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Hydrogen-Related Transportation R&D Portfolio

IEPR Commissioner Workshop on Role of Hydrogen in California's Clean Energy Future

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Gas R&D Program Overview

- Fund R&D not adequately addressed by competitive or regulated entities.
- Support state energy policy including the transition to clean energy, greater reliability, lower costs, and increased safety.
- Provide benefits to under-resourced communities including job creation, improved air quality, and economic stimulation.
- $24 million annual budget, funded by a surcharge on gas consumption in California.

Gas R&D Program Research Topics

- The $24 million annual budget is allocated to several research topics including:
  - Energy efficiency
  - Renewable energy and advanced generation
  - Energy transmission and distribution
  - Energy-related environmental research
  - Transportation
- Recent program plans include hydrogen-related R&D initiatives with the goal of decarbonizing hard-to-reach end uses.

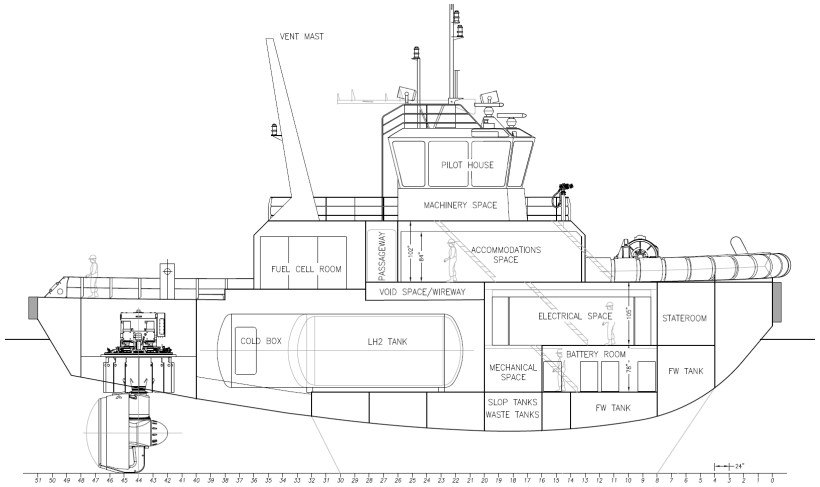
Hydrogen-Related Transportation R&D Summary

Plan	Research Initiative/Topic	Funding	Status
FY19-20	Hydrogen Fuel Cell Demonstrations in Rail and Marine Applications at Ports (H2RAM)	$6,600,000*	March 2021: 3 approved awards, active projects
FY20-21	Hydrogen Fuel Cell Truck and Bus Technology Integration and Demonstration	$4,000,000	March 2022: 2 approved awards, projects kicked off
FY21-22	Advanced Hydrogen Refueling Infrastructure Solutions for Heavy Transport	$4,000,000	Sept 2021: CPUC approved plan, solicitation in development
FY22-23	Advanced Hydrogen Refueling Infrastructure Solutions for Heavy Transport – Funding Augmentation	$4,500,000	March 2022: submitted plan to CPUC, pending approval

Total Investment: $19,100,000

* In partnership with the CEC's Clean Transportation Program, another $4,000,000 project was funded from the H2RAM solicitation

HyZET – H2 Zero-Emission Tugboat



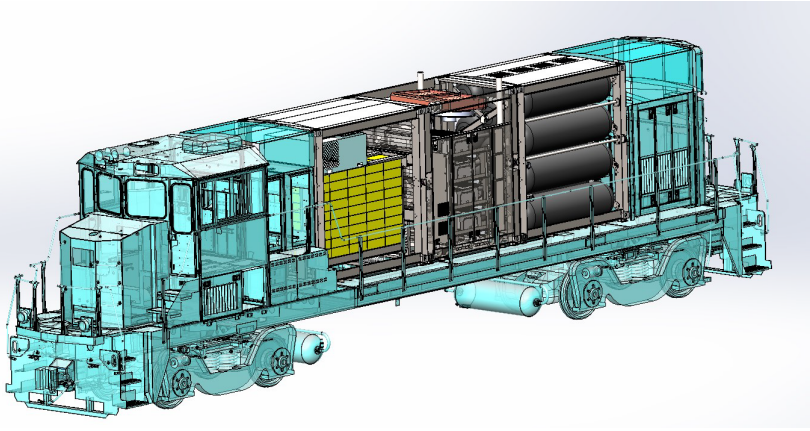
Objectives

- Design a H2 fuel cell harbor tug for future implementation at POLA.
- Evaluate liquid hydrogen fuel systems and bunkering solutions.

Benefits

- Marine vessels contribute to 60% of diesel PM, and 62% of NOx at POLA.
- Decarbonize marine vessels and improve air quality for portside communities.

Sierra Northern Hydrogen Locomotive



GTI ENERGY · Sierra Railroad · Sierra Northern · SoCalGas · FRONTIER energy · OptiFuel Systems · Sacramento Metropolitan Air Quality Management District · BALLARD · Railpower Tech LLC · UC Riverside CE-CERT · Shell Hydrogen · valley vision

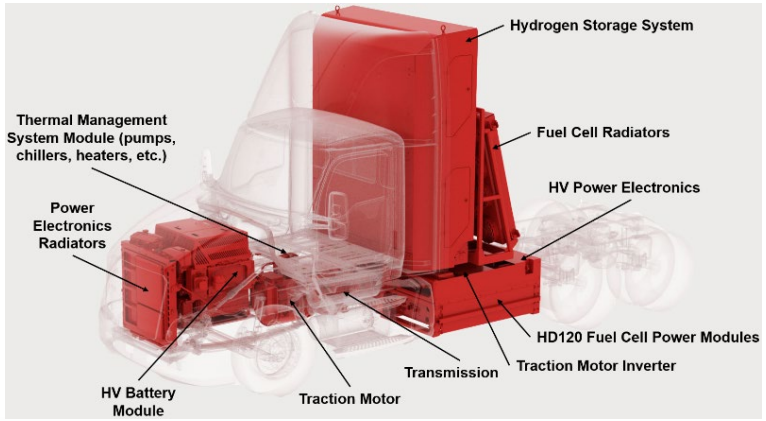
Objectives

- Demonstrate a H2 fuel cell switcher locomotive at the Port of West Sacramento.
- Develop a multi-modal H2 refueling station for locomotives and on-road vehicles.

Benefits

- Statewide, locomotives contribute to 12% of NOx and 8% of PM2.5 emissions.
- Decarbonize locomotives and improve air quality around ports and railyards.

Hydrogen for HD Trucks with Challenging Duty Cycles



Objectives

- Demonstrate H2 fuel cell trucks for bulk gas delivery and long haul.
- Improve efficiency and lower total cost of ownership.
- Assess feasibility of LH2 on-board storage.

Benefits

- Decarbonize HD trucks with heavy payloads, long routes, and limited refueling opportunities.
- Engage community college students and service facilities with H2 fuel cells.

Advancing H2 Refueling Solutions for Heavy Transport

Objectives

- Develop and demonstrate innovative H2 refueling solutions to decarbonize heavy transport:
  - MDHD on-road vehicles (trucks, buses)
  - Mobile off-road equipment (agriculture, construction, mining, cargo handling equipment)
  - Emerging off-road (rail, marine, aviation)
- Enable high flow rates, lower H2 refueling costs, improve reliability, and reduce energy losses from transportation/distribution.

Status

- Solicitation in development.
- Active coordination with Clean Transportation Program and CARB.