

Zero Emission Fuel Cell Power and Hydrogen Fueling Systems

National Shipbuilding Research Program
Business Technologies and Ship Design & Material
Technologies Joint Panel Meeting
September 14-15, 2021



ZERO EMISSION
—INDUSTRIES—

The *Sea Change*: Realization of a long effort...

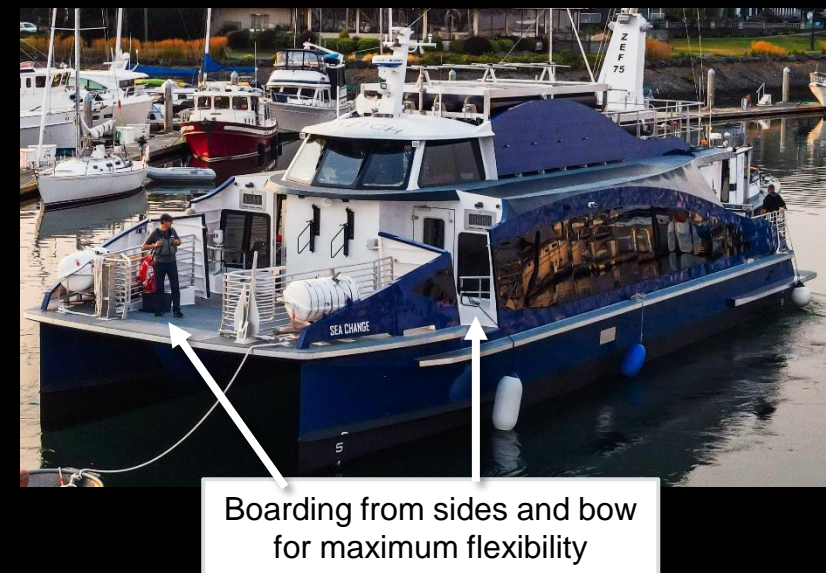
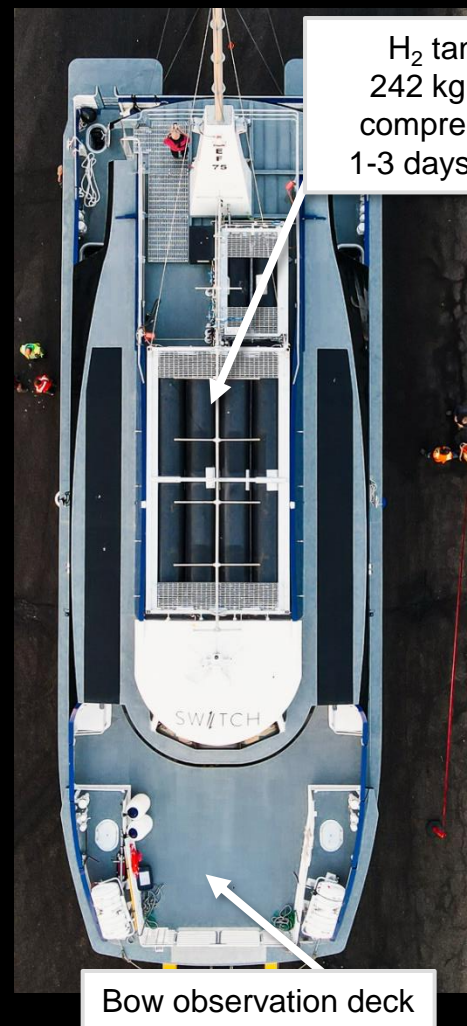
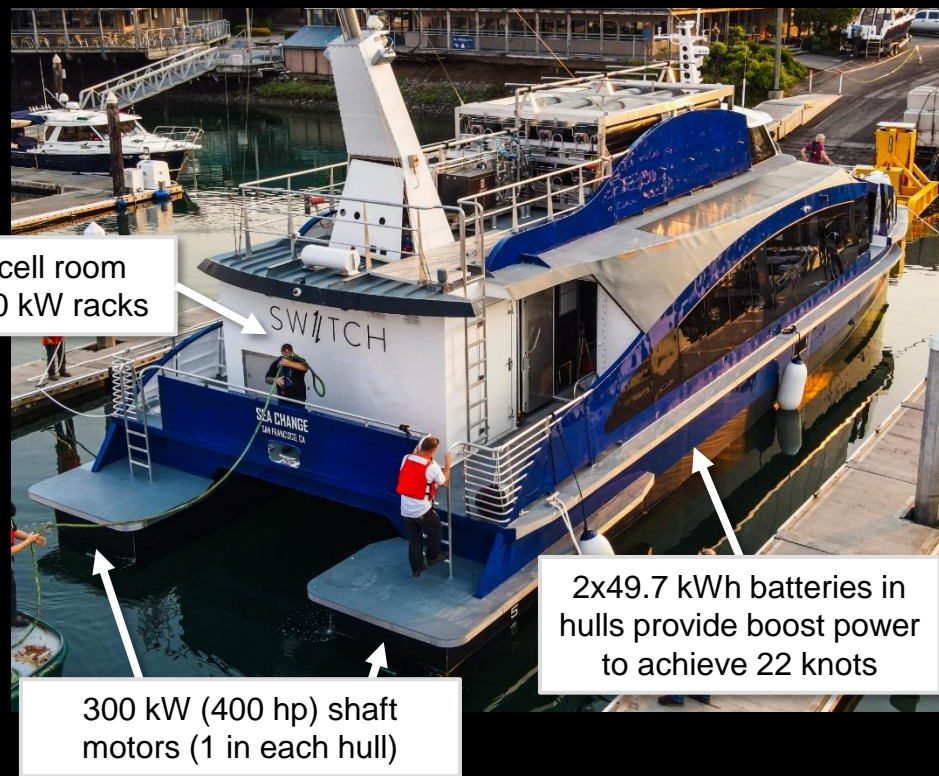


Vessel Overview



- Aluminum catamaran
- 72'-7" LOA
- 24'-6" beam
- 78 passengers + 2 crew
- 22 knot top speed
- 2x 300 kW electric motors
- 360 kW PEM fuel cell
- 100 kWh Li-ion battery
- H₂: 242 kg @ 250 bar (3,600 psi)

Vessel Features



The fueling will look like today's operation with diesel



California's Office of Spill Prevention and Response (OSPR) has exempted hydrogen fueling from the insurance requirements imposed on diesel fueling



ZEI's role in the project: Everything Hydrogen

- Integrated hydrogen and fuel cell system
- Hydrogen fueling system
- Hydrogen safety systems
- Hydrogen system controls
- Regulatory approvals for the hydrogen portions



Key Milestones

Project Began	June 11, 2018
Ferry Design Complete	Oct. 2018
Keel Laying Ceremony	Nov. 8, 2018
Ferry Build Began	Feb. 2019
Vessel Moved to All-American Marine	March 2020
Launched for Commissioning	August 12, 2021
Begin Operation in SF Bay (est.)	Nov. 2021

The *Sea Change* is
North America's first hydrogen fuel cell vessel
and the
First commercial hydrogen fuel cell ferry in the world



Lessons Learned

- Shipyards do not typically have the expertise needed
 - H₂ piping installation, inspection, and testing
 - Hazardous area electrical installations
 - High pressure or cryogenic temperatures
 - High voltage DC power
 - Integration of all of the above
- The regulations lag far behind the technology and regulators do not have the knowledge needed to fill in the gaps
- (...and various technical improvements)



Our Solution: Turnkey Fuel Cell Power System

A hydrogen fuel cell power system that is designed and factory-built to enable shipyards to easily deliver hydrogen powered vessels



Turn-key



Complete



Easy to integrate



Better performing



Above best-in-class technology



Provides fastest path to market

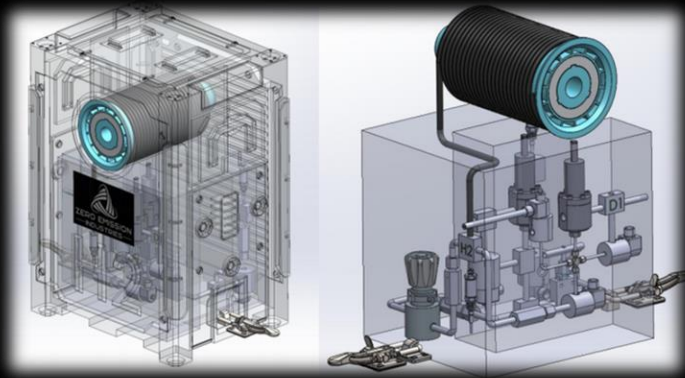
Power Output: 250kw (335hp) system

Scalable / stackable to meet a range of power requirements for multiple use cases

Built with the USCG in mind



Our Solution: The World's Easiest Hydrogen Fueler



THE ZE1 FUEL BOX

The World's First Man Portable Hydrogen Dispenser

Launching 2022

Patent Pending

Lowest Cost H₂ Fueling Solution

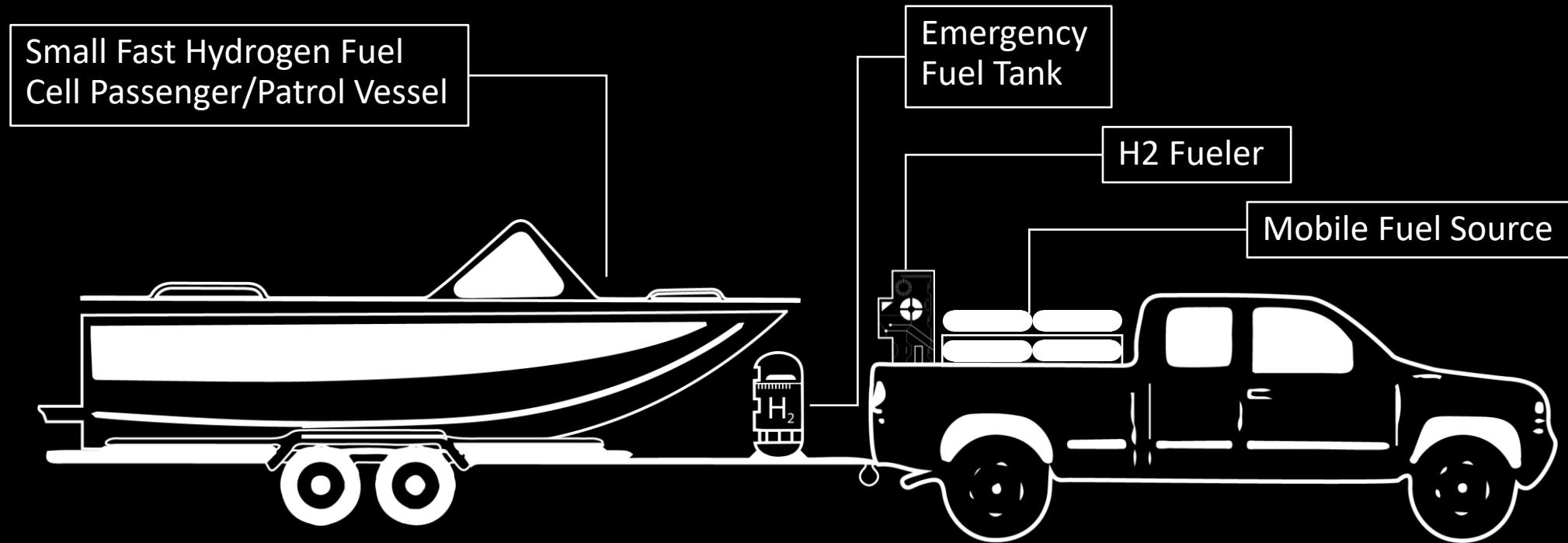
Reduces operational costs and significantly lowers time to market

Can be installed on the vessel

Works for fueling 95%+ of all hydrogen mobility types



First Implementation: Small fast boats



Vessel planned specifications

- 25' x 8.5'
- 40 knots top speed
- 300 hp

- 4+ hour endurance
- 700-bar compatible
- Harbor patrol, tourism

Our Partners

Correct Craft
Making Life Better



A wide variety of immediate use cases



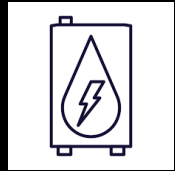
Single Screw (250 kW) and Twin Screw (500 kW)

- Law Enforcement
- Fire
- Military
- Fishing
- Pilot
- Tour
- Autonomous
- Watersports
- Leisure
- Ferry
- Research

Also scalable to multi-MW for commercial, defense, and private vessels

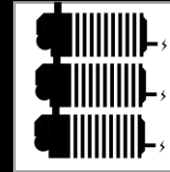


The advantages of fuel cells goes far beyond environmental



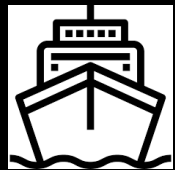
Reliable

Fuel Cells are solid state, and the rest of the power train has few moving parts



Scalable

Power can be scaled up/down depending on vessel type and operating needs



Modular

No more "engine room", power train can be distributed across the vessel



Flexible

Maintain current operational flexibility



Low Maintenance

Reduce operation and maintenance cost by 20% to 50%

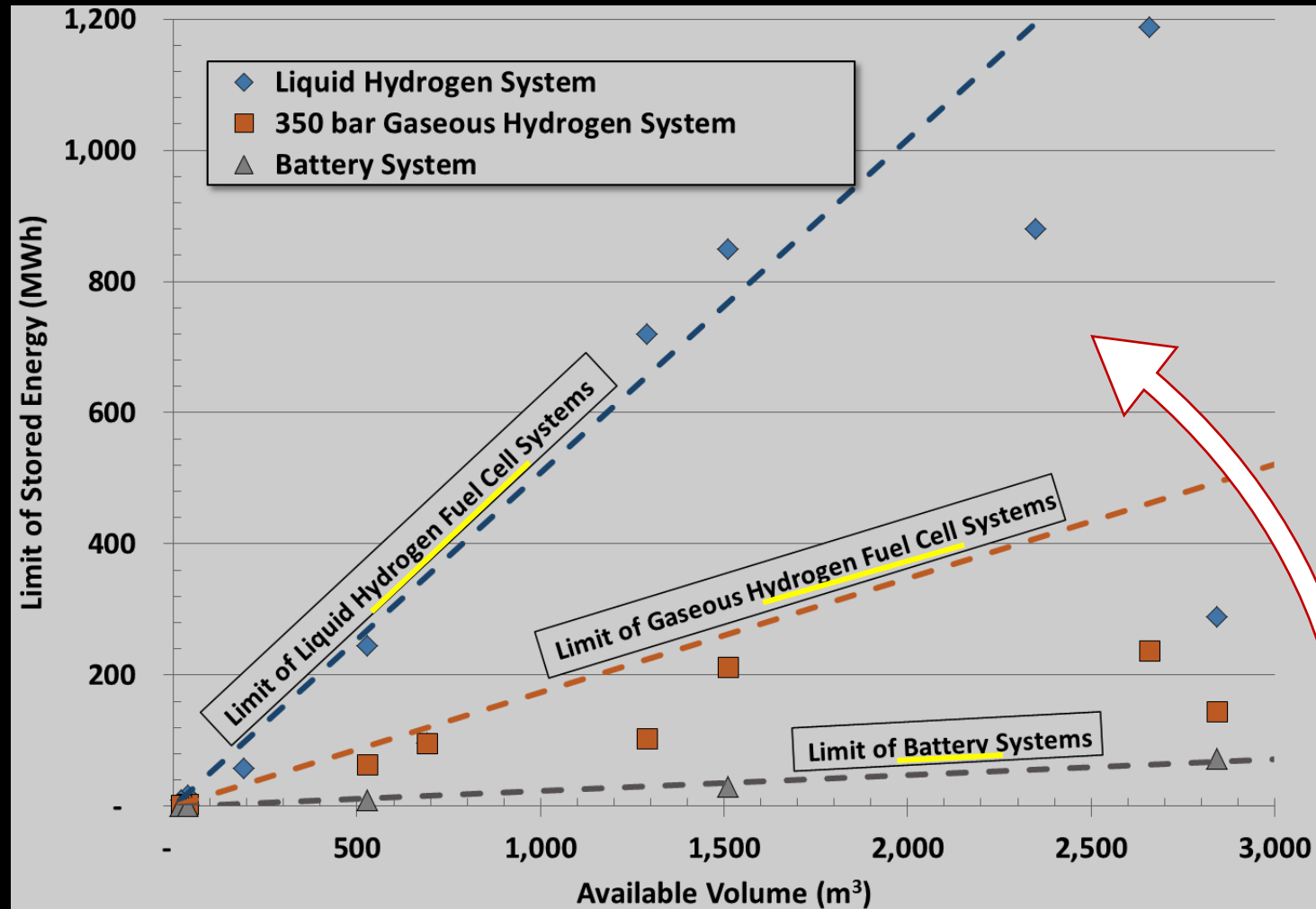


Connected

Remote monitoring and real time operational intelligence.



Hydrogen provides a solution where batteries do not work

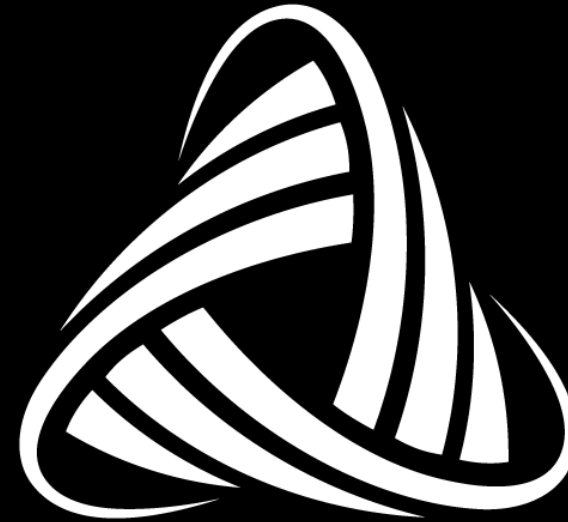


Bottom Line
Hydrogen provides *increased mission capability*

Our team has over 100
years' experience
innovating hydrogen tech,
all focused on making
hydrogen simple for you.

Drop us a line with any
questions or inquiries:

info@zeroei.com



ZERO EMISSION
— **INDUSTRIES** —

Hydrogen Simplified.