

BALLARD®

power to change the world



▶ **BALLARD POWER SYSTEMS**

ACCELERATING FUEL CELL MARKET ADOPTION

WWW.BALLARD.COM

2008



COPYRIGHT © 2008 BALLARD POWER SYSTEMS, INC. ALL RIGHTS RESERVED

■ CLEAN ENERGY FUEL CELL PRODUCTS...

▶ OUR COMPANY

- About 500 employees
- World-leading R&D & manufacturing facilities
- Locations in Vancouver, Canada (HQ), Lowell, MA & Fujisawa, Japan

▶ OUR BUSINESS

- Design, manufacture, sale & service of hydrogen fuel cell products

▶ OUR CUSTOMERS

- System integrators and OEM's addressing end-user needs: materials handling, telecom backup power, residential cogeneration, and transit buses

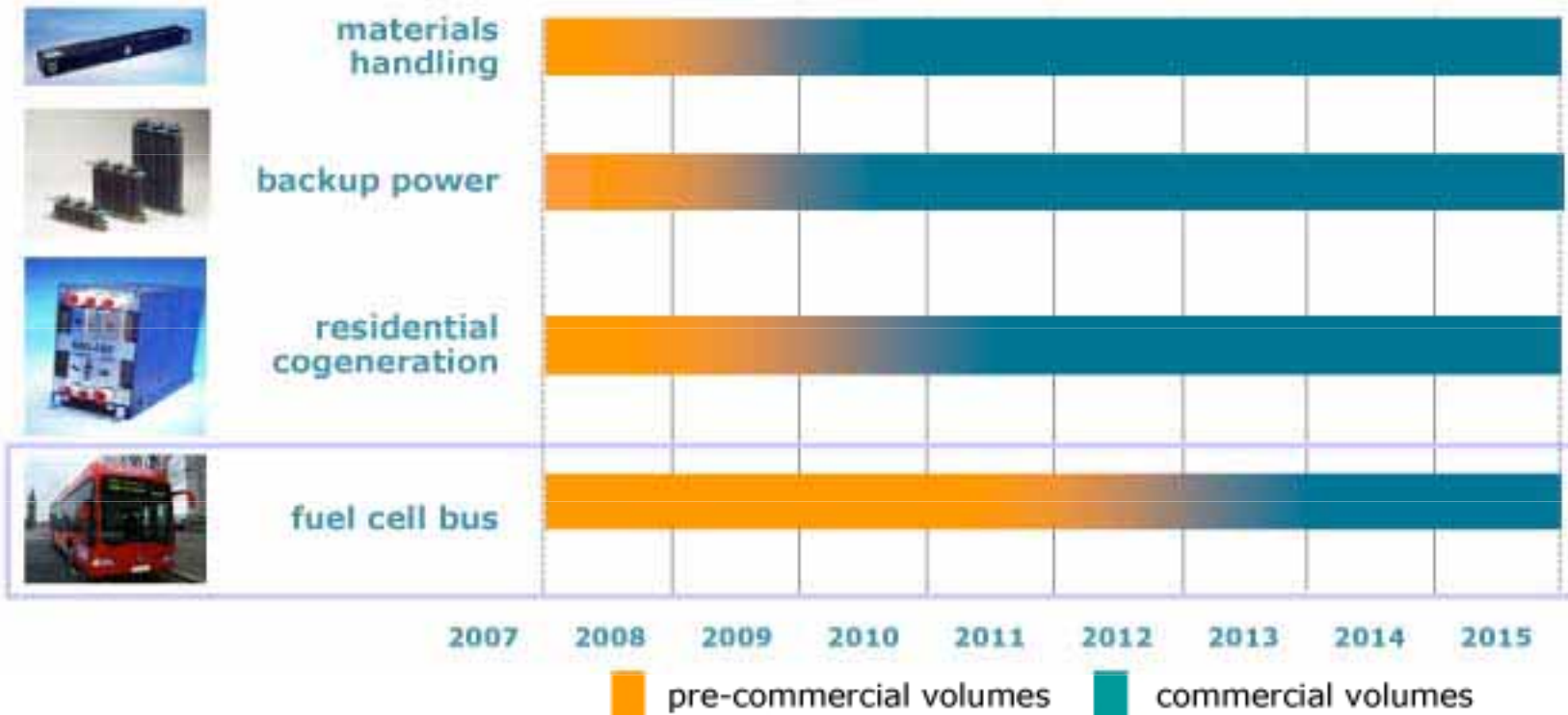
▶ OUR FOUNDATION

- Technology Leadership
- Production Expertise
- Expanding Go-to-Market Capabilities

- **Technology Leadership**
 - Extensive fuel cell IP portfolio
 - Deep technical fuel cell strength
 - Most advanced testing facility worldwide
 - Automotive IP rights
- **Production Expertise**
 - State-of-the-art manufacturing facilities
 - High quality manufacturing standards
- **Expanding Go-to-Market Capabilities**
 - Broad portfolio of fuel cell products
 - Growing set of strategic relationships
 - Industry-leading customer support

Fuel Cell Markets Commercialization Timelines

BALLARD



market commercialization timelines based on Ballard projections

ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2008

PAGE 4



Bus Program Evolution

1991 - 1992



Phase 1
Proof of
Concept

1993 - 1995



Phase 2
Commercial
Prototype

1996 - 1999



Phase 3 Fleet
Demonstration
Alpha Sites

1999 - 2002



Phase 4 Fuel
Cell Engines
Beta Sites

2002 - 2008



Phase 5
Serial
Production

Power	90 kW / 125 HP	205 kW / 275 HP	205 kW / 275 HP	205 kW / 275 HP	205 kW / 275 HP
Location(s)	Vancouver	Vancouver	Chicago (3) Vancouver (3)	California	5 Continents CUTE (30), Perth (3) California (3) Beijing (3)
Lessons Learned	Proof of concept	Full-size bus integration	Field service Site homologation	System optimization Cost reduction - single motor concept	International homologation Reliability growth Real world usage

ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2008

PAGE 5

Phase 5 - Ballard Powered Bus Demo Sites

BALLARD®



★ Phase 5 Bus Program Demo Sites

- 39 Fuel Cell Buses
- 13 cities around the globe
- More than 150,000 hrs of operation – 2.2M km's
- Revenue service with over 6 million bus passengers
- More than 90% availability, with some stacks exceeding 4,000 hours

ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2008

PAGE 6

Why Fuel Cell Buses ?

BALLARD

- **Reduced Greenhouse Gas Emissions on a well to wheel basis**

- ▶ A Fuel cell bus using hydrogen from renewable sources will displace up to 133 tons of CO2 per year

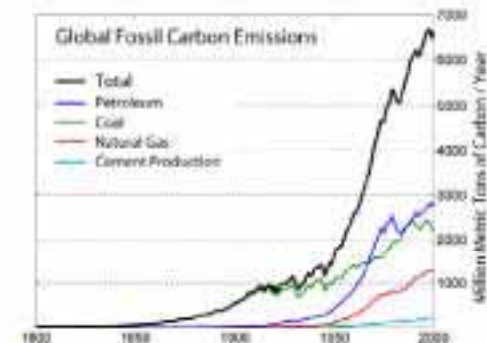
* CEERT, GHG Emissions Reductions - August 2007

- **Completely eliminates tailpipe emissions**

- ▶ Nox, Sox, PM

- **Improved fuel efficiency**

- ▶ 30-40% net improvement over diesel buses on an energy equivalent basis



ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2008

PAGE 7

Environmental ROI



Comparing the Capital Costs of GHG Avoidance

	tonnes/yr Avoided	GHG 20 year benefit (tonnes)
FC Buses 20	2660	53200
Diesel Hybrid Buses 20	798	15960

BC Transit Fuel Cell Bus Cost per/GHG Tonne Avoided

46.4M/53,200 tonnes | **\$872/tonne**

Commercial Diesel Hybrid Bus Cost per/GHG Tonne Avoided

15M/15,960 | **\$940/tonne**

At today's prices, fuel cell buses already represent a lower cost per GHG tonne avoided than diesel hybrid buses.

Next Generation Heavy-Duty Fuel Cell Module (HD6)

BALLARD

- **HD6 fuel cell module has greater power density and durability while maintaining some of the time tested components of the previous design.**
 - ▶ Applies next generation fuel cell stack technology
 - ▶ Offered with a 12,000 hr, or 5 yr warranty



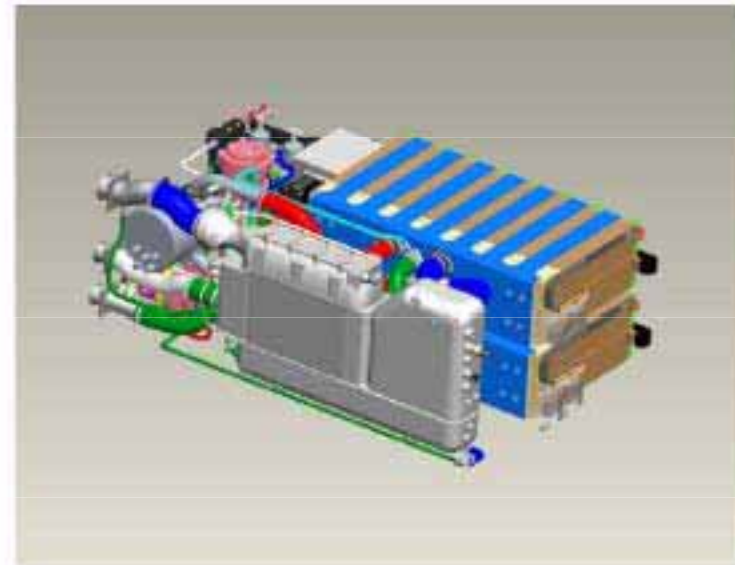
HD6 Module

Next Generation Heavy-Duty Fuel Cell Module (HD6)

BALLARD®

- **BOP Includes:**
 - ▶ air humidification system
 - ▶ hydrogen re-circulation
 - ▶ condenser for water management
 - ▶ CAN and power supply connections
 - ▶ controller

- **150 or 75 Kw configuration**



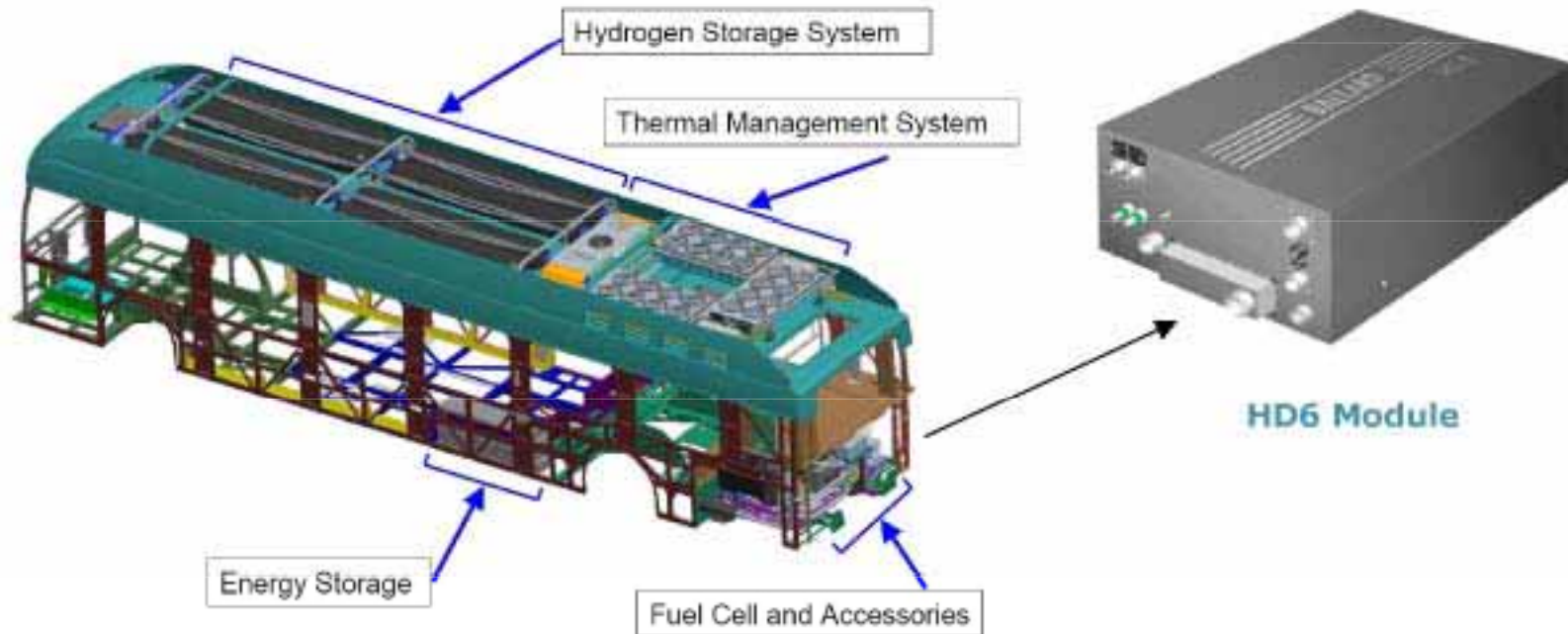
HD6 Module

Integration into a Hybrid Drive

BALLARD



Hybrid System Packaging Overview



ISE Confidential

Courtesy of: **ISE CORPORATION**
TRANSPORTATION FOR A CLEAN PLANET

Page 27

ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2008

PAGE 11

HD6 - Packaging in Bus

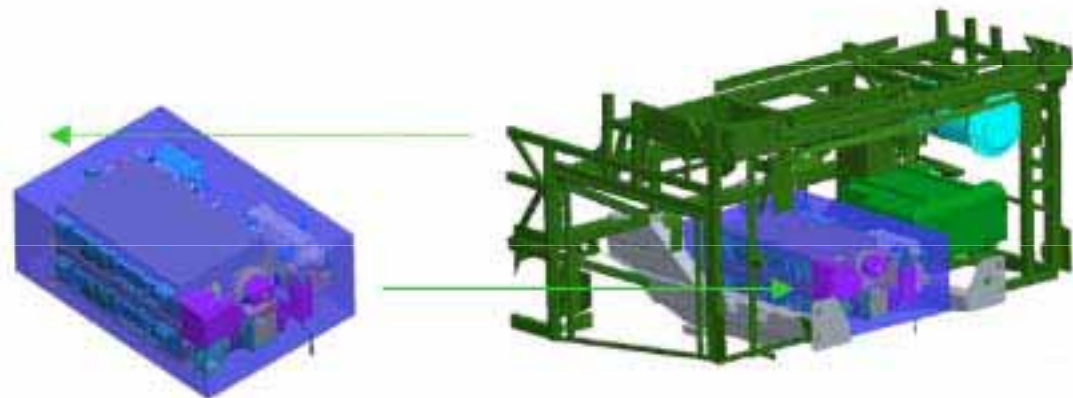
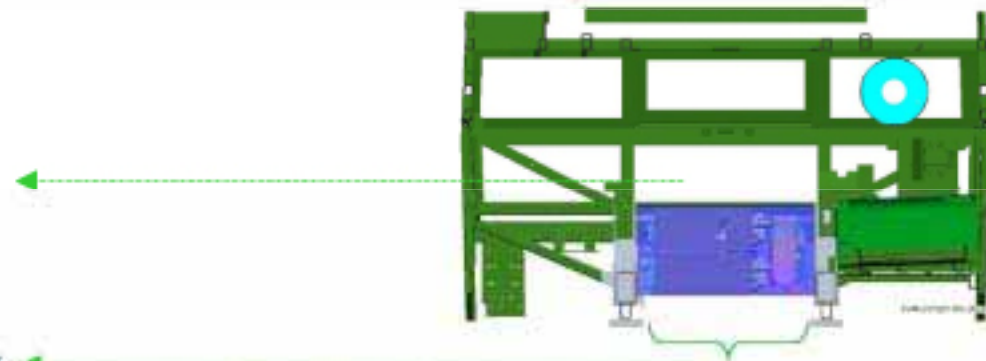
BALLARD

Rear Section View

Space for battery pack, air module, ancillaries

Stack module fits between frame rails in space formerly used by the IC engine

Integrator is able to locate the HD6 Module in existing engine bay



ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2009

PAGE 12

Path to Commercialization



Heavy-Duty Fuel Cell Module Development

2002-2008

2008-2012

> 2012



Key attribute improvements of each generation

- Performance
- Reliability
- Power density
- Durability (Warranty)
- Cost reduction
- Fuel Efficiency
- Cost reduction
- Design for manufacture

Fuel Cell Bus Capital Costs



ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2009

PAGE 13

Application of HD6

BALLARD®

- **10 to 18 mtr buses**
- **Locomotives**
- **Marine**
- **Aircrafts**
- **APU**
- **Power generation**

BC Transit Fuel Cell Bus Fleet

BALLARD®

- ▶ On August 3rd, BC Transit awarded a \$46.4M contract for 20 fuel cell buses for operation in Whistler.
- ▶ Delivery of 1st bus in 2008, 19 additional buses in 2009 for operation in normal revenue service.
- ▶ Buses will be operational for the 2010 Olympic Games Continuing through 2014



 **BC Transit**


NEW FLYER


ISE CORPORATION

BALLARD®
power to change the world™

ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2008

PAGE 15

Transport for London Fuel Cell Bus Fleet

BALLARD[®]

- ▶ On November 13th, Transport for London awarded a £9.65 million contract including 5 fuel cell buses for operation in London
- ▶ Using 75kW HD6 Modules
- ▶ London has committed to powering five per cent of all public sector fleet vehicles with hydrogen by 2015



Transport for London



ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2008

PAGE 16

FTA National Fuel Cell Bus Demonstration Program

BALLARD[®]

- ▶ The NY Power Authority and the Niagara Falls Transit Agency will procure and operate two fuel cell buses in revenue service starting in 2009
- ▶ Using 150 kW HD6 modules
- ▶ Same configuration as the BC Transit buses



ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2008

PAGE 17



The Fraunhofer Institute in Germany has developed fuel cell-flywheel hybrid trolley powered by an 80 kW fuel cell engine featuring the same Mk902 stack technology used in the P5 bus program

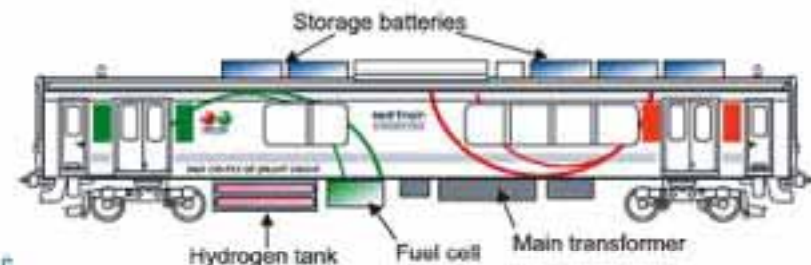




Ballard's Rail Experience

BALLARD[®]

Japan's JR East has incorporated two Mk 902, 65-kilowatt fuel cell stacks into hybrid fuel cell train capable of a travel at a maximum speed of 100 kph (60 mph) for up to 100 km. Currently undergoing field trials in Yokohama's Kanazawa ward.



ACCELERATING FUEL C



FEBRUARY 2008

PAGE 19

Ballard's Rail Experience

BALLARD

- **Ballard is supplying two P5 modules to Vehicle Projects for integration into a fuel cell/battery hybrid locomotive for demonstration in 2008 as:**
 - ▶ a switchyard locomotive in the Los Angeles basin and;
 - ▶ a mobile back-up power source for military bases and civilian disaster relief efforts



**VEHICLE
PROJECTS
LLC**

The Market for FC Buses – Who's Driving Adoption?

BALLARD®



Hydrogen Bus Alliance

Amsterdam (GVB)
Barcelona (TNB)
Berlin (BVG)
British Columbia (BC Transit)
Cologne (Regionalverkehr Köln)
Hamburg (Hamburger Hochbahn)
London (Transport for London)
South Tyrol
Western Australia - (Public
Transport Authority of Western
Australia)



CLINTON CLIMATE INITIATIVE

40 cities focused on reducing
energy and using cleaning energy
Ballard signed an MOU with the
Clinton Foundation in October 2007



Mandate requires 12 Zero Emission
Buses on the road by January 1, 2009

▶ 15% of Bus Purchases in 2011 for
Northern CA transit agencies

▶ 15% of Bus Purchases in 2012 for
Southern CA transit agencies

ACCELERATING FUEL CELL MARKET ADOPTION



FEBRUARY 2008

PAGE 21

BALLARD®

power to change the world

Thank you



▶ BALLARD POWER SYSTEMS

ACCELERATING FUEL CELL MARKET ADOPTION

WWW.BALLARD.COM

2008

BALLARD



COPYRIGHT © 2008 BALLARD POWER SYSTEMS, INC. ALL RIGHTS RESERVED