field.

BYD of Shenghen, manufacturers and worldwide exporters of over 70,000 electric buses, has revealed that it intends to get involved in the field of electric ships. Guoxuan Hi-Tech has also obtained ship orders.

On May 8, 2020, the first 1,000-ton pure electric cargo ship in the Yangtze River was tested in Changzhou. Zhongtian Dianyuan 001 is driven by LiFePO batteries and supercapacitors "dual electricity".

It was successfully tested on the Yangtze River section in Changzhou, east China's Guangsu Province. The battery capacity of the ship is 1,458 kWh, which is equivalent to 40 electric vehicles. According to its builder, Guangzhou Shipyard International, It takes about 2 hours to charge up for a run of 80 kms with a top speed of 12.8 kmh (7 knots).

Based on 150 voyages operated throughout the year, the annual electricity consumption is about 450,000 kWh, which can replace 20.16 tons of fuel. At present, a total of 4918 sets of shore power systems of various types have been built in Jiangsu Province.

The scale of shore power is the largest in the country. Among them, the coverage rate of berths in the eight cities along the Yangtze River is 60.5%. Using shore-based power to supply power to ships calling at the port, the annual shore power can reach 57.01 million kilowatt-hours.

Compared with fuel-assisted power generation, the annual reduction of fuel consumption is more than 20,000 tons, of nitrogen oxide emissions by more than 600 tons, and of sulfur dioxide emissions by more than 200 tons. Unfortunately, the Zhongtian Dianyuan 001's task is delivering coal to run China's power plants to generate the electricity for the 'no threat to the environment' ship.

The 53m / 175ft long Jun Iyu Hao, China's first electric ferry, was launched in mid-November 2019 and is now carrying up to 300 passengers and running sightseeing trips on the Yangtze River in Wuhan, a city of 11 million people about 800 km inland from Shanghai.

In June and July 2019 the city was the scene of protests over its poor air quality. The ferry was made by the Wuhan Institute of Marine Electric Propulsion, which is a subsidiary of the state-owned China State Shipbuilding

Corporation (CSSC) that claims to be the largest shipbuilding conglomerate in the world.

In an announcement at Shanghai's Marintec China 2019 marine industry exhibition last week, the CSSC said that the Junlyu (= 'makes good use of everything') is the first fully battery-powered passenger ship in China. She can sail at speeds of up to 19 kmh / 10kts while at speeds below 13 kmh / 7kts, she can travel for eight hours.

Japan



e5 Lab Inc., a Japanese joint venture consisting of Asahi Tanker, Exeno, MOL and Mitsubishi, is developing the ROBOSHIP, an electrically powered vessel with zero emissions, featuring also an integrated system called the “ROBOSHIP BOX,” which brings together telecommunications, Internet of Things (IoT), and software. The team has developed two types of electric vessels in the ROBOSHIP Ver. 1.0, with standard gross tonnage specifications — 499 tons and 749 tons.

These will be able to achieve the same speed and sailing range as vessels currently in service, while achieving zero-emission operation in port, due to the large-capacity storage batteries in combination with a diesel-powered generator.

In addition, the vessels will achieve higher energy efficiency than other vessels, as well as the world’s most efficient electric devices (DC grids, PM motors, AI technology), the company estimates. The first to benefit from this technology is Asahi Tanker Co Ltd, for whom Kawasaki Heavy Industries has ordered a Corvus Energy battery-based energy storage system (ESS) to integrate it into the zero-emissions all-electric propulsion and electrical systems aboard the “e5 tanker”

e5 technology will most certainly be applied for inland shipping as for offshore routes.

Finland



The Finnish ferry operator Finnlines, with a fleet of 20 ships is part of Italy's Grimaldi Group has commissioned the Chinese Nanjing Jinling shipyard to build three 780 ft LOA hybrid ro-ro car ferries with a 17,400 DWT.

In addition to Wärtsilä's Hybrid Power Conversion system which includes Corvus ESS li-ion battery systems that enables zero-emission operations in port, Finneco I, Finneco II, and Finneco III will be equipped with energy-efficient engines, exhaust gas scrubbers and an innovative air lubrication system to reduce hull resistance. The first ro-ro vessel is expected to start operation in 2021, and the other two in 2022.

Baltic Sea



Although the Baltic is a sea, the origins of using AltFuels goes back to 2013 when Scandlines converted the first ferry on the 24 km (14 mile) route Rødby-Puttgarden to hybrid propulsion.

This conversion proved successful so in 2014, co-financed by the European Union, Scandlines also converted the remaining three passenger ferries on the route to hybrid. When in 2016 they commissioned new ferries on the 63 km (39 mile) Gedser-Rostock route, Scandlines stayed with the hybrid option so operating the world's largest hybrid fleet.

In August 2019, the company signed an agreement with Finnish rotor sail pioneer Norsepower Oy Ltd, to install the latter's rotor sail solution, a modernized version of the Flettner rotor (a spinning cylinder that uses the Magnus effect to harness wind power to thrust a ship) - on board their existing M/V Copenhagen hybrid passenger ferry. With the addition of Norsepower's technology, the vessel will further reduce its emissions by 5%.

To this background, The BSR (Baltic Sea Region) Electric project aims to enhance the utilisation of e-mobility in urban transport systems by exploring unseized potentials and demonstrating applications of various types of urban e-mobility such as electric city logistics, e-bikes, e-buses, e-scooters and e-ferries.

Partners: Hamburg University of Applied Sciences (LP), ATI Küste GmbH Association for technology and innovation, Høje-Taastrup Municipality, Lindholmen Science Park AB, Zero Emission Resource Organisation (ZERO), Green Net Finland, Helsinki Region Environmental Services Authority (HSY),

Institute of Baltic Studies (IBS), Tartu City Government, LTD Ardenis, Riga City Council, City of Gdansk, Urban Transport Administration Gothenburg, Free and Hanseatic City of Hamburg , Borough of Bergedorf.

In June 2019, ATI Küste organized a workshop entitled "Electromobility on Waters - Contribution to Clean Shipping" in June 2019, focusing on alternative energy sources as well as autonomous driving in electric water mobility.

In March 2020, a workshop on "E-ferries and urban electromobility - benefits from the automotive sector" was implemented at the Porsche Zentrum in Leipzig, with stakeholders from different industries, such as aviation, road transport and water transport.

The 5-minute ferry connection linking Gehlsdorf to Rostock-Kabutzenhof (operated by antaris, AO 10) across the River Warnow is due for an overhaul in the coming years, and an e-ferry may present itself as a feasible alternative. In April 2020, a Europe-wide tender for a shipbuilding contract was launched by the City of Rostock. Commissioning of the electric ferry is planned for spring 2021.

This proof of concept vessel, solar powered / grid charged, will focus on analysing the planning and investment phases for electrification of ferries, particularly with regard to technical solutions and procurement processes, in the Baltic Sea Region harbour cities of Rostock and Gdansk.

Dubai



In 2018, the Roads and Transport Authority of Dubai has launched a fleet of electric water taxis for service the Dubai Creek, between Al Seef, Baniyas and Festival City stations. Known as Abras (Arabic = to cross) part of a 30-strong fleet in use on other venues such as the Crystal Lagoon. Their Torqeedo motors are supplied and fitted by Exalto Emirates in Sharjah.

USA: New York



Electric ferries on the River Hudson, New York go back one hundred years. In October 1921, as the world emerged from the Spanish Flu pandemic, a contract was awarded for the construction of an electric ferryboat to ply the Hudson River between Highland and Poughkeepsie which, according to the contractors, would be the first electric ferryboat around New York.

By 1939 the 7-strong fleet of an operating company called Electric Ferries Inc. of New York was in regular silent service. The Electric Ferries were financed by General Motors Corp and the engines were supplied by General Motors. The Bay Ridge operation was subsequently taken over by the Electric Ferries company on March 1, 1939. Fleet livery was dark green, with the words "Electric Ferries" across nearly the full length of each side.

In 2011, the 168ft New York Hornblower Hybrid 600 PAX ferryboat became the first hydrogen hybrid combining a 32kw proton exchange membrane fuel cell, two Helix Wind 5 kW wind turbines and a 20kW SunPower solar array;

In June 2019 New York City announced plans to alleviate the inevitable commuting nightmare with alternative electric bus routes, rentable electric bicycles and a 150 PAX electric ferryboat to shuttle commuters across the East River, from Brooklyn to Manhattan. SW/TCH E-Mobility a new electric transportation company based around multiple modes of EV commuting partnered with Clean Marine Energy ("CME"); No news since COVID-19...

US Postscript: Harbor Harvest, which sells locally sourced fresh veggies, artisan products, in-house butchered meats, and dairy foods to local restaurants, plans to move the transport of those goods from the road to the water. To do this, it will build and operate a fleet of battery-powered cargo vessels to connect to ports in Connecticut and New York.

Harbor Harvest held a keel laying ceremony on February 23 for the first of what could be as many as three 65 ft x 21 ft hybrid all-aluminum cargo vessels at Derecktor Shipyards in Mamaroneck, NY.

The boat will be fitted with a HybriDrive Marine Propulsion System from BAE Systems, along with an energy storage system and Cummins diesel generators. The first of its kind to be built in the U.S., the hybrid cargo vessel will be part of a new sustainable marine cargo transport network on Long Island Sound and the Hudson River. Every voyage eliminates several nine-hour truck trips along the length of Long Island and the Connecticut shore.

In November 2020, it was announced that the first in the fleet, Captain Ben Moore which had been delivering high-value goods from farmers and producers on Long Island to Fairfield County, Connecticut would be fitted with a Sea Machines SM300 fully-functioning autonomous navigation system, offering redundancy and flexibility for crew shifts, with the capability to autonomously command Captain Ben Moore from the company's land-based control station

Canada



In 2016, British Columbia BC Ferries issued a Request for Expressions of Interest to the international shipbuilding industry for two 81m electric ferryboats to provide inter-island ferry services between Vancouver and Vancouver Island.

After attracting interest from no less than 28 shipyards, the highly competitive tender process proceeded in October 2016 when short-listed companies – including five Canadian shipyards – were invited to submit their bids. Netherlands-based Damen Shipyards was selected as the subsequent winner of this tender process.

The vessels, with a capacity to carry approximately 44 vehicles and up to 300 passengers and crew have become part of BC Ferries' ongoing fleet renewal programme of their Island Class ferries because they run from the mainland to an archipelago of nearby small islands.. The ships are fitted with hybrid technology that bridges the gap until shore charging infrastructure becomes available.

BC Ferries operates 24 ferry routes along the coast of British Columbia, Canada. The new 8117 E3 hybrid ferries vessels will soon be able to cover many of the company's routes to the Northern and Southern Gulf Islands off the coast of Vancouver. Built in Galati, Romania, Island Discovery and Island Aurora have replaced the 59-year old North Island Princess and the 53-year old Quadra Queen II .

Their decision justified, in November 2019, BC Ferries ordered four additional to continue standardisation across their fleet: Campbell River – Quadra Island

(2 ferries) and Nanaimo Harbour – Gabriola Island (2 ferries), going into service in 2022. Due to COVID-19, this new hybrid fleet has not been seeing “business as usual”.

In February 2021, BC Ferries announced its decision that a Canadian shipyard to modify the existing six from hybrid diesel-electric to full battery-electric operations. In addition to the vessel changes, it would modify nine terminal facilities, adding rapid plug-in charging systems. Qathet Regional District has written a letter of support for the pure electrification including Island Discovery ferry, already running on the route between Texada Island and Powell River.

In the second phase of the electrification plan, B.C. Ferries proposes building seven additional electric driven ferries. All of these ferries would be built at a Canadian Shipyard and possibly a yard located in the province of British Columbia. But there is one major caveat: building these ships at home is only possible if the federal and provincial governments are able to provide additional funding for the higher cost.

Also in Canada, to reduce greenhouse emissions by 1,357 cars (7.4 million kg of CO₂/year), in November 2019 the Province of Ontario invested approximately \$94 million and the Government of Canada contributed up to a maximum of \$31 million towards building the new all-electric ferries for service from Kingston to Amherst Island and Wolfe Island near the mouth of the St. Lawrence River.

The new ferries also purchased from Damen – one 98m and the other 68m – match the capacity and speed of the existing diesel ships. The larger of the two will run from Kingston to Wolfe Island, carrying up to 400 people and 75 cars, the smaller Amherst Island model carrying 300 and 42. Both have top speeds of 12 knots.

Since 2017, Ottawa Boat Cruise has also operated a tour of Rideau Canal in the nation’s capital on a 100-passenger partially solar-powered electric boat. At the time, it was advertised as the largest electric passenger vessel in North America.

The Quyon Ferry is a battery-electric powered ferry which brings passengers and cars back and forth across the Ottawa River between Québec and Ontario. The ferry, which closes for the winter, uses 14 3,400-pound batteries to propel itself across a cable stretching across the river.

Joining these other Canadian ferries in leading the switch to electric and hybrid options, Ports Toronto announced that their Marilyn Bell I, which runs between the city shore and the Billy Bishop Airport on the Toronto Islands be retrofitted in 2020. The conversion from the ferry's current bio-fuel power to renewable electricity, supplied by Bullfrog Power, is expected to reduce greenhouse gas emissions by 530 tonnes.

On a much smaller scale, the Alutasi, a 44 ft e-boat that can take up to 25 guests out deep sea fishing in the waters around Halifax, Nova Scotia, is the first such boat to gain safety approval from Canada's Marine Technical Review Board.

Formerly diesel-powered it was retrofitted by Glas Ocean Electric with financial assistance and grants from a variety of public and private sources, including Nova Scotia Power and Canada's national Research Council.

Along with the propulsion makeover she received a bright hull mural depicting various ocean animals designed by world renowned indigenous artist Alan Syliboy of the Mi'kmaq (pronounced meeg mah) First Nations. The vibrant images, inspired by Mi'kmaq petroglyphs, were made into a hull wrap by Mattatall Signs. The new name of the boat, 'Alutasi' is Mi'kmaq for 'a boat that guides to the best fishing'

On the Canadian-American border, one of the most incredible boat rides on the planet is now experienced in a ferry powered by electric motors in new versions of the Maid of the Mist boats that take 230 visitors per trip to get drenched at the foot of thundering Niagara Falls.

The Maid of the Mist boats have been plying the lower Niagara gorge since 1846 and now take about 1.6 million visitors per year literally to the bottom of the Falls. Designed by Propulsion Data Services, the new totally integrated vessels have been built by Burger Boat Company in Manitowoc, Wisconsin, USA.

In a private family ceremony on July 31, Maid of the Mist's 2 new all-electric, zero-emission passenger vessels were christened at the corporation's drydock and maintenance facility on the Lower Niagara River: James V. Glynn and Nikola Tesla entered into regular service on October 6th 2020, replacing the diesel-engined Maid of the Mist VI (1990) and Maid of the Mist VII (1997).

Across the Border, the USA's largest ferry owner by tonnage, the State of Washington, is heavily in favour of electrification. Under the direction of Governor Jay Inslee, who has made climate action his defining issue, Washington State Ferries has adopted an ambitious plan: It wants to have 22 plug-in-capable hybrid vessels and 17 shore-charging stations by 2040. Joining forces with shipbuilder Vigor Industrial and engineering and technology company ABB, Washington State Ferries will build the first five in a total of 16 new vessels and move to a fully hybrid-electric fleet by 2040.

Iceland



ABB will supply integrated power and electric storage solutions to the Icelandic Road and Coastal Administration's new ferry that will take 3,600 annual trips in the rough waters between Landeyjahöfn on the mainland and the Westman Island, covering 13 km in about 45 minutes.

The 70m-long ferry, with a capacity of 550 passengers and 75 cars was due for delivery from the Crist S.A. shipyard in 2019. Conceptual design of the ferry was completed by Polarkonsult, and StoGda Ship Design & Engineering was responsible for the class design and production documentation of the vessel.

The vessel will feature a large battery pack (3000kWh) and is designed to operate in a fully electric mode for most of time, with onshore charging in both harbors. During particularly challenging weather conditions, when the consumption of battery power may exceed the available energy, the ferry will utilize its diesel-electric generator set.

Germany



In 1884, Siemens und Halske, now with their Berlin premises along the banks of the western Spree River, launched the Elektra, its first electric boat on local waters. The wooden hull and two 40 cm. diameter propellers were supplied by the Reinhold F. Holtz shipyard in Harburg to Berlin. The Elektra, carrying up to 25 passengers was demonstrated during the Berlin Trade Fair at a speed of up to 14 km/h. (9 mph).

The situation in Germany is complex. There are national waterways with their own set of regulations, there are State Waterways "owned" by different states each with different sets of regulations. There are regional bodies of water with their own diverse jurisdictions.

The City of Berlin is said to suffer from heavy air pollution due to the many diesel-powered passenger vessels. While there are (and have been for a while) several solar electric passenger lines and while there have been operating large solar electric passenger tour boats for many years, Berlin's tour boat operators have formed a powerful lobby group opposing any change in the regulations as long as possible.

The Berlin City Senate sponsors the conversion of diesel powered vessels to Biofuels and particulate filters claiming a possible 30% reduction of CO₂ and a 90% reduction in toxic emissions will be possible by 2030.

In 2014, Berlin-based Solar Circle Line, co-founded by a conventional tour boat operator and Berlin's solar electric boat pioneer, SolarWaterWorld, commissioned two solar electric tour boats.

Their 180-passenger Suncat 120 was put into service in June of 2020; a second identical boat to follow in September of 2020. The success of these boats will hopefully convince the tour boat lobby and the Berlin City Senate of the economic feasibility of solar electric boats. A soft transition without major administrative intervention may eventually happen.

Several powerful environmental groups in Germany NABU (Nature and Biodiversity Conservation Union), BUND, and GREENPEACE demand the government's swift transition towards non-polluting transportation technology.

Their activities peaked in 2018 with respect to air and water pollution caused by boats with internal combustion engines. As these groups do manage to influence government policy it will be important to secure their support. Daniel Rieger, NABU's head of transportation policy reports that NABU's focus is on large ships e.g. cruise ships and container vessels including seaports, also including large cruise ships on inland waterways such as the Rhine.

As far as Berlin waterways are concerned there is a powerful lobby resisting change. The German government contributes 50% of the cost for a tour boat being converted to "cleaner" diesel technology (filters etc.), and the Berlin City Senate contributes another 25%. Yet there are no takers as the tour companies see no policy forcing them to make any change their boats.

A German Parliament initiative for non-fossil watercraft which is in (slow) progress. Due to COVID-19 many stakeholders are now trying to delay or postpone any progress indefinitely. NABU has not yet focused on small watercraft on inland waterways but is sympathetic to AltFuels mission.

The German National Waterway Administration (WSV) governs, among other things, 7300 kms of Germany's inland waterways. The WSV reports to the German National Ministry of Transportation and Digital Infrastructure (BMVI).

Their main concern is to keep waterways navigable for commercial transport. Environmental concerns do not yet play a significant role in their waterway policy, at least not in terms of a transition towards electric propulsion. In

recent years there was some acknowledgement of water tourism claiming an ever bigger economical relevance. A BMVI department for water tourism ("Secondary Waterways") was formed. Their position is evolving with a funding prospect for historic and recreational waterways (such as our Finow Canal).

The WSV currently does not see itself in a position to regulate environmental standards. They do cooperate with other entities thus closing certain segments to small waterways for environmental reasons (e.g. Biospheres, Fauna Flora Habitat, and others. Whenever a segment of waterway is closed for motorboats this will include electric boats as well.

As there are many categories of water craft already acknowledged by the WSV (including jet skis, stand-up boards and others), a differentiated treatment of combustion vs. electric engines would be desirable, thus facilitating a possible future distinction of waterways that are open to human-powered and electric boats.

A recent development regarding Germany's State Waterways was the introduction of a new regulation limited to the State of Brandenburg recognizing electric propulsion as eco-friendly.

This regulation was the result not of insight but of anglers lobbying for their use of trolling motors on bodies of waters where motorized water craft were thus far not permitted. This new regulation allows the use of electric motors on Brandenburg State waterways of up to 1kW. While this would be too limiting for other types of recreational boating activity, it shows that change can be effected on administrative bodies through public pressure.

This has been the method how the Feldberg Lake area in the State of Mecklenburg-Vorpommern has become electric (and human-powered) exclusively. Still, other lobby groups maintain their claim on the use of fossil boats, e.g. for water skiing still permitted there in restricted areas.

Interviews have been conducted with various stakeholders conveying details of their strategy and with tour boat operators having to convert their vessels to electric by 2023. Generally there is a high level of acceptance in local tour boat operators, with customers asking directly for rides on electric boats and houseboats.

Other waterways exist in Germany where (solar-) electric personal and commercial boats are in use, and have been so for 20 years or longer with

many bodies of water restricting the most polluting types of watercraft or prohibiting the use of personal watercraft altogether.

The German inland waterway system is a jumble of responsibilities and jurisdictions in desperate need of consolidation.

There seems to be a slow transition taking place through individual companies investing in eco-friendly technologies with national and state authorities trying to stay out of trouble but offering a funding opportunity or two for companies venturing into areas of eco-friendly technology. The fossil lobby is still being strongest, but with electric and solar electric vessels increasingly claiming their place on Germany's waterways.

Czech Republic



There are 50 passenger ships operating on the Vltava (Moldau) River in Prague in the Czech Republic. This is comparable to the number of vessels in Berlin or Budapest.

The association of passenger boat operators feels that there should be no additions to the fleet, only replacement of the existing fleet. The Prague fleet's environmental performance has already been greatly improved by modernisation and retrofitting in recent years.

The new diesel engines reduce nitrogen oxide emissions by 50% and particulate matter by up to 90%. After retrofitting, the vessel's emissions are equivalent to that of a normal van. This is also in the operators' interests, since they save on operating costs and improve the environment for their passengers.

A serious move was made towards AltFuels in 2010, when Jan Hamza, Director of the tour company European Water Transport, designed and created the Republic's first and only solar-boat Elektronemo, inspired by Captain Nemo in Jules Verne's novel "20,000 Leagues Under the Sea".

The boat was equipped with three solar panels that generate 2.2kW of power using a system of two suitcase-size electric motors, giving it an autonomy of up to 10 hours on the Vltava River. Electronemo became part of the Prague Boats tourist fleet.

Seeing tourists attracted to her silent running, Prague Boats decided to scale up with the 25 m 250 PAX Bella Bohemia, her aluminium hull built by the

German Bolle shipyard in Derben and energy storage system (12 Green Orca 1050 lithium nickel manganese cobalt oxide (LiNiMnCoO₂) batteries, 126kWh at 600V) supplied by EST-Floattech, integrated by SER (Schiffselectronik Rostock GmbH).

Voith inline thrusters with a maximum power of 2 x 55 kW were used as propulsion for this vessel. These are electric motors with the ability to rotate 360 °, which guarantees excellent maneuverability. This type of electric motor is used on luxury yachts and seagoing ships as a steering gear, but it was used as the main drive for the first time.

Thanks to her panoramic windows and open upper deck, Bella Bohemia offers gorgeous views of the surrounding monuments, such as Charles' Bridge, Prague Castle, the National Theatre, Dancing House, and Vyšehrad. Under normal operation at 50% engine power, the boat can cruise for over 6 hours.

At full load, the battery capacity gives one hour of operation. On-shore overnight charging at its home base at Kampa dock takes approximately three hours. The ship is also trickle-recharged from charging points on the river embankment between individual voyages. Year-round operation is possible thanks to air conditioning and heating.

EST-Floattech has also delivered their Green Orca batteries to the 17 m LOA (with 5 m access flaps) x 8.6 m.B Sankta Maria II, built by Ostseestaal and claimed as the world's first solar-powered electric car ferry to serve a crossing on the Moselle river, between Oberbillig, Germany and Wasserbillig, Luxembourg – replacing the previous Sankta Maria diesel ferry.

She entered service from December 2017. With a carrying capacity of 25 tonnes and the ability to transport 45 pedestrians and six passenger cars on 2 lanes each 2.5 metres wide per crossing, Sankta Maria II will be transporting annually an average of 143,000 people, 66,000 cars, 1,600 motorcycles and almost 20,000 bicycles.

The power required for this transmission comes from the drive batteries, which are recharged overnight with shore power (approx. 6 hours charging time). The battery capacity is designed for 13 hours of ferry operation plus a further 13 hours as a safety backup.

Taiwan



The Taiwanese port city of Kaohsiung relies on its marine network to transport machined goods across its bustling harbour. It is the thirteenth largest in the world. Kaohsiung is typical of many harbour cities in Asia, where air-polluting diesel ferries have been a necessary part of life. In nearby Hong Kong, air pollution kills an estimated 3,200 people every year.

As part of a wider drive to improve air quality, the Kaohsiung City Government tasked Taiwan's Ship with reducing emissions from its ferry fleet. They included Ocean Industries R&D Center (SOIC) as well to help.

In 2017, Kaohsiung City Government launched a 100t, 23m-long retrofitted hybrid electric ferry named Ferry Happiness which serves the popular Cijin Island passenger route and was proclaimed as the first of its kind in Asia. SOIC had worked with Danfoss of Denmark. Ferry Happiness has since been saving more than 25,000l of fuel every year and is capable of carrying 15,000 passengers every day.

Following the success of this project, the Kaohsiung City Government plans to retrofit the rest of its diesel fleet. In June 2018, a new ferry route from Cijin Island to Kaohsiung Port Warehouse No.2 (KW2), next to Kaohsiung Pier-2 Art Center, began with an official launch ceremony at KW2.

After attending the ceremony, Minister of Transportation and Communications Ho Chen Tan, Taiwan International Ports Corp. Chairman Wu Hong-mo and acting Kaohsiung Mayor Hsu Li-ming boarded the ferry for its maiden voyage.

Noting that the new route will be serviced by electric boats, the transportation minister said this new green transport choice, together with the Kaohsiung Mass Rapid Transit (KMRT) and light rail system, will not only help boost local tourism and economic development but also promote environmental protection.

The electric propulsion of the vessel has been designed to ensure pure electric cruising for half the ferry's operation time

Alongside this, from January 2020, the State-supported CPC Corporation has deployed two new electric powered refuelling tankers N° 21 and N° 22 at the port of Kaohsiung. The vessels, each weighing 1,999 tons with a capacity of up to 2,700 tons, will produce 29% less CO₂ than any of the other nine gas-powered vessels in CPC's fleet. The ships were built in Singapore and tested in Vietnam.

Vard in Ålesund, Norway is designing an offshore wind Service Operation Vessel (SOV) for Taiwan's Ta San Shang Marine Co., Ltd., a joint venture between Mitsui O.S.K. Lines Ltd. (MOL) and Ta Tong Marine Co., Ltd. Measuring 84.4 meters long and with a beam of 19.5 meters, the hybrid drive Service Operation Vessel (SOV) will be the first of its kind in Asia, developed to serve maintenance support operations for Ørsted in a 15 years charter in the Greater Changhua offshore wind farms in Taiwan.

The SOV is of Vard 4 19 design, developed by Vard Design in close cooperation with the customer and partners, and will be built at Vard's shipyard Vard Vung Tau in Vietnam, scheduled for delivery in first half of 2022. For optimal efficiency, the hybrid vessel will be equipped with diesel-electric propulsion in combination with a Vard Electro SeaQ Energy Storage System.

Thailand



For decades, the air in Bangkok, Thailand, whose Chao Phraya River and its Khlongs or canals are known as the “Venice of the East”, its cacophonous, wooden longboats (“Gondolas of the South”) spewing fossil fuel exhaust as they motored past the centuries-old Grand Palace and Temple of Dawn, had threatened a poisonous haze as seasonal weather changes prevented pollutants, including exhaust fumes, from dissipating.

From 2018, as part of the city’s efforts to improve air quality, Bangkok Metropolitan Authority (BMA) decided to trial a 40 PAX 47.5-ft fibreglass all electric ferry on a 5km daily run, stopping along 11 ports on Phadung Krung Kasem canal, starting at the Hua Lamphong train station pier and ending at the Wat Devaraj Kunchorn pier.

It had been retrofitted at the MariArt Shipyard, replacing the existing 205hp diesel engine with twin Torqeedo Cruise 10 kW electric outboards, each with six BMW i3.lithium battery banks and two fast chargers. This followed the initiative of David Hunter, MD of Torqeedo Asia-Pacific (APAC).

Prime Minister Prayut Chan-o-cha celebrated the launch, giving his symbolic approval to the city’s efforts to ease congestion and improve air quality through investments in green transportation.

The project was a key part of Thailand’s 4.0 Smart City vision for an integrated clean, green public transportation system, both on land and water. This model was tested for one year, allowing passengers to ride for free every day from 6am until 8pm to the end of the year. Torqeedo-Deutz had already provided their motors to 15 excursion boats in a holiday resort near the Vietnamese Hoi An.

Soon after, Wolfgang Grimm in conjunction with Torqeedo and Hans Chalomark, introduced the world's first electric (solar-powered) long-tail gondola for trips through Thailand's tranquil mangrove-lined canals around Koh Klang. A larger 6-seater version was planned

In conjunction with World Environment Day 2019, UN Environment and the Climate and Clean Air Coalition announced they would be supporting Thailand's Pollution Control Department to assess the impact of canal transport on air pollution in the city.

The Bangkok Harbour Department announced a project in May to develop a 100-passenger proof of concept electric boat with the city's Kasetsart Research University. The boat would act as a proof of concept and allow the Department to study the feasibility of switching to electric boats.

In August 2020, the aluminium BanpuNext, with a calculated range of 60 km, made its maiden voyage on the Saen Saeb canal in Bangkok, running at 22 km./h for four kilometres from Phan Fah Lilat pier to Pratunam pier without noise pollution.

Four parties from the public and private sectors, including the Marine Department, National Science and Technology Development Agency (NSTDA), Banpu Next Co., Ltd., a subsidiary of Banpu PCL, and Sakun C Innovation Co., Ltd., joined hands to sign an MoU in "Design development, production and standardization of quality electric ferries (e-Ferry) for the safety of water transportation and the promotion of maritime commerce."

The program is for an initial 54 ferries providing service up and down the Chao Phraya river and its Khlongs in the first phase before expanding to no less than 200 ferries in three to four years.

On September 22, 2020 EGAT (Electricity Generating Authority of Thailand) launched electric motorbike taxis and boats to support electric vehicle use for public transportation with an aim to reduce air pollution and PM2.5 as well as connect transportation points among wheels, rails, and boats, in accordance with the Government's One Transport Policy.

Moreover, EGAT has developed 2 electric boats which run by electric power from 214 kW-hour lithium-ion batteries, with the speed not less than 10 knots and distance of 60 km in a single charge.

The air conditioner system in the passenger rooms has been designed to use electric power from solar cells installed on the roofs. Each boat can carry 80

passengers in total. For the first phase, their cruising is tested to assess their performance by using them for EGAT mission before expanded for public use in the future to connect the transportation points of “wheels, rails, and boats.” Meanwhile, installation of charging stations for electric boats is in the process.

In December 2020 the Bangkok Metropolitan Authority (BMA) introduced its new fleet of electric commuter ferries into service. The MariArt Shipyard has repowered these 48-foot fiberglass ferry boats, replacing their 200-horsepower diesel engines with twin Torqeedo Cruise 10 kW electric outboards, twelve large lithium batteries and four fast chargers.

The 30-passenger, zero-emission water taxis are part of a fleet of ferries operated by BMA's Enterprise Krungthep Thanakom Company (KT BMA). They are covering a five-kilometre express ferry route with departures every 15 minutes.

Alongside this, billionaire Somphote Ahunai, CEO of Energy Absolute is building 42 aluminium-alloy 235 PAX (104 seats plus 131 standing) ferries, as part of a strategy which includes a \$3 billion battery factory and a line of electric cars .

It's called MINE Smart Ferry, where MINE is for "Mission No Emission" Energy Absolute is investing 1 billion baht (\$33 million) in the business and will install its own fast-charging stations dockside capable of recharging the 24-meter-long (79-foot-long) vessels in about 15 minutes. This is achieved by a recharging system using a total of 26 CCS2 DC fast charging inlets and plugs. Each fill-up will last between two and four hours on the water, with a range of 80-100 kilometres (50-62 miles).

The batteries below deck each weigh about 300 kilograms, giving the vessel an 800-kWh capacity. The marine batteries are designed to withstand a high-impact collision and the batteries can be submerged underwater safely for at least an hour.

The technology is seen as a way to ease Bangkok's air pollution. The vessels will be operated by the Chao Phraya Express Boat Co. Ltd., a century-old company that also operates riverside malls, hotels and restaurants, carries millions of passengers a year.

According to Anil Srivastava, CEO of Swiss battery producer Leclanché SA, which supplies maritime customers: “More than 70% of ferry traffic around the world could become all-electric.”

Russia: Saint Petersburg



In 1839, with financial assistance of Czar Nicholas, a German scientist called Moritz Hermann von Jacobi, , working on the transference of power from a primary battery to an electric motor, constructed the Elektrokhod, an 8.5 m (28ft) electric paddleboat and tested it against the current of the River Neva at Saint Petersburg The boat travelled at 2.6 knots. This was World First.

180 years later, in August 2020, the concept of using passenger vessels with electric propulsion on the water routes of St. Petersburg was presented to Maxim Sokolov, Vice-Governor of St. Petersburg at an offsite meeting onboard the Ecovolt.

Although first unveiled at the NEVA 2019 Exhibition and Conference, the 19.9 m Ecovolt double-decker fibreglass catamaran was officially launched in the Passenger Port on June 27th 2020 as the first all-electric passenger ship in Russia (since Jakobi), able to cruise at 15 knots with 110 passengers maximum on board for 11 hours without being recharged.

It is powered by two motors: a 50kW direct driver azimuth thruster and a 50kW bow thruster. Energy comes from swift recharge lithium-titanite batteries (up to 300 kWh) and lithium-iron-phosphate (up to 600 kWh). Charging can take place either by Onshore Bidirectional inverters 75 kW to 5000 kW, whilst topping up by a floating barge.

The concept had been developed by the Directorate for the Development of the Transport System of Saint Petersburg and the Leningrad region in conjunction with NPK Morsvyazavtomatika (MSA) and Emperium. The concept goal is to create a charging / recharging installations infrastructure for

all-electric boats. As of now the initial data have been provided by LENENERGO for the design of 16 onshore and floating charging stations with a capacity of 150 to 2 mW with connection to the power supply networks.

The vessel is designed for river cruises and is to replace Meteor river boats. The meeting considered six main routes to be serviced by the vessels with electric propulsion.

A list of state support measures has already been developed for three types of vessels: Cityvolt, Ecovolt, and Ecocruiser. The support measures are the following: the provision of subsidies from the federal budget to producers of all-electric vessels, indefinite zero property and transport tax, preferential electricity cost for the electric boats at the charging stations, the temporary zero rate for use of berthing facilities for electric ships, the program of preferential leasing of all-electric vessels.

Participants of the meeting proposed to launch the laws / regulations amendments procedure at the regional level. Kirill Polyakov, the Chairman of the local Transport Committee, noted that the all-electric vessel can be used by various executive authorities of Saint Petersburg, including for interdepartmental control inspections within the basins and coastal territory.

Maxim Sokolov supported the implementation of the concept, noting that the St. Petersburg government will provide the necessary support for its further success.

South Korea



In February 2020, South Korea commissioned Haemin Heavy Industries, a small aluminium-vessel shipyard in Busan to build a 100 PAX, all-electric ferry for the Busan Port Authority. The 40-m catamaran will commute between Busan's North and South ports, a one-hour round voyage at an average operating speed of 13 knots, multiple times a day. ABB will provide the DC grid distribution system and the power and energy management system for the propulsion and all auxiliary power loads.

It is the first government contract issued under a plan to replace no less than 140 South Korean state-owned vessels with new, clean-power models by 2030. The project is part of the South Korean government's broader pledge to achieve net-zero carbon emissions by 2050, in line with the Paris Climate Accord and would represent one of the world's biggest green transportation construction campaigns, twice the fleet being built for Kochi, India!

The Netherlands: Port-Liner Project



Based in the Netherlands, Ton van Meegen, inland waterways entrepreneur in the Nijmegen Area, Netherlands has started up Port-Liner Holdings CV to develop a fleet of fully-electric crewless container barges to transport freight initially from the ports of Antwerp, Amsterdam, and Rotterdam.

Called “Tesla ships”, One Kempenaar-sized vessel called the Tempship is 170 ft (52 m) long and 19ft (6.7m) wide, and able to carry twenty-four 20ft (6 m) containers weighing up to 468 tons (425 tonnes). Its electric motors will be driven by 20-ft (6 m) Vanadium Redox Flow Batteries (VRFB), giving it 15 hours of power, charged on shore by the carbon-free energy provider Eneco.

Although designed to operate without any crew, EC52 will be manned initially. Adjustable wheelhouses enable them to go under 5m60 (16 ft) bridges, while by flooding its ballast tanks, it can further reduce its height.

The EC 110 version has a length of 328 ft (100 m) and a width of 38 ft (11m45), to load 14 containers of 20 ft (6 m). or 7 containers of 40 ft.(12 m) or any combination of the two sizes.with four E-Powerboxes would have an action radius of about 30 hours (143 mi or 230km).

This allows the vessel to easily cover the Rotterdam/Antwerp/Duisburg corridors, at competitive cost compared to conventional diesel propulsion. The ship can be customized (dimensions, cargo type) up to 7700 tons (7,000 tonnes).

Port-Liner submitted a project under which it will build five hybrid barges that will ply between De Kempen intermodal terminal in the Netherlands and

Antwerp. Thanks to these hybrid barges there will be 23 000 fewer diesel trucks on the roads annually and a reduction of about 18,000 tonnes per year of CO₂.

According to a report from transportation news site Elektrek, the 100 million-euro (US\$122 million) project has been supported by a €7 million (US\$8.6 million) subsidy from the European Union, with Loadstar also having reported that the Port of Antwerp had added a €200,000 (US\$245,000) subsidy as part of a wider initiative to improve its port's efficiency. Port-Liner can build 500 of these ships per year.

The battery pack could also be used to retro-fit existing river barges. During summer 2020, the 443 ft (135 m) Portliner Anna went on trials from Werkendam, southern Netherlands. (portliner.nl)

In this context, the Port of Antwerp, the Port of Rotterdam Authority, the Port of Amsterdam, North Sea Port Netherlands, Drechtsteden and De Vlaamse Waterweg are planning to set up a single shore-based power system for inland shipping and the river cruise industry. Inland shipping has been identified as a more environmentally-friendly and efficient way of cargo delivery when compared to road haulage.

Using shore-power for different types of inland vessels further reduces their carbon footprint while in ports, allowing crews to use their onboard facilities without having to use diesel generators or the ship's main engine.

"Ideally, this new standardisation will be adopted by many other countries besides Belgium and the Netherlands," the Port of Antwerp said in a joint release.

Greece



Dr. Georgios Vokas, Prof. in Electrical and Electronics Engineering Dep. of the University of West Attica and his Renewable Energy Sources Research Lab staff, in collaboration with Greek Ministry of Maritime Affairs and Insular Policies .

With almost 14,000km / 8,500 miles of coastline, Greece has hundreds, if not thousands, of ferries large and small, fast and not so fast, for visitors and locals going from island to island and from mainland port to mainland port. Greece is in an ideal location to benefit from sustainable energy.

Photovoltaics, wind and sea & tidal waves can produce energy and in turn hydrogen to supply a variety of electric loads like marine and inland waters (lakes, rivers) electric vessels.

The EU has declared that all its Member States should urgently adopt practices for the transition to zero emissions in all means of transport. Greece can be no exception, on the contrary Greek Government is taking significant steps towards this target.

In the past times Greece had been at the forefront of innovation; nowadays, has the duty to continue doing so. In 2020, a project started between the Greek Electric Boats Organization (EBA Greece), the University of West Attica (UNIWA) and the Ministry of Maritime Affairs and Insular Policy.

The scope of the project is to convert an existing ferry into a hybrid one, powered by diesel and/or electricity via batteries. This ferry, crossing 10 km of the Gulf of Corinth will connect the port of Aeghio on the Peloponnese side with the village of Agios Nikolaos on the mainland's Dorida region.

The electric energy for the batteries will be supplied by renewable energy sources installed on land, close to the harbor. A pilot project that could become a leading paradigm for the 86 conventional passenger vessels that operate in the country and emit gaseous pollutants.

For this project, some of the largest companies in the world (Transfluid, Watzila, ABB) have expressed their interest to participate in its realization offering cutting-edge technology proposals. My team and I have proceeded to all necessary analysis of the proposals and in collaboration with the General Secretary of the Ministry of Maritime Affairs Dr. Kyriazopoulos we are working towards the financing of the project so that it will start within the year 2021.

Turkey: Istanbul



According to Sinem Dedetaş head of Istanbul City Lines, his fleet of diesel engined ferries currently make 621 trips per day on 21 routes, carrying some 13,213,000 passengers during 2019. Dedetas is planning to put electric ferries into operation. "We have lagged behind other countries regarding this issue.

We have started the feasibility of this project on paper. The issue of electric ferries is one of the topics that the Industry and Technology Ministry is giving importance. The City Lines has assumed the coordination for projects undertaken by the ministry regarding this issue."

Turkey has already been building electric ferries. Tersan Shipyard has delivered three battery-powered ferries to Fjord1, one of the leading public transportation companies of Norway (see below).

Navtek Naval Technologies has designed and built an 18.7-m-long NV-712 ZeeTug (Zero Emissions Electric Tug) for GİSAŞ Shipbuilding Industry to operate in the Port of Istanbul. Elkon, a subsidiary of Imtech Marine of Turkey claims to have taken orders for more than 30 electric ships in six months' alone for use in especially the Golden Horn, Bosphorus and Çanakkale Strait (Dardanelles).

It has been awarded an interesting contract from Sedef Shipyard (Tuzla, Istanbul) for the delivery of the electrical equipment, propulsion system and services for two 148.9 m Canadian Seaspan hybrid ferries, using diesel and liquefied natural gas. Uzmar Shipyard in Kocaeli, has also built diesel-electric pusher tugs

On the pleasureboat side, GreeNaval of Antalya, Turkey offer their aluminium GN47 and GN60 cabin cruisers with a pure electric or hybrid propulsion options. So the technology for Istanbul City Lines is certainly national.

New Zealand



The first electric boat in New Zealand was called Australia when the two islands were then part of the British colony of New South Wales.

The year was 1884. Built by Forrest of Millwall and also fitted with EPS accumulators, the mahogany-hulled Australia was ultimately destined to go out to the firm of Stephen Smith & Co. based by Kaipara Harbour, on the north western side of the North Island of New Zealand.

Before shipping, Australia competed with Electricity in a match race on the River Thames, England, on a course from Millwall to Charing Cross Bridge and back. There is no record of which boat won, but apparently Australia was very slightly ahead at Charing Cross on the way upstream!

In August 2020, New Zealand companies HamiltonJet and EV Maritime signed a Memorandum of Understanding to build advanced composite, battery-powered commuter ferries. Their cooperation had been formalized at HamiltonJet's Christchurch headquarters in May, in the presence of Hon Dr Megan Woods, New Zealand's Minister of Energy & Resources and Minister of Research Science & Innovation.

With the aim of decarbonizing the harbor cities of the world, the firms are seeking to develop one of the world's first truly high-speed, full-size, zero emission fast ferries.

Meanwhile Cam Harris and Adam Wrightson of Beacon Marine, along with naval architect Dan Leech have designed two boats, the EVO33 Leisure craft, and the EVO33c commercial craft. Both are 33ft catamarans.

The vessels will be fully manufactured in New Zealand and powered by OceanVolt, an electric propulsion system from Finland who Beacon Marine have secured sole agency for distribution in New Zealand and the Pacific Islands.

Meanwhile the Wellington Electric Boat Building yard at Lower Hutt concern has built a fully electric carbon fibre ferry with a passenger capacity of 135 passengers.

In August 2020, Damen Shipyards and Echandia Marine formed a partnership to develop what is said will be the world's first fully electric ship-handling tug. The venture combines Damen's renowned tugboat experience and Echandia's expertise in battery energy systems.

The RSD-E Tug 2513 will serve the Ports of Auckland (POAL), the company administering New Zealand's largest container and international trade terminal. The port manages over half of the country's imports and exports, as well as hosting hundreds of thousands of cruise ship voyagers every year.

In November 2020, New Zealand's state-owned transport operator KiwiRail selected the Isle of Man Ship Registry to oversee construction of two rail-enabled ropax ferries that will operate in the Cook Strait. Denmark's OSK-ShipTech will design the two 220-m diesel-electric hybrid ferries capable of carrying 1,900 passengers each.

Diesel generators and batteries will provide electrical power for azimuth thruster propulsion. The ships are targeted to enter service in the mid-2020s,

In Australia, Queensland's determination to lead the way with hydrogen has reached new levels. Brisbane-based outfit H2X Marine, the new boat building arm of fledgling automotive manufacturer H2X Australia, has partnered with Queensland-based ship building specialist WildCat Marine to manufacture a range of zero-emission, hydrogen-fuelled passenger ferries for industrial and commercial use.

By November 2020, construction on the first of the ferries had already begun with the company to access the Fuel Cell Electric Vehicle (FCEV) technology developed by H2X Australia as part of their automotive design process.

The first of the ferries, the Maroochy, will comprise an aluminium hull, have 50-passenger capacity and will be fitted with two 120 kW electric powertrains driven by Hydrogen Fuel Cell (HFC) technology. Projected launch date is early 2021. The aim is to manufacture up to 30 ferries at the company's Brisbane

factory to take advantage of a passenger ferry market worth an estimated \$3.5 billion globally and growing at more than 3.4% a year

In February 2021, Austal, the global ship building company based in Henderson, a suburb of Perth, Western Australia has launched their VOLTA series of electric-powered high speed ferry solutions, with the introduction of the Passenger Express 46V, a fully electric-powered 46-meter catamaran ferry design. Boasting a capacity of up to 450 passengers, a maximum speed of 25 knots and fast charging capability, with a range of over 175 nautical miles per day.

Austal claims that its VOLTA series is distinct from existing, electric-powered vessels in the marketplace by going beyond the replacement of diesel engines with an electric (battery) power plant, to offer a completely integrated design, construction and support solution - including on-shore charging infrastructure and in-service support programs for operators.

This also combines all new, light-weight, low-resistance hull forms, specifically designed, tested and optimised for electric-power propulsion, with state-of-the-art lithium ion batteries.

Portugal: Lisbon



Transtejo & Soflusa is a public ferry company operating between Lisbon, on the right (north) bank of the Tagus River, to the left (south) bank of the river at Trafaria, Porto Brandão, Cacilhas (Almada), Seixal, Barreiro and Montijo.

The company has been operating a fleet of 35 vessels of different types built in Portugal, Singapore, Australia, the United Kingdom and Germany. It includes 20 catamarans, 2 car ferries and 13 conventional ferries

In January 2020 Transtejo relaunched, through the publication in both the Diário da República and in the Official Gazette and the Official Journal of the European Union, an international tender for the acquisition of ten 100% electrically powered ferries for the river crossing between the South Bank and Lisbon, in an investment of €57 million.

This procedure had been annulled in December 2019, due to the "failure of the bidders to demonstrate compliance with the technical capacity requirements," The delivery should take place between 2021 (the first three ships) and 2024.

On a smaller scale, a 12pax electric dayboat, Rio-a-Dentro is used for nature and bird watching on the River Tejo. The two-and-a-half-hour tour departs from the Escaroupim's Pier (Salvaterra de Magos' Marina), 40 minutes away from Lisbon, and takes wildlife lovers on a visit to Tejo's many islands.

Malta



As long ago as the year 1241, there was a ferry service between the Mediterranean islands of Malta and Gozo, known in Maltese as “id-dghajsa tal-mghodija”, literally, the boat of the passage.

One thousand two hundred years later, Malta is planning 2 hybrid-electric ferries cruising from the main island of Malta out to Comino Island and taking locals and tourists to the famous Blue Lagoon swimming and diving area. The hybrid vessels were designed by Maltese naval engineers to be larger and faster than the current fleet and will include Wifi, disabled seating and baggage stowage facilities.

Mark Bajada of Comino Ferries, who will operate the service, said “These will be the first hybrid vessels to operate in Maltese waters and are designed using the latest technology. The vessels will operate in fully electric mode when in the vicinity of Comino, Marfa and Cirkewwa – meaning zero emissions and zero noise around the bay areas – and with reduced drag to minimize wake.” According to the tender, these boats must be in service by 2022

UK: Guernsey

Travel Trident Ltd.'s Iveco diesel-powered Herm Trident V is a 250 pax passenger ferry, sailing 8 times a day in peak season from Guernsey in the Channel Islands to Herm in just 20 minutes. Harrison Aviation Ltd. while planning to establish a passenger electric aircraft service is also working with Travel Trident to convert Herm Trident V to electric power. Richard Nettleton, CEO of Waterside International Ltd in Guernsey, has stated that in three or four years' time electric ferries could be operating between Guernsey and Herm.

Ecuador



In 2012 U.S. environmentalist Oliver Utne founded the Kara Solar ngo to produce a solar-electric ferryboat for service along the 67-km (42-mile) stretch of the Amazon's Capahuari and Pastaza rivers in Ecuador that connect the nine isolated indigenous Achua settlements that live along their banks. The community had previously relied entirely on gasoline canoes, known as *peque peques*, but they are expensive to run and are only owned by a few families per village.

The 20 PAX pv boat Tapiatpia, named after a mythical electric eel in the area, gave the Amazon its first affordable solar powered public transport system. While transporting green bananas, chicken, and peanuts to the markets in Peru, Tapiatpia could back clothes and rubber to Achua. More children were able to attend school, with more inter-community sports events.

Between February of 2015 and December of 2018, Fundación ALDEA welcomed Kara's project with enthusiasm and tireless support. This confidence allowed them to materialize important objectives like the beginning of a network of community recharge centres and enterprises.

In 2019, with additional funding from Nia Tero, a Seattle-based global collaborative designed to directly advance indigenous peoples' and local communities' stewardship of vital ecosystems around the world, Kara Solar built a second boat 14 PAX Sunkirum. In 2020, 40 round-trips were made without problems.

The boats generate their own electricity but can increase range and run time by recharging at waterfront recharge stations installed by Kara. The surplus energy is available in the community for other uses. Two that are being tested are

electricity for a community-owned hotel that normally uses a generator, and solar powered plant processing, using native species harvested by local students according to management plans created by a local women's cooperative. "Kara" means "a dream that will come true" or "a vision of the future".

USA: Hawaii

Since 2002, Gary Brookins, owner of Brookins' Boatworks on Sand Island, Honolulu, Hawaii has planned to replace the US Navy's aging Arizona Memorial shuttles with a fleet of 150 PAX electric ferries. Brookins had already built a small e-shuttle to operate on the Ala Wai Canal

At the time, because the Pearl Harbor Naval Station did not have the infrastructure to support electric boats, they were looking for diesel-fueled vessels that meet or exceed federal and local environmental regulations. But they stated then that they would eagerly support an electric alternative if the infrastructure could be established.

Brookins, with support from the federally financed Hawai'i Electric Vehicle Demonstration Project and the assistance of naval architect Robert Armstrong, had designed a 75-foot, 149-passenger fantail shuttle powered by new fuel cell technology. This boat's physical design harkens back to the Victorian era, rather like the current design features being added to Waikiki by city planners

Additional Projects...?

Alt/Fuels Committee welcomes reports on any other zero-emission ferryboat and pleasure boat fleet projects around the world for inclusion in future versions of this portfolio.

Kevin Desmond (compiler)