

FUELCELL LOCOMOTIVES FOR URBAN RAIL APPLICATIONS

Arnold R. Miller, PhD
President
Vehicle Projects LLC
Denver, Colorado, USA
www.vehicleprojects.com

*FFCA Conference
Long Beach, CA
28 February 2007*



Green Goat™ diesel-battery hybrid switcher, the platform for our fuelcell hybrid locomotives. (Photo courtesy of RailPower Hybrid Technologies)



Copyright © 2007 by Vehicle Projects LLC

1

PROGRAM OBJECTIVES

An industry-government partnership will develop and demonstrate two prototype fuelcell-hybrid locomotives – a switcher locomotive and a road-switcher locomotive – leading to commercial locomotives that will:

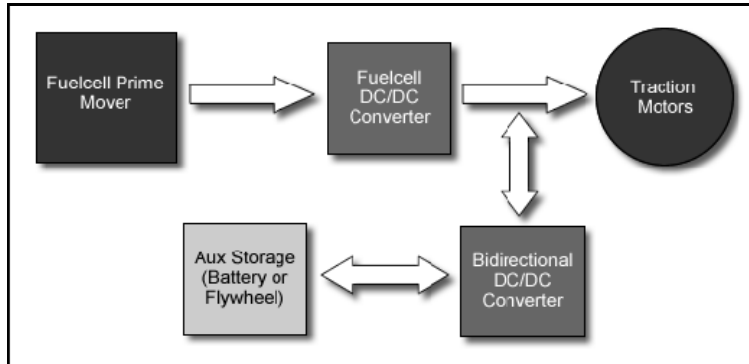
- Reduce air pollution in urban rail applications, including yard-switching associated with seaports
- Serve as a mobile backup power source (“power-to-grid”) for military bases and civilian disaster relief efforts



Copyright © 2007 by Vehicle Projects LLC

2

FUELCELL HYBRID POWERTRAIN



Power of prime mover and auxiliary power/energy device is additive.

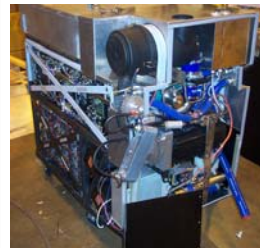


Copyright © 2007 by Vehicle Projects LLC

3

BACKGROUND OF VEHICLE PROJECTS LLC

Vehicle Projects has an unique history of leading large fuelcell vehicle projects from design through implementation.



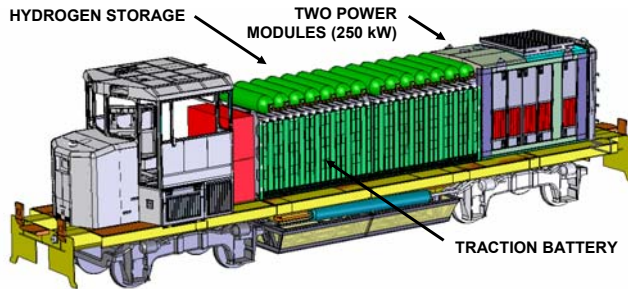
Copyright © 2007 by Vehicle Projects LLC

4

CONCEPTUAL DESIGN – HYBRID SWITCHER (GEN 1)

The switcher locomotive is the first-generation (Gen 1) fuelcell-hybrid locomotive.

Its fuelcell prime mover provides 250 kW of continuous net power for traction or power-to-grid, and the auxiliary lead-acid traction battery allows transient power in excess of 1 MW.

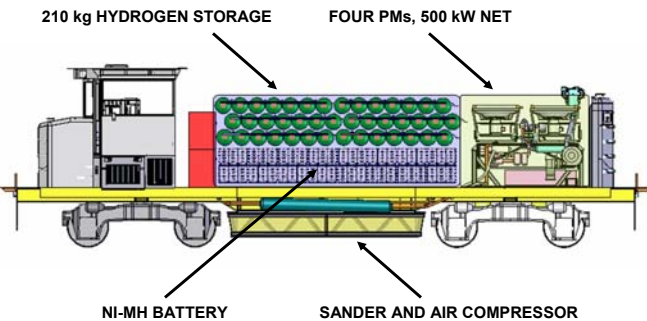


Copyright © 2007 by Vehicle Projects LLC

5

CONCEPT – HYBRID ROAD-SWITCHER (GEN 2)

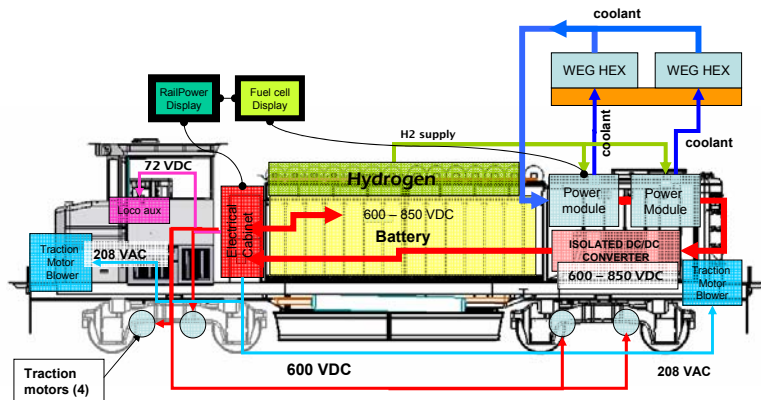
The road-switcher is a second-generation (Gen 2) upgrade of the hybrid switcher and will be capable of, besides switching, delivering short trains in urban areas. The upgrade involves adding two more power modules (PMs), replacing the lead battery with a Ni-MH battery, and increasing hydrogen storage capacity



Copyright © 2007 by Vehicle Projects LLC

6

LOCOMOTIVE TOTAL VEHICLE SYSTEMS DIAGRAM



TECHNICAL CONSORTIUM

Ballard Power Systems
BNSF Railway Company

Defense Gen. & Rail Equipment Center (DGRC)

Dynetek Industries

General Atomics
RailPower Hybrid Technologies
Transportation Technologies Center, Inc
Vehicle Projects LLC
Washington Safety Management Solutions LLC

Fuelcell manufacturer
Industry funder; vehicle integrator; rail-yard demonstrator
Adviser on military applications; power-to-grid demonstrator
Hydrogen storage manufacturer

Power electronics developer
Manufacturer of Green Goat platform
Railway safety regulations interpreter
Engineering design; project manager
Safety analysis

BNSF TOPEKA RAIL SHOP



Vehicle integration will take place at the BNSF Topeka Rail Shop. The completed chassis is being loaded onto a flatcar for transfer to RailPower Hybrid Technologies for addition of the body shell, traction battery, and vehicle controls.



Copyright © 2007 by Vehicle Projects LLC

9

PROJECT SCOPE – HYBRID SWITCHER (GEN 1)

Phase	Executor	Start	Finish
1. Engineering Design	Vehicle Projects	May 06	Apr 08
2. Fabrication of Green Goat Platform	RailPower	Jul 06	Mar 07
3. Fabrication of Major Subsystems: Fuelcell power modules Power electronics Hydrogen storage subsystem	Ballard, Vehicle Projects General Atomics Dynetek	Mar 07	Aug 07
4. Integration of Major Subsystems into Platform	BNSF Topeka Rail Shop	Aug 07	Dec 07
5. Demonstration in Rail Yards	BNSF	Jan 08	Jun 08
6. Demonstration of Power-to-Grid	DGRC	Jul 08	Sep 08

Total period of performance: 29 months



Copyright © 2007 by Vehicle Projects LLC

10

PROJECT BUDGET – HYBRID SWITCHER (GEN 1)

(Thousands of Dollars)

Task/Phase	BNSF	DoD FY07	DoD FY08*	Total
Engineering Design (Phase 1)	150	200	50	400
Fabrication of Green Goat Platform (Phase 2)	800			800
Fabrication of Major Subsystems (Phase 3)		1,050		1,050
Integration of Major Subsystems into Platform (Phase 4)		100		100
Demonstration in Rail Yards (Phase 5)			400	400
Demonstration of Power-to-Grid (Phase 6)			750	750
Project and consortium management	50	600	300	950
Total:	1,000	1,950	1,500	4,450

* To be requested



PROGRAM STATUS

- **Conceptual design of both locomotives (Gen 1 and Gen 2)**
- **Substantial engineering design of fuelcell power module**
- **Recruitment of technical consortium**
- **Preliminary analysis of onboard hydrogen storage safety**
- **Fabrication of Green Goat platform**
- **Appropriation of most of Gen 1 vehicle-development funding**
- **Commencement of fundraising for Gen 1 demonstration phases and Gen 2 upgrade**

