# MARITIME ADMINISTRATION

## Office Of Environment

H2@Ports
September 2019

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- **Objectives - Stimulate technology advances for improved sustainability; seek solutions; demonstrate and inform**
  - ✓ **Maritime Use of Alternative Energy and Technology**
    - Natural gas
    - Advanced renewable "drop-in" biofuel
    - Hybrid propulsion
    - Fuel cell
  - **Goals:**
    - ✓ Technology validation and demonstration
    - ✓ Reduction of polluting emissions from ships and in and around ports
    - ✓ Generate cost/benefit and Technical Data
    - ✓ Identify gaps

- **MOU with DOE Established June 2013 to Evaluate Fuel Cell Applications for the Maritime Transportation Industry *Port Equipment and Vessels***
- **Key Issues**
  - ✓ Size, Weight, Power
  - ✓ Cost
  - ✓ Power Integration and Regulation
  - ✓ Source of Hydrogen
  - ✓ Hydrogen or Reformation of Other Fuels, Biogas
  - ✓ Safety/Fuel Storage

- **Prototype project funded by MARAD & DOE with several industry partners**
  - Demonstration of fuel cell auxiliary power unit for shore/shipboard power
  - Collaboration *with multiple industry partners*
    - ✓ *Hybrid hydrogen PEM fuel stack in a 20' container*
    - ✓ *100kW 230V AC 3 phase*
    - ✓ *Power for 10 refer containers*
      - ABS and USCG approval

# Fuel Cell Reefer Project

- Designed to replace a diesel generator - 20 ft. TEU, 100kW nominal power~ 200 reefer hours of continuous operation – 10 reefers
- Assess operating and cost parameters
- Partner with Sandia, Hawaii Ports, Young Brothers, Navy

## Shipboard technology demonstration of fuel cell for auxiliary power

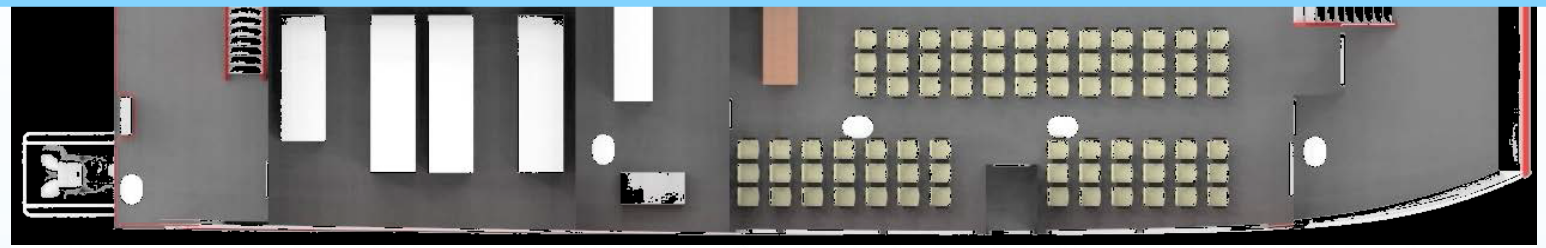
- ✓ Work with the Navy
- ✓ Demonstrate aboard MARAD ship
- ✓ Small fuel cell: 10kW s120-240 V AC
- ✓ **Major Focus on Fuel Reformation** JP-8, ULSD, No. 2 diesel

## Zero Emission Ferry

- ✓ Partnership with Sandia National Laboratory and Red & White Fleet
- ✓ Design Feasibility Study for High Speed Ferry and Shore-based Storage and Fueling Station Serving vessels, cars, buses and trucks
- ✓ 2,500 kg/day capacity & 80% base utilization
- ✓ 150 passenger, 35 kts

# Zero Emission Ferry

* **OPERATION**
  * 23 nm one-way
  * Each round trip uses about 500 kg LH2
  * Daily logistics: Two morning round trips
  * Refuel in less than 1 hr.
  * Two afternoon round trips
  * Designing the ferry to meet the long distance challenge
* **PERFORMANCE**
  * 35 knots
  * Zero emissions
  * 130' x 39' preferred size envelope, 150’ long is maximum
  * <100 Gross Registered Tons (GRT)
  * 90% MCR (i.e., power margin)
  * Prefer one refueling per day.




S.F. - BREEZE

- Stage I – Design and feasibility analysis for fuel cell vessel
  - ✓ Cost prohibitive
  - ✓ Good concept for quiet operation to support research needs
- Stage 2 – Evaluate more cost effective alternatives (RV Sproul)
  - ✓ Diesel Electric
  - ✓ Diesel Electric/Battery
  - ✓ Hybrid System with Diesel-Electric and Hydrogen Fuel Cell
  - ✓ Evaluate Design, Capital and Operating Cost

* August 2019 workshop
* Identify top three H2 scenarios to be investigated based upon needs of US Coast Guard, classification societies (DNV-GL), and other stakeholders
* Scenarios to be modeled include vent mast, bunkering (fueling), and fuel cell room
* Goal is to identify shape and size of hazardous zones. Examine differences between H2 and natural gas as permitted by schedule and budget. Examine LH2 and H2 releases as permitted by schedule and budget.
* Modeling will be applicable to both vessel and port applications

- Shipboard auxiliary power with higher power fuel cell
- Ship propulsion – hybrid vessel/ferries/tug
- “Cold ironing” or hoteling/shore power for vessels
- Port equipment/back-up power
- Microgrids and electrification

* Regulatory/standards
* Risks and liability – public, private, mariner, shore-based workers
* Fuel availability and source
* Size and weight remain issues
* Power management particularly with hybrids
* **COST**