MARITIME ADMINISTRATION

Office Of Environment

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OFFICE OF ENVIRONMENT

- **Two primary missions**
  - **MARAD Environmental Compliance**
  - **Maritime Industry Stakeholder Assistance**
    - ✓ Vessel owners and operators
    - ✓ Port, shipyards
    - ✓ Federal, state, local environmental regulatory and resource agencies
    - ✓ Public

Maritime Industry Environmental Drivers

- **Challenges = Opportunities for Innovation**
  - We are seriously lagging landside transportation in environmental innovation
  - Need for technologies that work in the marine environment – ballast water treatment, exhaust gas treatment
  - Need for demonstration of and innovation in alternative fuels and energy
  - Need for advanced systems and technologies for energy efficiency and conservation

Maritime Industry Stakeholder Support

- **Maritime Environmental and Technical Assistance (META) Program**
  - **Objectives**
    - Stimulate technology advances for improved sustainability
    - Address critical marine transportation environmental issues
    - Collaborate among Federal, state and local agencies/organizations, academia, industry and public stakeholders

META Focus Areas

- **Maritime Use of Alternative Energy/Air Emissions**
  - Natural Gas
  - Advanced Renewable "drop-in" Biodiesel
  - Hybrid propulsion
  - Solar/Wind
  - ***Fuel Cells***
- **Exhaust Gas Treatment Technology**
  - SCR and Scrubbers
- **Other Vessel Discharges**
  - Ballast Water Treatment/Hull Biofouling

Marine Application of Fuel cells

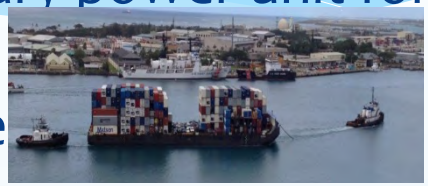
- **MOU with DOE Established June 2013 to Evaluate Fuel Cell Applications for the Maritime Transportation Industry *Port Equipment and Vessels***
- **Key Issues**
  - Size, Weight, Power
  - Cost
  - Power Integration and Regulation
  - Source of Hydrogen
  - Hydrogen or Reformation of Other Fuels, Biogas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

Marine Application of Fuel cell

MOU with DOE established on June 2013

On-going project on marine fuel cell project)

- Prototype demonstration of fuel cell auxiliary power unit for shore/shipboard power



- Collaboration with multiple industry partne
  - ✓ Hybrid hydrogen PEM fuel stack in a 20' container
  - ✓ 100kW 230V AC 3 phase
  - ✓ Power for 10 refer containers
    - ABS and USCG approval

Current marine fuel cell project (FY 2014 currently under planning)

- Shipboard technology demonstration of fuel cell for auxiliary power
  - ✓ 10kW s120-240 V AC solid oxide fuel cell
  - ✓ JP-8, ULSD, No. 2 diesel

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
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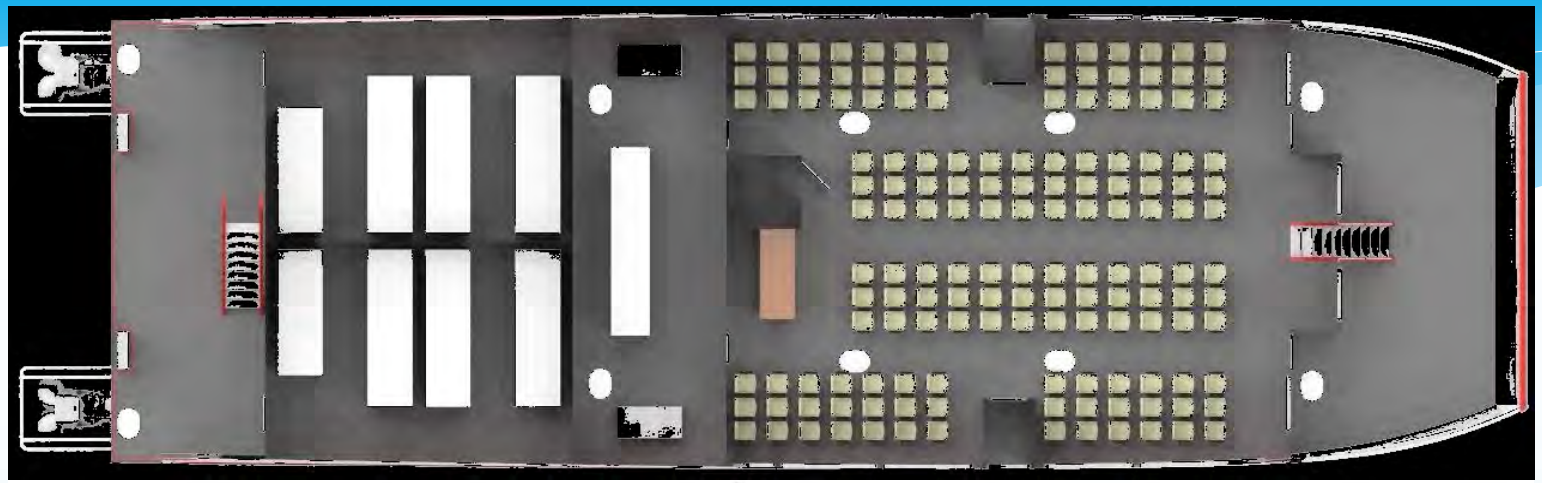
- Partner with Sandia, Hawaii Ports, Young Brothers, Navy

Ship Auxiliary Power & Propulsion

- **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 is on Fuel Reformation** JP-8, ULSD, No. 2 diesel
- **Zero Emission Ferry**
  - ✓ Partnership with Sandia National Laboratory & 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
* **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

Future Fuel Cell Opportunities

- **Future marine fuel cell projects**
  - Shipboard auxiliary power with higher power fuel cell
  - Ship propulsion – Research Vessel/Tug
  - "Cold Ironing"/Shore Power for vessels
  - Port applications – port equipment/ back-up power

Alternative Fuels
Natural Gas Renaissance?

- **Driver -- Looming ECA and Search for Alternatives to ULSD**
- **META Response**
  - **Government Partnership**
    - Met with agencies that have a role in LNG in January 2013 (DOE, FERC, USCG, PHMSA, et al)
    - Goal - Identify current hurdles, issues, and gaps
  - **2012 Natural Gas Feasibility Study**
    - Great Lakes centric but transferable
    - Assessed availability, infrastructure needs, regulations, and safety
    - Expanded to Ohio River and Lower Mississippi

Natural Gas Continued

- **2013 Infrastructure, Bunkering, and Feasibility Study**
  - Performed by DNV
  - Identifies issues, regulatory gaps, and provides best practices
- **2013 Total Fuel Cycle Study**
  - "well to hull" for NG versus conventional fuels
  - Performed by UDEL/RIT cooperative partnership
  - 3 scenarios: international, coastal, inland
  - Overall reduction of SOx, PM, CO_2 **-- BUT** GHG
- **2014 Methane Slip and Release Study**
  - UDEL/RIT
  - Engine slip, system leaks with bunkering

Natural Gas Continued

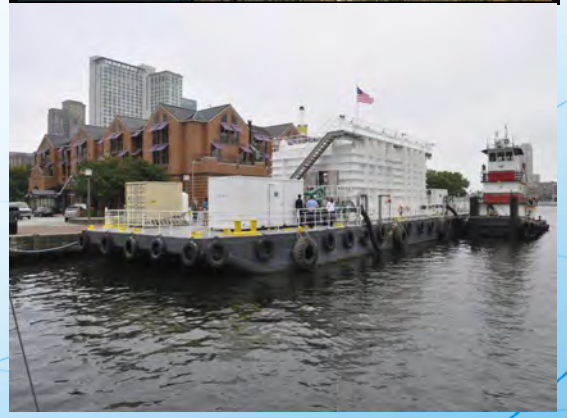
- **Demonstration Projects**
  - **TOTE**
    - Emissions Analysis
    - Lessons Learned
  - **Pittsburgh Region Clean Cities**
    - Fumigation Technology (off the shelf; modified for the tug)
    - Emissions Analysis and Lessons learned
    - Insight into Refueling Options

Advanced Renewable Fuel Oil Tests Bio-Diesel

- **Two MARAD Ship Tests of Blended Bio-Diesel/ULSD vs. ULSD**
  - Results – **IT WORKS**
    - **Reduction of NOx, SOx, CO, CO2, PM and Sulfur**
    - No Changes in Engine Operation
    - No Changes in Material Condition of Engine
- **Longer-term Study with Scripps School of Oceanography**
  - Underway

Aquatic Invasive Species

* **Three US Based Ballast Water Treatment System Testing Facilities** - certified as part of IL for USCG and IMO testing
* **Support Field Scientific Teams for Ship Board Tests**
* **Assist in Developing Tools to Monitor Efficacy of the BWTS and Compliance**
* **Underwater Hull Fouling** – Underwater Hull Cleaning



Thank You

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