ADVANCING PUBLIC TRANSPORT

REPORT

ZERO EMISSION WATERBORNE TRANSPORT

DECEMBER | 2024

TABLE OF CONTENTS

TABLE OF CONTENTS 1

GENERAL OVERVIEW AND SECTOR EVOLUTION TOWARDS THE ELECTRIFICATION OF VESSELS 2

INFRASTRUCTURE NEEDS (INCLUDING POWER AT KEY LOCATIONS) 3

1.HAMBURG, GERMANY 7

2.STOCKHOLM, SWEDEN 9

3.LISBON, PORTUGAL 11

4.SAN FRANCISCO 15

CONCLUSION AND RECOMMENDATIONS 19

This report is based on data collected from the operator companies, operating electric ferries mode on short distances as a public transport in densely populated areas. This report examines the advantages, practical implementation, recommendations and conclusions of electrification and achieving zero emissions in waterborne public transport.

GENERAL OVERVIEW AND SECTOR EVOLUTION TOWARDS THE ELECTRIFICATION OF VESSELS

Waterborne public transport has long been an integral part of urban mobility, particularly in cities with extensive waterways. It provides an essential means of transportation in many coastal and riverine cities worldwide. However, traditional watercraft powered by fossil fuels contribute significantly to air pollution and greenhouse gas emissions, while also causing water pollution through fuel leaks and spills. The shift towards zero-emission waterborne public transport offers a transformative solution to these environmental challenges. With growing concerns over environmental sustainability and the urgent need to reduce greenhouse gas emissions, electrification of waterborne public transport is a potential part of the solution.

INFRASTRUCTURE NEEDS (INCLUDING POWER AT KEY LOCATIONS)

At the heart of electric waterborne transport is the need for efficient charging infrastructure. As with land-based electric vehicles, waterborne vessels require strategically located charging stations along their routes. These must be capable of handling differing vessel sizes and power capacities, ensuring seamless integration into existing docks and terminals. Rapid charging solutions will be crucial for minimising downtime for vessels, maximising operational efficiency.

OVERVIEW OF THE KEY COMPONENTS REQUIRED

Charging Stations

Specialised stations at docks and ports for recharging vessels' batteries. These may rely on shore power to minimise emissions while docked.

Fast-charging Systems

Fast-charging technologies in order to reduce downtime for vessels, enabling quicker turnaround times at ports.

Battery Swap Stations

An innovative approach, where depleted batteries can be quickly replaced with fully charged ones, avoiding charging delays.

THE BENEFITS OF STATIONARY BATTERIES:

1 **Grid Integration and Smart Grid:**
An adequate and reliable electrical supply from the grid or renewable sources (such as wind and solar) to meet the demands of electric vessels. Implementation of smart grid technology to manage energy distribution and demand efficiently, optimise charging times and integrate renewable energy sources.

2 **Battery Technology:**
Development of advanced battery systems with higher energy density, faster charging capabilities and longer life spans.

3

Energy Efficiency:

A smaller battery is a lighter one, which is more energy efficient. Also, a kilowatts charging system is a cost-saver in contrast to a megawatts charger.

4

Renewable Energy Sources:

Future waterborne transport will likely rely on a combination of renewable energy sources, enabled by advances in technology and supportive policies. Initiatives focusing on sustainability will both benefit the environment and create economic opportunities and innovations in waterborne transportation. Adapting existing vessels and developing new designs tailored to these renewable solutions will be vital in making waterborne transportation more sustainable.

5

Energy Storage Systems:

As electric waterborne transport continues to evolve, energy storage systems will be increasingly pivotal. With advances in battery technologies and hybrid systems, as well as regulatory support for sustainable practices, the future of waterborne transport looks promising. Adopting and investing in these technologies will be essential in meeting global environmental goals, while enhancing the efficiency and viability of waterborne transport. On-site energy storage can help manage peak demand and provide backup power. Moreover, as communities transition to electrification and the strain on the power grid increases, it will become increasingly important to ensure the energy efficiency of vessels.

6

Docking Facilities:

Well-equipped docking facilities will be central to the success of electric waterborne transport. These must cater to differing vessel sizes and types as well as providing secure mooring and disembarkation points for passengers. Advanced docking systems, which can incorporate automated guidance and mooring technologies, will enhance safety and efficiency while also minimising the environmental impact of vessel operations.

7

Navigation and Control Systems:

Safe and efficient navigation is essential in waterborne transport. Advanced navigation and control systems, powered by AI and real-time data analytics, can optimise vessel routing, reduce energy consumption and increase passenger safety. Integration with smart city infrastructure, including traffic management systems and weather monitoring technologies, will be essential for mitigating operational risks and ensuring reliable service delivery.

Electric ferries offer numerous advantages, including reduced greenhouse gas emissions, lower operating costs and quieter operations. In this part, we will explore these benefits further and examine examples of cities around the world that have successfully implemented electric ferry systems.

1

Environmental Benefits:

Electric vessels produce zero emissions at the point of use, significantly reducing the carbon footprint and improving air quality in urban areas. They also help protect biodiversity and the conservation of nature. As electric motors are much quieter compared to traditional diesel engines, contributing to a reduction in noise pollution and enhancing the quality of life for residents near waterways. Furthermore, the level of reliance of electric grids on fossil fuels significantly influences their environmental impact. From a global warming perspective, Germany's electricity mix has 12.5 times the carbon footprint of Sweden's, while India's is 31.6 times higher.

2

Economic Advantages:

Electric vessels have fewer moving parts and require less maintenance than internal combustion engines. This leads to lower operating and maintenance costs.

3

Energy Efficiency:

Electric engines are more efficient than internal combustion counterparts, converting a greater proportion of energy into propulsion thus and long-term cost savings. However, batteries have a lower energy density than fossil fuels, making vessel conversion more challenging and placing additional demands on the electricity grid, It will be crucial to design vessels for maximum energy efficiency in order to support electrification.

4

Technological Advancements:

The shift to electrification is stimulating technological advances in battery technology, energy management systems and charging infrastructure. This in turn is driving broader innovation in the maritime industry.

5

Regulatory Framework and Policy Support

The successful deployment of electric waterborne transport also hinges on supportive regulatory frameworks and policies. These could include government and local authorities incentives for green transport solutions, such as via grants, tax breaks and regulatory exemptions. Clear guidelines on emissions standards, energy efficiency, safety protocols and operational requirements will provide certainty for stakeholders and encourage private sector participation in expanding electric waterborne transport networks.

6

Funding and Investment:

Public-Private Partnerships between government and private sector to invest in docking and charging infrastructure, along with funding for constructing vessels.

7

Subsidies and Grants:

Financial incentives for companies to develop electric vessels and charging infrastructure. Financially, the transition to zero-emission waterborne transport can also have positive impacts. While the initial investment in new technology and infrastructure may be high, long-term operational costs can be lower due to reduced fuel consumption and the lower maintenance requirements of electric or hydrogen-powered vessels. In addition, municipalities and organisations investing in sustainable transport options may be eligible for grants, incentives or funding opportunities to support such initiatives.

8

Training and Workforce Development:

Transitioning to an electric fleet represents a dynamic shift for companies, requiring overcoming various challenges. Furthermore, they face a variety of workforce challenges while transitioning; not least of these are training programmes for operators, crew and maintenance staff on electric vessel technology and operations. It is essential to have specialised training in maintaining and repairing electric vehicles and ensuring that the infrastructure remains operational. Installing charging stations at workplaces, depots and along routes is vital for ensuring the seamless operation of electric vehicles. Range anxiety can also be a concern for ship crews accustomed to traditional, fossil-fuel vehicles. Educating employees on the range capabilities of EVs, and providing support for longer trips can help alleviate this issue, particularly if combined with the re-thinking and re-planning of routes. Embracing sustainability and innovation, Waterborne public transport companies can both reduce their environmental footprint and drive long-term operational efficiency and cost savings. The emphasis should be on skills relating to electric propulsion, battery maintenance, safety protocols and route planning.

9

Public Awareness and Acceptance:

Waterborne public transport tends to record high consumer satisfaction ratings. Nevertheless, programmes educating the public on the benefits of electric water transportation can encourage wider usage and support. Promotional Campaigns on adopting electric vessels as sustainable alternatives will also help.

10

Research and Development:

Innovation Grants for funding for R&D in electric propulsion technology, energy storage solutions and alternative energy sources for ships.

Implementing pilot projects to test the feasibility and efficiency of electric boats and ferries in different settings.

I.HAMBURG, GERMANY

HADAG Seetouristik und Fährdienst AG is a renowned ferry and maritime tourism company based in Hamburg, Germany. Since its foundation in 1888, HADAG has provided reliable and efficient ferry services within the Port of Hamburg and to the surrounding areas. The company operates a fleet of modern ferries providing scenic and convenient transportation across the Elbe River for both commuters and tourists.

ROUTE MAP

HADAG's ferry network is comprised of a number of principal routes that connect important points in the Hamburg port area:

- Route 61: Landungsbrücken – Neuhof
- Route 62: Landungsbrücken – Finkenwerder
- Route 64: Finkenwerder – Teufelsbrück
- Route 68: Teufelsbrück – Airbus – Finkenwerder
- Route 72: Landungsbrücken – Elbphilharmonie
- Route 73: Landungsbrücken – Ernst-August-Schleus

These lines connect important parts of the city and offer passengers a means of transport along with a unique view of the Port of Hamburg. Detailed information on routes and timetables can be found on the official HADAG website.

Company name	HADAG
No. of vessels in operation 2024	26-29
No. of vessels in operation for 2025-26	29-32
No. of lines	8
No. of stops	20
Type of vessels (size)	Different types of vessels, mostly 30m
Vessel range	
Vessel max pax capacity	250 pax
Average time to load per route	1-2 minutes on average
Type of Fuel	Diesel
Total refuelling time	Question unclear
Does operator have a carbon reduction plan? Target? By when?	Yes, as many low/zero emissions as possible; depending on financing
Is there any current or future emission legislation for carbon reduction measures?	Not currently
Total greenhouse gas reductions	Question unclear
Electric Vessels (mention if retrofitted)	Awaiting three plug-in hybrid vessels in 2024
Charging infrastructure (Nº of charging locations)	Expected by 2026
Max speed Limit (knots)	10 knots
Average staff on board the vessels for operations	1
Annual journeys 2023	Approx. 10 million
Average passenger capacity rate	Question unclear
Maximum speed limit	Question doubled
Types of piers and pontoons	Mainly floating pontoons
Ticketing and fare integration with land public transport network	Full integration with no extra charge
Integrated marketing with land public transport network	Full integration, separate marketing through social media
Passenger increase over the last 5 years	No increase due to covid
% of commuters	Depends on route
% of tourists	Depends on route
No. of bicycles transported annually	No data available
Retrofitted conventional ferries	Currently one project
Vessel design aspects (for example, hydrofoils, carbon fibre) and why they were chosen.	Hull optimisation for newbuilds, steel hull for ice class
Expected vessel lifespan (if battery electric, battery lifespan)	At least 30 years, battery life at least 10 years
Any info relating to the type of routine and unplanned maintenance that occurs.	Question unclear
NATURAL ENVIRONMENT PROFILE	
Geographical environment	River and harbour
Maximum tide level	4 metres
Natural hazards that may cause system unavailability	None
Water type	Fresh/saltwater/brackish

Hydrogen vessels – there are no plans for hydrogen power in Hamburg.

2.STOCKHOLM, SWEDEN

Waterborne public transport is delivered by two different brands; SL for short-distance traffic (commuter lines), while Waxholmsbolaget provides the archipelago service. There are 35 lines during the peak season and around 7 million passengers annually. Stockholm region has about 2.4 million citizens, with around 1 million people using the public transport system each day.

PROFILES OF OPERATION

Region Stockholm owns four of the 23 vessels.

Operation is through contracts; standard contract length is eight years:

We are planning to build up to 15 charging points within the commuter ferry operation area. Operational aspects: route planning, timetable possibilities, winter and summer operations. Icing conditions can impact vessel types and maximum speeds.

Operational costs versus traditional combustion engine vessels: In the long run, it is more cost efficient to switch from diesel to electric, however, you also need to invest in infrastructure and a new fleet. If the investment is performed by an external partner, the length of the contract needs to be longer (approx. 15 years) to justify the investments.

The aim is to be fossil fuel-free by 2030 and net zero by 2035. There are no existing incentives, but new contracts will require 100% electric vessels for commuter traffic.

Company name	Region Stockholm (SL) Commuter traffic
Region Stockholm of vessels in operation 2024	23
No. of vessels in operation for 2025-26	23
No. of lines	5
No. of stops	30
Type of vessels (size)	25 x 7 m
Vessel range	If electric, three hours
Vessel max pax capacity	190 (Sjövägen)
Total time at each landing	5 minutes
Type of Fuel	HVO/Electric
Total refuelling time	6 hours (charging)
Does operator have a carbon reduction plan? Target? By when?	NA
Is there any current or future emission legislation for carbon eduction measures?	Fossil free 2030
Total greenhouse gas reductions	
Electric Vessels (mention if retrofitted)	
Charging infrastructure (Nº of charging locations)	One low powered
Max speed Limit (knots)	12 knots
Average staff on board the vessels for operations	2
Annual journeys 2023	69,000 hours
Average passenger capacity rate	
Maximum speed limit	Differs 8 – free speed
Types of piers and pontoons	Fixed piers
Ticketing and fare integration with land public transport network	Yes
Integrated marketing with land public transport network	Yes
Passenger increase over the last 5 years	15%
% of commuters & residents	N/A
% of tourists	N/A
Nb of bicycles transported annually	79,000
Retrofitted conventional ferries	None
Vessel design aspects (hydrofoils, carbon fibre, etc.) and why such aspects were chosen.	Light hull glass fibre
Expected vessel lifespan (if battery electric, battery lifespan)	30 years (10)
NATURAL ENVIRONMENT PROFILE	
Geographical environment	Inner archipelago
Maximum tide level	No tide
Natural hazards that may cause system unavailability	NA
Water type	Mixed (brackish and fresh)

Hydrogen vessels: there are no plans for hydrogen power in Stockholm.

3.LISBON, PORTUGAL

TTSL (Transtejo Soflusa, SA) provides a public river transport service for passengers and vehicles as part of the overall transport system of the Lisbon Metropolitan Area. It is a key component of crossing the Tagus.

PROFILES OF OPERATION

TTSL operates five river connections:

- Barreiro - Terreiro do Paço (Lisbon) / passengers
- Montijo - Cais do Sodré (Lisbon) / passengers
- Seixal - Cais do Sodré (Lisbon) / passengers
- Cacilhas (Almada) - Cais do Sodré (Lisbon) / passengers
- Trafaria (Almada) – Porto Brandão (Almada) – Belém (Lisbon) / passengers and cars

To support passenger traffic, TTSL has six terminals and three river stations. The 10 new electric vessels will operate only at Montijo, Seixal and Cacilhas.

In 2023, TTSL recorded 19,658,611 passengers.

- The project to renew the electric fleet is supported by the Portuguese government environmental fund and PO SEUR (Operational Programme for Sustainability and Efficient Use of Resources (European Union)).
- Installed electrical infrastructures in four terminals (Seixal; Montijo, Cais de Sodré and Cacilhas) to allow charging of the electric vessels at a total of five charging stations.
- The charging tower provided by Zinus was installed on the pontoon for connection to the vessels.

Loading systems are automatic.

The installations will be supplied with electrical energy from the medium voltage (MV) network; 10-15 kV.

Advantages/ disadvantages

Innovative, but complex project.

Many authorities and entities involved in licensing of all phases of the project.

As the electric ships have yet to start operations, there is no information on potential changes to the TTSL timetables for current river connections.

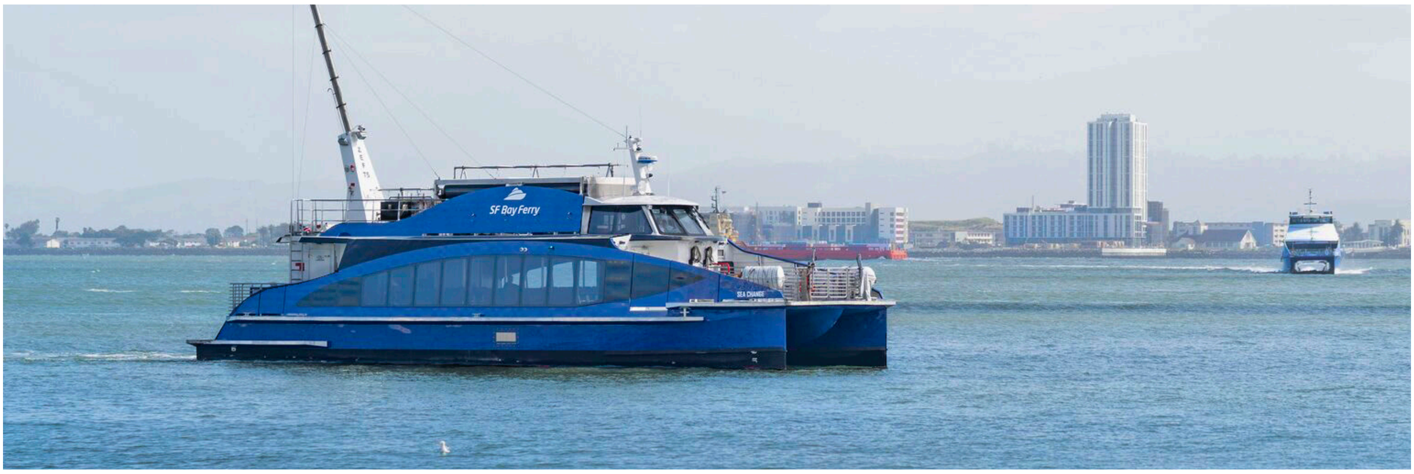
OPERATOR PROFILE

Company name	TTSL (Transtejo Soflusa, SA)
No. of vessels in operation 2024	28 vessels (five electric)
No. of vessels in operation for 2025-26	To be determined
No. of lines	Five river connections
No. of stops	N/A
Type of vessels (size)	The new electric vessel is 40 metres
Vessel range	Catamaran
Vessel max pax capacity	540 seats over two lounges
Total time at each landing	N/A
Type of Fuel	100% electric; The energy storage system has a global capacity of 1860 kWh and a maximum voltage of 1024V
Total refuelling time	As the electric ships have yet to start operations, there is no data on this
Does operator have a carbon reduction plan? Target? By when?	N/A
Is there any current or future emission legislation for carbon reduction measures?	Law Decree No. 84/2018, 23 October 2018 (https://files.diariodarepublica.pt/1s/2018/10/20400/0504805059.pdf)
Total greenhouse gas reductions	The new fleet will be more energy efficient and will have zero GHG emissions (In 2019, diesel consumption was 5,248,741 litres, corresponding to 13,122 tonnes of CO2 emissions)
Electric Vessels (mention if retrofitted)	10 new vessels
Charging infrastructure (Nº of charging locations)	Five (one Seixal; one Montijo; two Cais de Sodré; one Cacilhas)
Max speed Limit (knots)	16 knots (service speed)
Average staff on board the vessels for operations	Crew four (one captain, one driver and two crew)
Annual journeys 2023	In 2023, the punctuality of TTSL on the five river connections was 92%
Average passenger capacity rate	Varies according to the type of ship operating Check https://ttsl.pt/terminais-e-frota/frota/
Maximum speed limit	17 knots (contractual speed of the 10 new electric vessels)
Types of piers & pontoons	45-metre pontoons
Ticketing & fare integration with land public transport network	Yes, with bus, tram, metro and train. All transport in all the municipalities of the Lisbon metropolitan area can only be used with 'Navegante®'. This is an individual card designed for those depending on busses, trains, metro, streetcars or boats for their daily commute. The price is €30 and €40 per month. For more information, see https://www.navegante.pt/
Integrated marketing with land public transport network	There have been campaigns organised by the Mobility and Transport Authority
Passenger increase over the last 5 years	Reference year 2019 is used, because of the COVID-19 pandemic that followed (19,328,415 passengers transported). Comparing 2023 with 2019, the increase in passenger numbers is 2% (19,658,611 passengers transported)
% of commuters & residents	
% of tourists	The ticketing system does allow the type of passenger to be identified. However, those who buy the monthly pass (Navegante) are assumed to be commuters and residents
Nb of bicycles transported annually	N/A
Retrofitted conventional ferries	N/A
Vessel design aspects (hydrofoils, carbon fibre, etc.) and why such aspects were chosen	Carbon fibre (GRP) catamarans
Expected vessel lifespan (if battery electric, battery lifespan)	10 years

Any info related to what kind of routine and unplanned maintenance that occurs	Dry dock inspection every five years
NATURAL ENVIRONMENT PROFILE	
Geographical environment	Tagus river estuary
Maximum tide level	Data not available at the moment
Natural hazards that may cause system unavailability	Storms, rising sea levels, earthquakes, tsunamis
Water type	Saltwater

Hydrogen vessels: there are no plans for hydrogen power in Lisbon.

4.SAN FRANCISCO, UNITED STATES



The San Francisco Bay Area WETA (Water Emergency Transportation Authority) is a regional public transit agency. It is tasked with operating and expanding ferry service on the San Francisco Bay and with coordinating the water transit response to regional emergencies. Under the San Francisco Bay Ferry brand, WETA carries over 3 million passengers annually using a fleet of 15 high-speed, passenger-only ferry vessels. San Francisco Bay Ferry currently serves the cities of Alameda, Oakland, Richmond, San Francisco, South San Francisco and Vallejo.

WETA is committed to working with cities, communities and stakeholders to establish new ferry routes where the proposed route can reduce traffic congestion in the transit corridor, is cost effective and financially viable. Website: San Francisco Bay Ferry | San Francisco Bay Ferry

San Fransisco Bay Ferry has secured $177 million in funding to date to support implementation of our transition to zero emissions. Majority of this funding is from state and federal funds from the following sources:

State of California's Transit and Intercity Rail Capital Program (TIRCP) – this is a program that is funded by California's cap and trade economy.

Federal Transit Administration's Passenger Ferry Grant Program

Regional Measure 3 Bridge Toll Funds (local funding from tolls collected on Bay Area bridges).

San Fransico Bay Ferry needs shoreside charging infrastructure to be able to shift its operations to zero emissions. We have conducted a feasibility report and found that the system will require about 18MW of power for our plan to transition about two-thirds of our fleet to zero emissions by 2035.

Company name	San Francisco Bay Ferry
No. of vessels in operation 2024	18
No. of vessels in operation for 2025-26	18-19
No. of lines	Six routes
No. of stops	11 terminals
Type of vessels (size)	140 ft aluminium catamaran
Vessel range	3–30 miles
Vessel max pax capacity	Range: 225- 445
Total time at each landing	Varies generally 5-10 mins
Type of fuel	Diesel (phasing in battery electric starting 2026)
Total refuelling time	Ships fuelled once per day, takes around one hour
Does operator have a carbon reduction plan? Target? By when?	Shift at least 50% of fleet to zero emissions by 2035. Commitment to procure no further diesel vessels beyond two currently under construction
Is there any current or future emission legislation for carbon reduction measures?	The State of California has a requirement (Commercial Harbor Craft Regulations) to reduce emissions by requiring operators to shift to one of two paths: • Tier 4 engines with a diesel particulate filter (when available on the market), or • Develop an alternative control of emissions plan that reduces them to the same level of greater than the amount reduced by the use of Tier 4 engines + Diesel Particulate Filter. In addition, the State of California requires zero-emission technology on routes under three nautical miles by 1 January 2026. Compliance is staggered based on engine model and the year. All commercial harbour craft vessels in California are mandated to be complian by 2035
Total greenhouse gas reductions	Still working to develop our final plan and emission reductions. This information is not yet available.
Electric Vessels (mention if retrofitted)	However, WETA currently has a procurement underway to select shipyards for the construction of two large electric vessels (300-350 passengers) and three small ones (149 passengers)
Charging infrastructure (Nº of charging locations)	Currently working to install shoreside charging infrastructure. We have developed a design for a charging float that can rapidly charge the vessels while boarding/deboarding. We currently anticipate installing battery electric charging at seven of our 11 terminals around the Bay Area.
Max speed Limit (knots)	30 knots
Average staff on board the vessels for operations	Four staff per vessel (typically one captain and three crew)
Annual journeys 2023	San Fransisco Bay Ferry tracks 'journeys' as individual route segments, which are defined by the direct (one-way) travel between two ferry terminals without stops. **Total trip segments in 2023 were around 64,000.**
Average passenger capacity rate	Vessels range in capacity from 200-445 passengers. Average vessel capacity across the fleet is 334.
Maximum speed limit	Vessel service speeds range between 26-34 knots, with average vessel speed 29 knots. We limit our throttles to achieve these service speeds. Maximum speed for our Dorado vessel (fastest in our fleet) would be 38 knots.
Types of piers & pontoons	San Fransisco Bay Ferry's terminals generally consist of a pier structure with gangways connecting to a metal or concrete float, anchored to the bay floor with pilings.
Ticketing & fare integration with land public transport network	San Fransisco Bay Ferry offers a regional transit card usable at all Bay Area transit agencies. It has also aligned its fare structure with a regional fare structure used by most of the 27+ transit agencies in the Bay Area.

OPERATOR PROFILE

Integrated marketing with land public transport network	San Fransisco Bay Ferry coordinates with other San Francsico Bay Area transit agencies on regional marketing efforts. However, SF maintains its own distinct marketing.
Passenger increase over the last 5 years	In 2019, San Fransisco Bay Ferry carried 3,215,631 riders. In 2020 after local governments instituted severe stay at home mandates to respond to the COVID 19 pandemic, ridership dropped by 95%. We have spent the last 3 years working to increase ridership. In 2023, we carried 2,233,691 passengers. Ridership change between 2019-23 was -30.54%.
% of commuters & residents	56% commuters 46% non-commuters
% of tourists	11% tourists
No. of bicycles transported annually	In 2023, the San Fransisco Bay Area ferry carried 189,052 bicycles
Retrofitted conventional ferries	San Fransisco Bay Area Ferry currently operates17 diesel vessels and one hydrogen fuel cell ferry. San Fransisco Bay Area has two additional diesel vessels under construction that will be delivered by mid-2025. We are currently procuring five electric vessels, two of which will replace existing diesel vessels. San Fransisco Bay Ferry's battery electric vessels will start operations in 2026.
Vessel design aspects (hydrofoils, carbon fibre, etc.) and why such aspects were chosen.	San Franscico Bay Ferry operates aluminium catamarans. We are exploring all vessel types and technologies, but do not currently have plans to build any hydrofoil or carbon fibre vessels.
Expected vessel lifespan (if battery electric, battery lifespan)	Our vessels have a useful life of 25 years.
Any info related to what kind of routine and unplanned maintenance that occurs.	Overview of expected maintenance activities for electric vessels: Battery replacements and recycling; cyclic insulation resistance checks of motors, coolant level checks; annual state of battery health checks, bearing and grease level checks; annual sea valve inspections; annual security inspections, dry dock inspections every two years, running gear inspections.
NATURAL ENVIRONMENT PROFILE	
Geographical environment	The Bay Ferry operates in the San Francisco Bay in Northern California in the US. The San Francisco Bay Ferry has routes in five counties in the nine-county Bay Area.
Maximum tide level	The San Francisco Bay's tidal range can be as much as 9ft (2.7m) between high and low tides, with an average range of 4-4.5ft (1.2-1.4m) New moon tides typically range from 5-8ft (1.5-2.4m), but king tides can expand the range to 7-10ft (2-3m).
Natural hazards that may cause system unavailability	Strong southern winds may lead to service cancellations in some of our exposed terminals.
Water type	Bay water – a mix of ocean (salt) and fresh water

Infrastructure:

San Francsico Bay Ferry currently leases the world's first hydrogen passenger ferry that is 100% powered with fuel cells. The vessel was built by All American Shipyard in the State of Washington and is owned by SWITCH Maritime. San Francsico Bay Ferry operates this hydrogen vessel in a public-private partnership with United Airlines, Chevron, Golden Gate Ferry and Blue & Gold Fleet. The vessel operates along the San Francsico waterfront three days a week. Thanks to the funding raised through the public-private partnership, the service is free. This is a demonstration project that is expected to operate for around six months, given the current level of funds raised.

Vessel flag state policy for passenger hydrogen vessels:

The San Francsico Bay Ferry is subject to the Jones Act, which requires all vessels operating in the United States to be constructed in the United States.

Safety and legislation framework to accommodate hydrogen (flag state and land side) – does this exist yet?

The San Francsico Bay Ferry worked with SWITCH Maritime for over a year to get the vessel certified by the US Coast Guard. The US Coast Guard does not have specific regulations for hydrogen vessels. The San Francsico Bay Ferry also had to work with the Port of San Francisco, local firefighting departments from around the Bay area - and others - in order to address concerns over hydrogen fuelling.

Current initiatives to drive this shift in fuels; government policy or grants?

There are numerous State of California regulations, initiatives and grants that focus on shifting to alternative technologies - including hydrogen - and achieving a drastic reduction in greenhouse gas emissions. California has a cap-and-trade economy, requiring polluting companies to purchase pollution credits in order to operate. The money raised from these purchases funds grant programmes for public and private organisations to implement greenhouse gas emission reduction measures.

Advantages/disadvantages

San Fransisco Bay Ferry is at the earliest stages of its hydrogen fuel cell demonstration project. It is too early to provide a full analysis of advantages and disadvantages; however, below are a few early findings:

Hydrogen technology provides a greater power density than current battery technology, so it could allow for longer operating distances.

Hydrogen fuel availability is problematic – and one of the reasons that we are only operating it a couple days a week (concerned about finding enough of a supply). There is also currently no option for 'green hydrogen'.

Operating costs

The cost of operating the demonstration service for six months in FY 2024/25 will be $2.6 million. Partner donations, including from Chevron, Golden Gate Bridge and Highway Transportation District and others, provided $1.69 million in direct funding for the service. In addition, donations from United Airlines of $100,000 in airline and marketing credits have been applied to the agency's travel and marketing budgets, to further offset the cost of the demonstration.

CONCLUSION AND RECOMMENDATIONS

1 **Investment in Infrastructure:** Develop comprehensive electric charging infrastructure at key docking points to ensure efficient and quick recharging. Integrate renewable energy sources, such as solar and wind power, to supply the stations with clean electricity. Electrifying public transport systems will put a heavy load on electricity grids, making it important to look closely at a vessel's energy efficiency.

2 **Policy and Incentives:** Implement supportive policies and regulations - including subsidies, tax incentives and grants for operators - that encourage the adoption of electric waterborne transport. Set and enforce emission reduction targets and stringent environmental standards for waterborne transport.

3 **Collaboration and Partnerships:** Foster collaboration between public authorities, private companies and research institutions in order to encourage sharing knowledge, technology and best practices. Encourage public-private partnerships as a way of funding and accelerating the deployment of electric waterborne transport solutions.

4 **Training and workforce development:** Engage workers from the outset and invest in workforce training, particularly cruise and maintenance workers.

5 **Public Awareness and Engagement:** Undertake public awareness campaigns to highlight the benefits of electrified waterborne transport among citizens and to encourage its acceptance and use. Engage communities in planning and implementation to improve buy-in and ensure the solutions meet local needs and preferences.

The electrification of waterborne public transport represents a pivotal step towards sustainable urban mobility. The environmental, economic and technological benefits should be hugely attractive for cities seeking to reduce their carbon footprint and improve residents' quality of lifer. However, successful implementation will require strategic investment in infrastructure, supportive policies and a detailed rethinking of route and traffic planning. Cities themselves can significantly increase the appeal and demand for waterborne public transport by enhancing accessibility and seamlessly integrating it with existing systems.

The transition will demand innovative approaches to route planning that ensure convenience for passengers. In return it will reduce congestion on roadways and complement existing transport networks. Collaborative efforts and public engagement will be essential for ensuring that waterborne transport becomes a viable and appealing option for daily commuters.

As cities like Stockholm, Lisbon and San Francisco have already shown, the transition to electric waterborne transport is not only feasible but also potentially transformative. It can also pave the way for a cleaner and more energy-efficient future.

Through embracing electrification, cities can be in the vanguard for sustainable transport, setting a positive example and playing their part in global efforts to combat climate change.

International Association of Public Transport (UITP)
Rue Sainte-Marie, 6 | B-1080 Brussels | Belgium

Tel: +32 2 673 61 00
info@uitp.org
www.uitp.org

This is an official Report of UITP, the International Association of Public Transport. UITP has over 1,600 member companies in 99 countries throughout the world and represents the interests of key players in this sector. Its membership includes transport authorities, operators, both private and public, in all modes of collective passenger transport, and the industry. UITP addresses the economic, technical, organisation and management aspects of passenger transport, as well as the development of policy for mobility and public transport worldwide.

DIGITAL VERSION AVAILABLE ON
MYLIBRARY

UITP ADVANCING PUBLIC TRANSPORT

Rue Sainte-Marie 6, B-1080 Brussels, Belgium | Tel +32 (0)2 673 61 00 | Fax +32 (0)2 660 10 72 | info@uitp.org | www.uitp.org