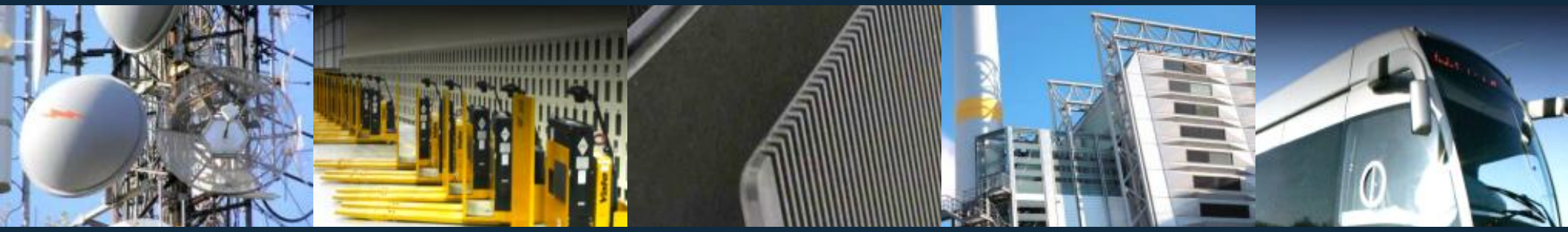

BALLARD®

PUTTING FUEL CELLS TO WORK

NASDAQ:BLDP • TSX:BLD

Business Case for Heavy Duty Fuel Cells

Jeffrey Glandt

World of Energy Solutions Conference, Stuttgart, October 7, 2014

Outline

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- **About Ballard**
- **Fuel Cell Bus**
  - Why Fuel Cell Buses?
  - Fuel Cell Bus Experiences
- **Fuel Cell Rail**
- **Fuel Cell Marine**
- **Addressing A Significant Barrier for Heavy Duty Fuel Cell Commercialization: Cost**
- **Summary**

About Ballard - Who We Are

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- **Ballard is the global leader in clean energy proton exchange membrane ("PEM") fuel cell products and services … design, manufacturing & deployment**
  - Telecom Backup Power ➔ 2,500 systems … *9MW's of power*
  - Engineering Services ➔ C$60-100M contract with Volkswagen
  - Material Handling ➔ 4,000 stacks … *10M hours of runtime*
  - Heavy duty modules for buses ➔ 49 buses on the road worldwide
- **355 employees**
  - HQ in Vancouver, Canada
  - Product Engineering in Vancouver, Bend, Oregon & Denmark
  - Manufacturing in Vancouver & Mexico

Ballard HQ facility – Vancouver, B.C., Canada

Key Customers

nsn, VANHOOL, SOLARIS, Mercedes-Benz, plug power, AZURE Hydrogen, VOLKSWAGEN AKTIENGESELLSCHAFT

About Ballard - Competitive Advantage

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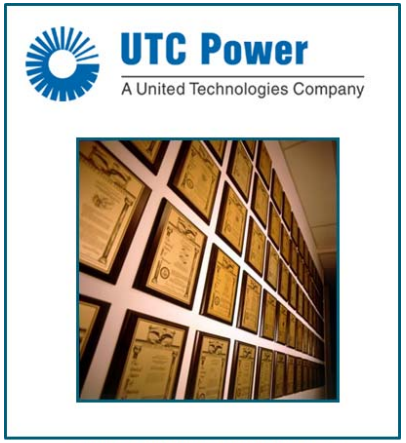
- **Long history with Motive power industry**
  - 4 major automotive development programs
  - 8 major Bus OEMs
  - Supplier to more than 20 small automotive and bus fleets and demonstrations
  - Major market share in fuel cell forklift application
- **Extensive R&D work over past 15 years**
  - $1B+ investment in development
  - Significant contribution from Ford & Daimler
- **Extensive patent portfolio, licensing rights, and recent acquisition of UTC's PEM intellectual property ("IP") portfolio**
  - Creates opportunities for incremental Licensing revenue and expands Engineering Services capabilities
  - Over 200 patents/applications owned, and license rights to >700 patents/applications



Integration of Ballard and UTC portfolios of patents and patent applications, patent licenses, invention disclosures & know-how now underway

About Ballard - Fuel Cell Product Portfolio

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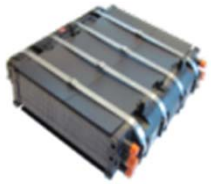
Fuel Cell Stacks

FCgen®-1020ACS

- 500W-2kW
- Up to 8k hrs



FCgen®-1300

- 2-8kW
- Up to 30k hrs

FCvelocity®-9SSL

- 4-20kW
- Up to 12k hrs

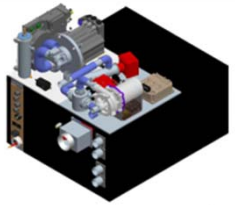
FCvelocity®-1100

- 100kW
- > 10k hrs

Fuel Cell Modules

FCvelocity®-HD6

- 75-150kW
- Up to 20k hours



FCvelocity®-HD7

- 100 kW
- Up to 20k hours

Complete Fuel Cell Systems

ElectraGen™-H2

- 2kW & 5kW
- Direct hydrogen
- Indoor (rack-mountable) & outdoor use

ElectraGen™-ME

- 2.5kW & 5kW
- Methanol fuelled
- Outdoor use

- Multi-MW power

Ballard's product portfolio includes industry-leading PEM fuel cell stacks, fuel cell modules and complete fuel cell system solutions

About Ballard - Fuel Cells in the Field

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~2,000 installed telecom systems

>3,000 forklift trucks operating

~45 fuel cell buses operating

+300 fuel cell cars operating

Ballard is experienced in developing technology to customer requirements, success mainly driven by development approach learned from Ford and Daimler

Why Fuel Cell Buses – Emissions and Efficiency

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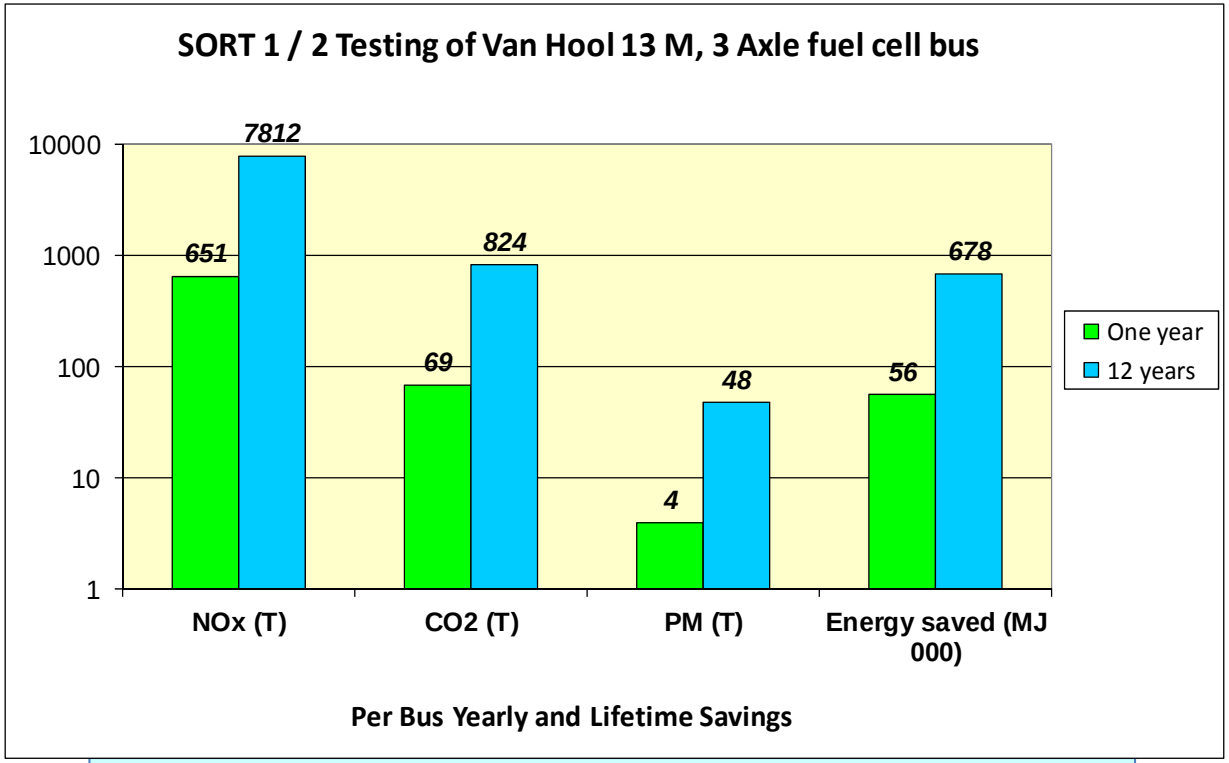
- **Eliminates tailpipe emissions**
  - Nitrogen Oxides (NOx)
  - Sulphur Dioxides (SOx)
  - Particulate Matter (PM)
- **Greenhouse Gas Emission reductions**
  - Calculated on a well to wheel basis
- **Improved fuel efficiency**
  - 1.5-2.5x improvement over conventional diesel buses on an energy equivalent basis
- **Flexibility of operation**
  - No underground or overhead charging required



Source: Testing witnessed by TUV for 13 metre Van Hool fuel cell electric bus on SORT 1 & 2 drive cycles, dated June 24, 2013

Why Fuel Cell Buses – Total Cost of Owner Ship vs GHG Projections

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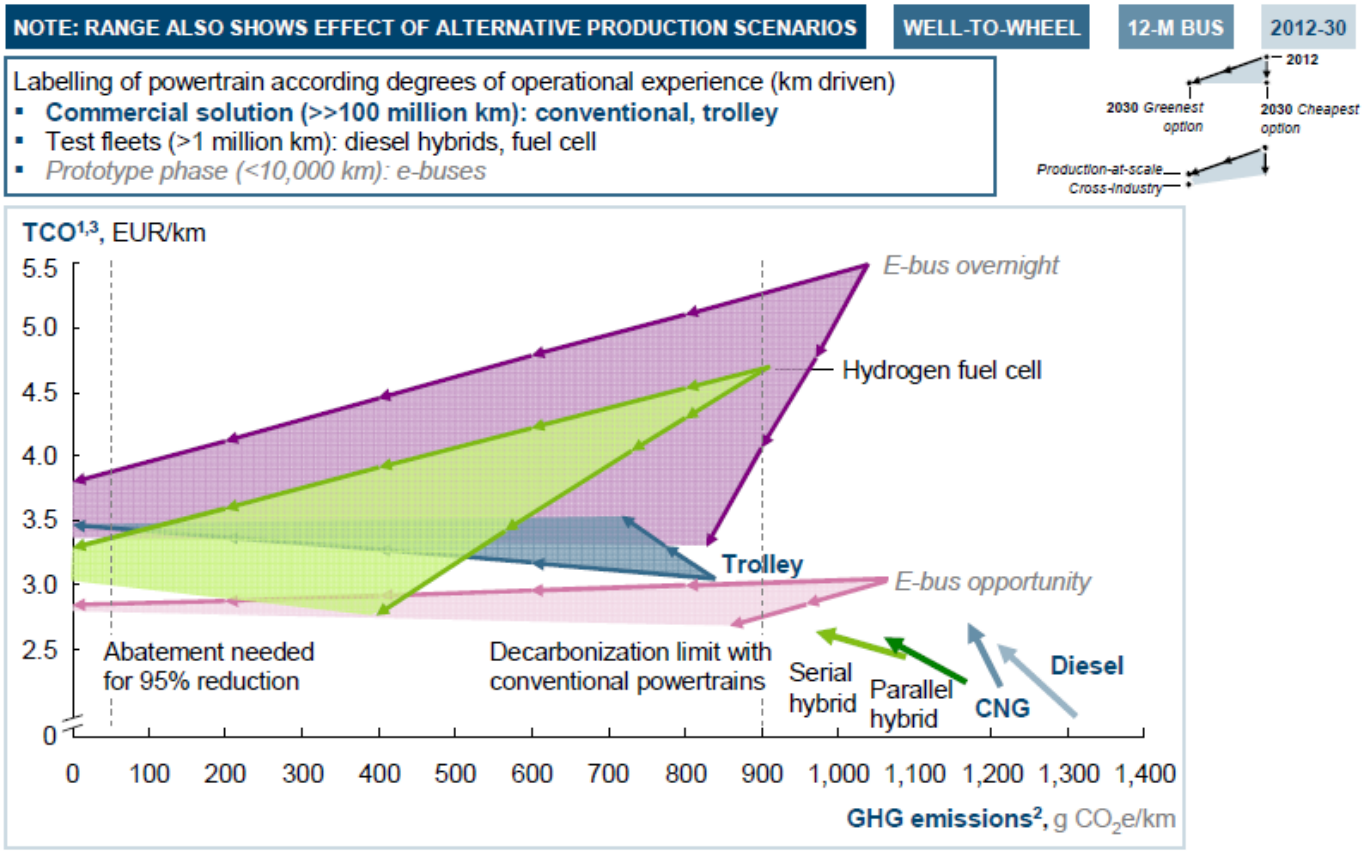
CO_2e/TCO (EUR/KM) COMPARISON OF STANDARD BUS POWERTRAINS



1 TCO for a 12-m bus incl. purchase; running and financing costs based on 60,000 km annual mileage and 12 years bus lifetime
2 Total CO_2e emissions per bus per km for different fuel types from well-to-wheel
3 Electricity costs for e-bus and water electrolysis part of hydrogen production based on renewable electricity price with a premium of EUR 50/MWh over normal electricity

Source: Urban buses: alternative powertrains for Europe (McKinsey, 2012)

- **Diesel, CNG, Serial & Parallel hybrid small GHG improvements with increase in TCO**
- **E-bus overnight unlikely to meet TCO and GHG targets**
- **Trolley is limited by catenary infrastructure**
- **E-bus opportunity limited proof of overhead/underground charging systems**
- **Fuel cell is the most promising technology projected to meet longtime GHG and TCO targets**

Fuel Cell Bus Experiences – Global Deployments

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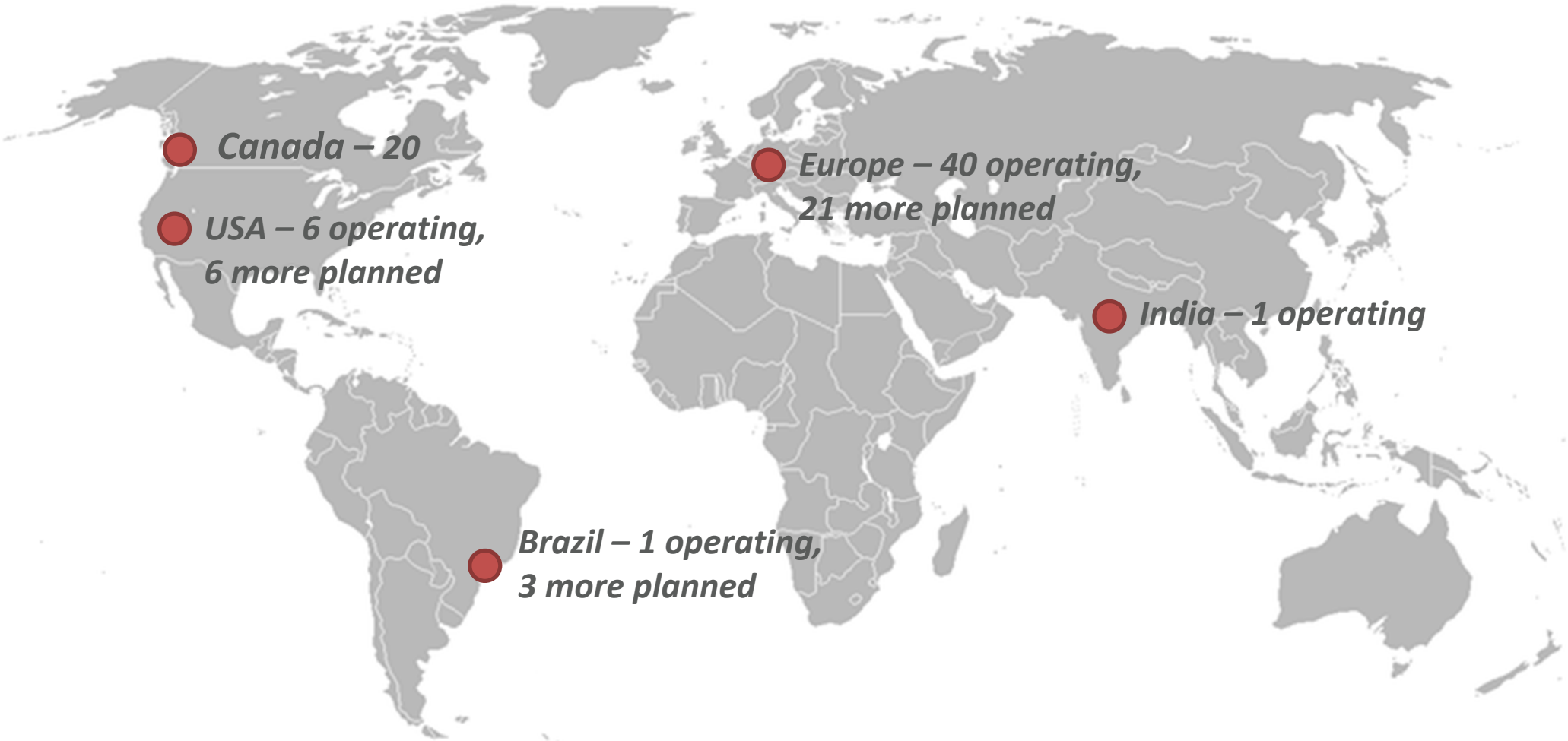
Ballard-powered buses are operating worldwide today



Fuel Cell Bus Experiences – European Deployments

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Location	Fleet Size	Deployment Date
London	8 buses	2010
Oslo	5 buses	2012
Amsterdam	2 buses	2011
Cologne	4 buses	2011, 2014
Aberdeen	10 buses	2014
San Remo	5 buses	2013
Flanders	5 buses	2014
Hamburg	2 buses	2014

Recipient of the Busworld Ecology Award, in partnership with Van Hool, for demonstrating outstanding ecological credentials in fuel cell bus design

busworld EUROPE KORTRIJK

By mid-2014, a total of 40 Ballard-powered fuel cell buses will be deployed in Europe, with an additional 21 buses to be deployed in 2015

Fuel Cell Bus Experiences - Case Studies

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Customer	Transport For London	BC Transit	SunLine Transit Agency
Location	▪ London, England	▪ Whistler, BC, Canada	▪ Coachella Valley, CA, USA
Challenge	▪ Implement a transit system that will help tackle London's goals for air quality improvement	▪ Provide enhanced and efficient transit services for the 2010 Winter Olympic Games in Vancouver	▪ Implement a clean technology bus into the company's fleet which meets FTA 'Buy America' standards
Solutions	▪ Introduced a fleet (5 initially, 3 added later) of Ballard's FCvelocity-HD6 powered fuel cell buses	▪ Fleet of 20 hydrogen fuel cell powered buses deployed ▪ World's largest fuel cell bus fleet, housing the world's largest hydrogen vehicle fuel station	▪ 40' fuel cell powered buses developed by Ballard, ElDorado and BAE Systems
Advantages	▪ Hydrogen fuel cell buses produce no emissions at the tailpipe ▪ Can be twice as energy efficient as conventional buses with internal combustion engines, while providing a quieter and smoother ride		

Fuel Cell Bus Experiences – Performance vs. Operating Hours: London, UK

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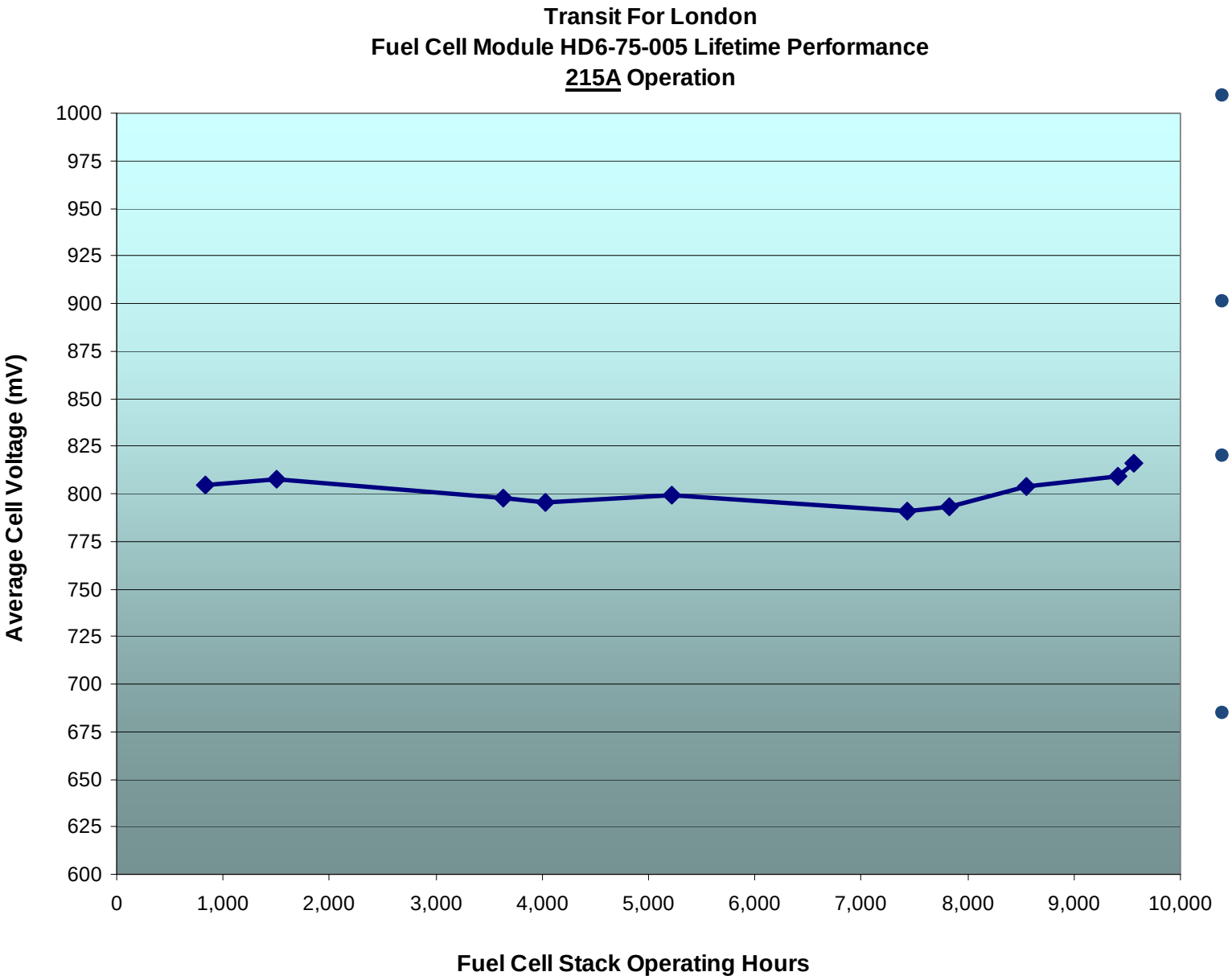

- Average cell voltage vs operating hours
- 215A is roughly 70% of max load
- No significant performance degradation over 9000 hours
- Performance degradation is highly dependent on drive cycle and power level

Fuel Cell Bus Experiences – Drive Cycle Parameters: Whistler, Canada

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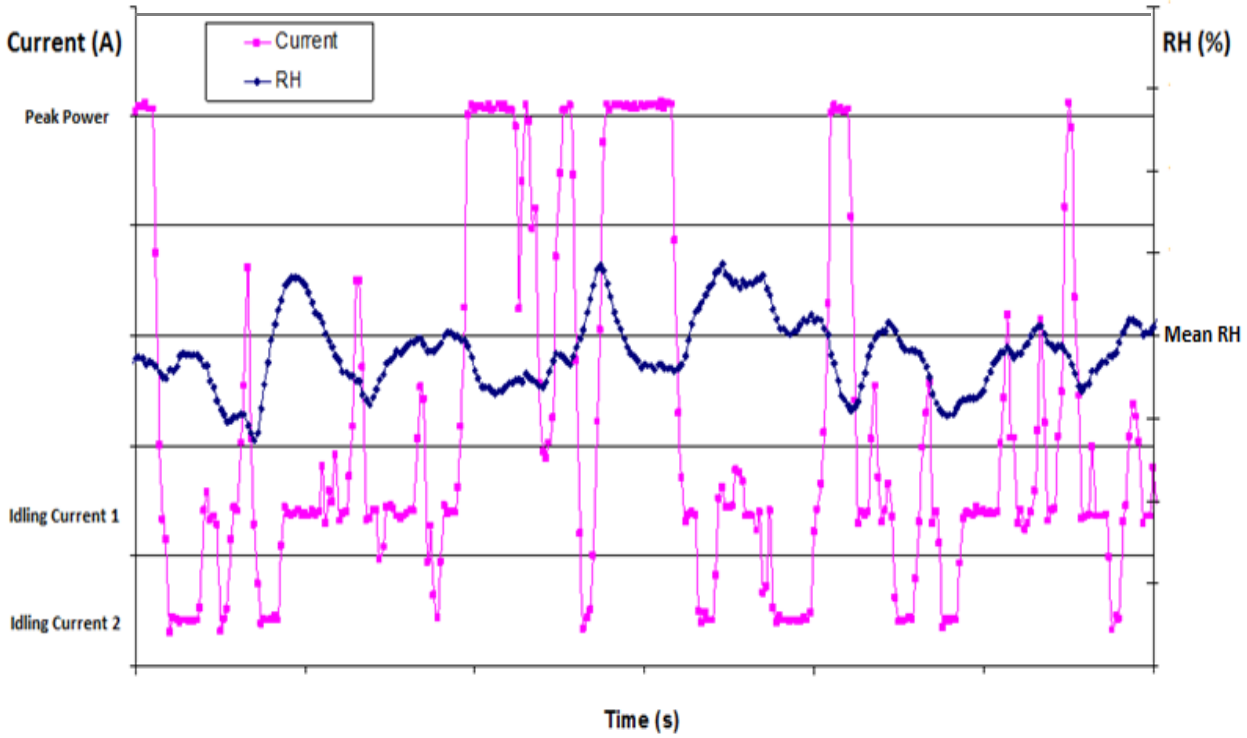

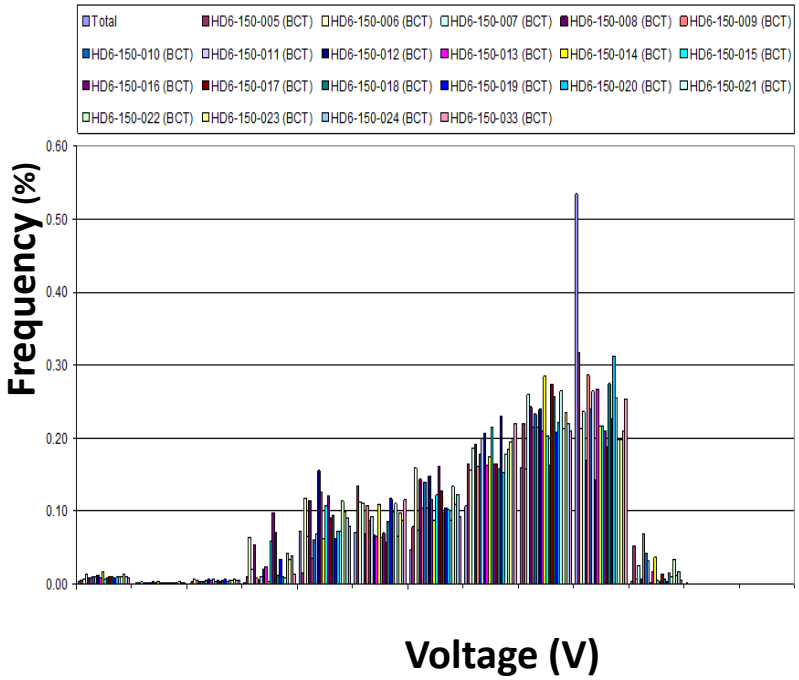

- Example of drive cycle variables
  - Current and Relative Humidity
  - Cell Voltage Distribution

Fuel Cell Bus Experiences – Performance vs. Operating Hours: Whistler, Canada

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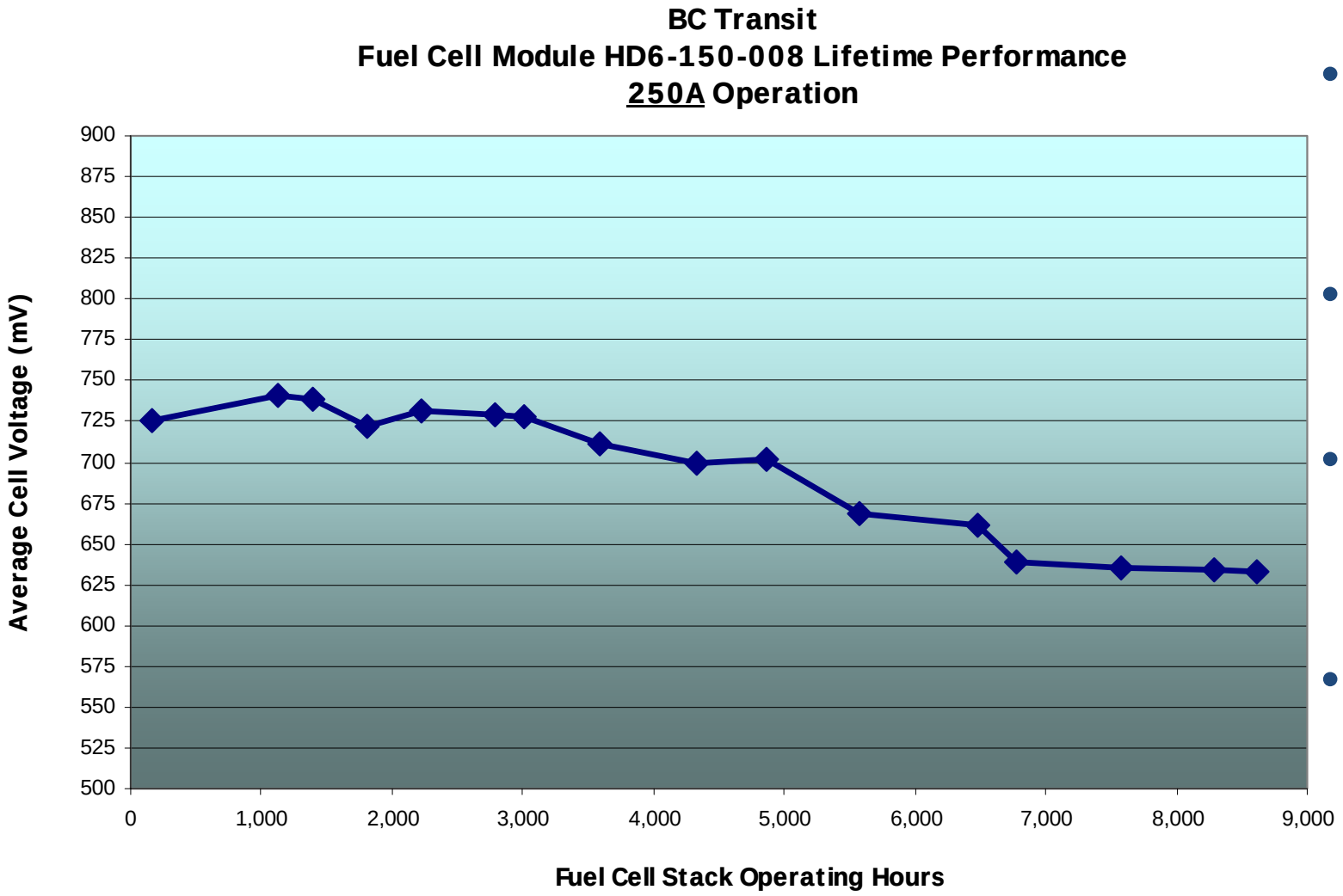

- Average cell voltage vs operating hours
- 250A is roughly 80% of max load
- ~13% performance degradation over 9000 hours
- Performance degradation is highly dependent on drive cycle and power level

Fuel Bus Experiences – Ex-Situ Analysis of Field Returns: Whistler, Canada

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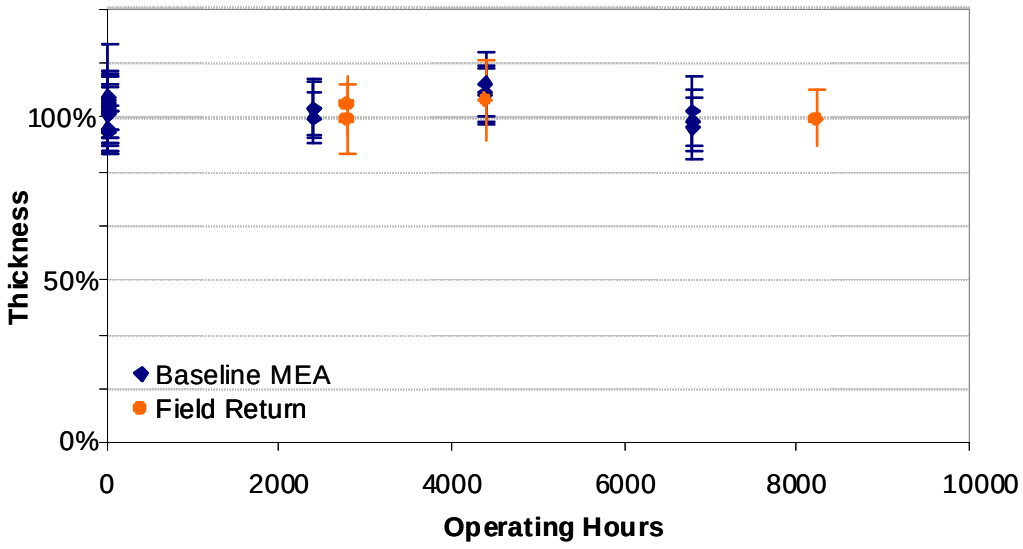
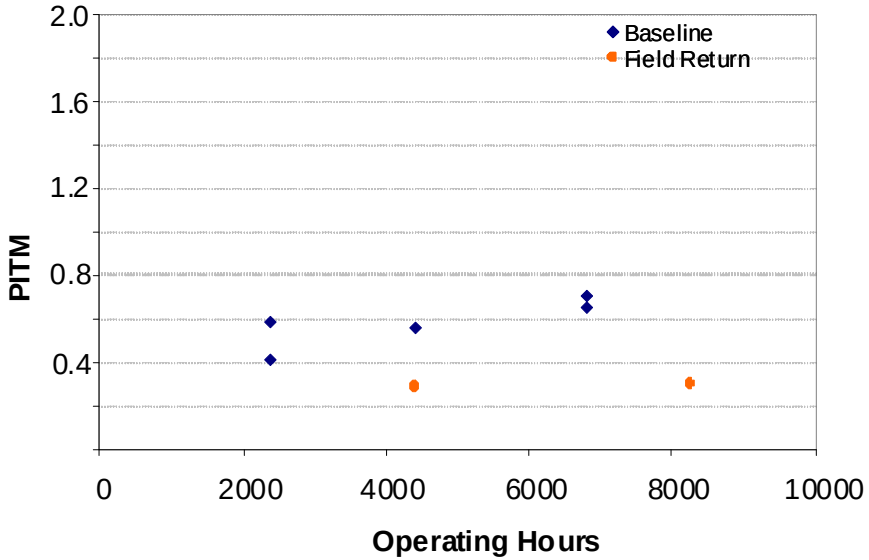
Whistler Bus Field Returns and Stacks Operated on Test Stands





- Field and test stand operated stacks exhibit similar results
  - Insignificant membrane thinning
  - Similar Pt in the membrane (PITM) concentrations

Fuel Cell Bus Experiences – Sun Line Fuel Cell vs CNG Palm Springs, USA

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Data Item	AFCB	CNG
Number of buses	1	5
Data period	March 2012–February 2013	March 2012–February 2013
Number of months	12	12
Total mileage in period	42,988	228,225
Average monthly mileage per bus	3,582	3,036
Total fuel cell operating hours	2,758	N/A
Average bus operating speed (mph)	15.6	15.5
Availability (85% is target)	85	77
Fuel economy (miles/kg or GGE)	6.54	2.80
Fuel economy (miles/DGE[a])	7.39	3.13
Miles between roadcalls (MBRC) – bus	3,908	8,151
MBRC – propulsion only	7,165	32,604
MBRC – FC system only	14,329	N/A
Total maintenance ($/mile)[b]	0.39	0.53
Maintenance – propulsion only ($/mile)	0.12	0.24

Higher availability than CNG

2x better fuel economy

Lower maintenance costs

[a] Diesel gallon equivalent.
[b] Work order maintenance cost.

http://www.fta.dot.gov/documents/FTA_Report_No._0047.pdf

Fuel Cell Rail – Drivers & Challenges

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- **Drivers/Advantages**
  - Reduced emissions (vs. diesel; like electric)
  - Reduced noise (vs. diesel; like electric)
  - Higher efficiency (all loads vs. diesel; regenerative braking with hybridization)
  - Autonomous
    - Linear infrastructure (technology, fueling) that can be modeled/scaled like diesel (good range)
    - Avoids infrastructure and maintenance costs associated with catenary electric rail
- **Challenges**
  - Fuel cell capital and operating costs
  - Expense/lack of hydrogen sources and infrastructure

Source: http://www.vehicleprojects.com/proj.html

Fuel Cell Rail – Ballard Experience

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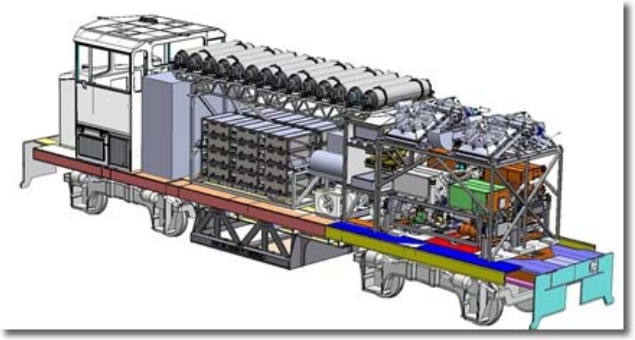
- **Ballard has participated in a number of rail fuel cell applications:**
  - USA
    - 1st shunt locomotive delivered with 2 x P5 bus units to BNSF (240 kW net fuel cell)
    - 2nd shunt locomotive design completed. Awaiting funding (500 kW net fuel cell)
  - South Africa
    - 6 mine locomotives powered by FCvelocity-9SSL fuel cell stacks (17 kW gross fuel cell)
  - India
    - 2 shunt locomotives fitted with 2 kW APUs
    - Another 20 APUs delivered and under integration
    - Indian Railway expected to issue tender for shunt locomotive power modules in Q2 2015
  - Japan
    - JR East integrated and evaluated a two coach inter-city shuttle train



Source: http://www.vehicleprojects.com/proj.html

Source: http://www.vehicleprojects.com/proj.html

Fuel Cell Marine – Drivers & Challenges

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- **In the past Ballard has participated in marine fuel cell applications; recent experience consists of feasibility studies**
- **Interest in the application continues to build, and leveraging Ballard's bus technology could minimize development time and cost.**
- **Where is the market interest coming from?**
  - Vessel propulsion (short haul ferries, water taxis, etc.)
  - Vessel onboard power
  - Shore power
- **Why is there interest?**
  - Reduced emissions of fuel cells
  - Higher efficiency of fuel cells (all loads)
  - Reduced noise of fuel cells
- **What is limiting the adoption?**
  - Higher fuel cell capital and operating costs
  - Lack of fueling sources and infrastructure
  - Challenges with marine codes and standards

Source: http://products.damen.com/en

Addressing Fuel Cell Cost – Ballard Bus Program Evolution

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PHASE 1 - Proof of Concept
1991-1992
Vancouver, Canada

PHASE 2 - Commercial Prototype
1993-1995
Vancouver, Canada

PHASE 3 - Fleet Demonstration Alpha Sites
1996-1999
3 Vancouver, Canada & 3 Chicago, USA

PHASE 4 - Fuel Cell Engines Beta Sites
1999-2002
Palm Desert, USA

PHASE 5 - Serial Production
2002-2009
5 Continents, CUTE (30), Perth (3), California (3),
Beijing (3)

PHASE 6 – Hybridization of Fuel Cells
2009 - Current
40+ Canada\Europe\USA\Brazil

Addressing Fuel Cell Cost – Current Generation (FCvelocity™-HD6)

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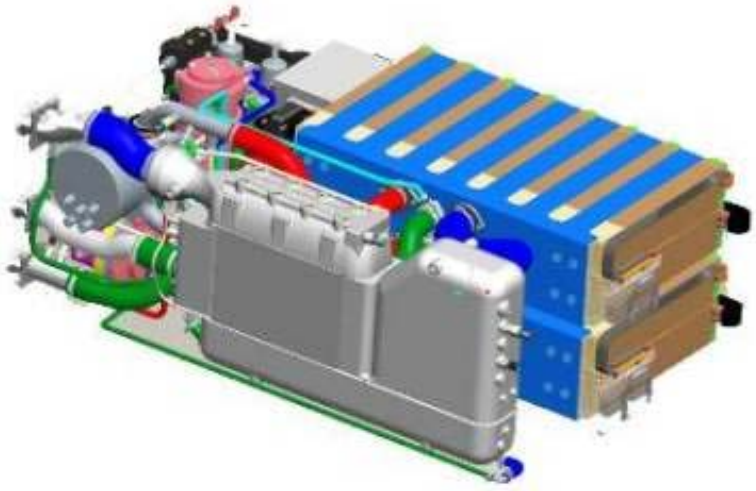
- **Current generation fuel cell bus module:**
  - Available in 75kW or 150kW configurations to appropriately match bus type and application
  - Power density: 400 kgs, delivering 150 kW gross power
  - Leveraging state-of-the-art automotive stack technology (economies of scale)
  - Air compressor supplied separately
  - Offered with a 12,000-hour or 5-year fuel cell stack warranty
  - Module lifetime 10+ years

FCvelocity™–HD6



Addressing Fuel Cell Cost – Fuel Cell Bus Cost: Volume Effects and Breakdown

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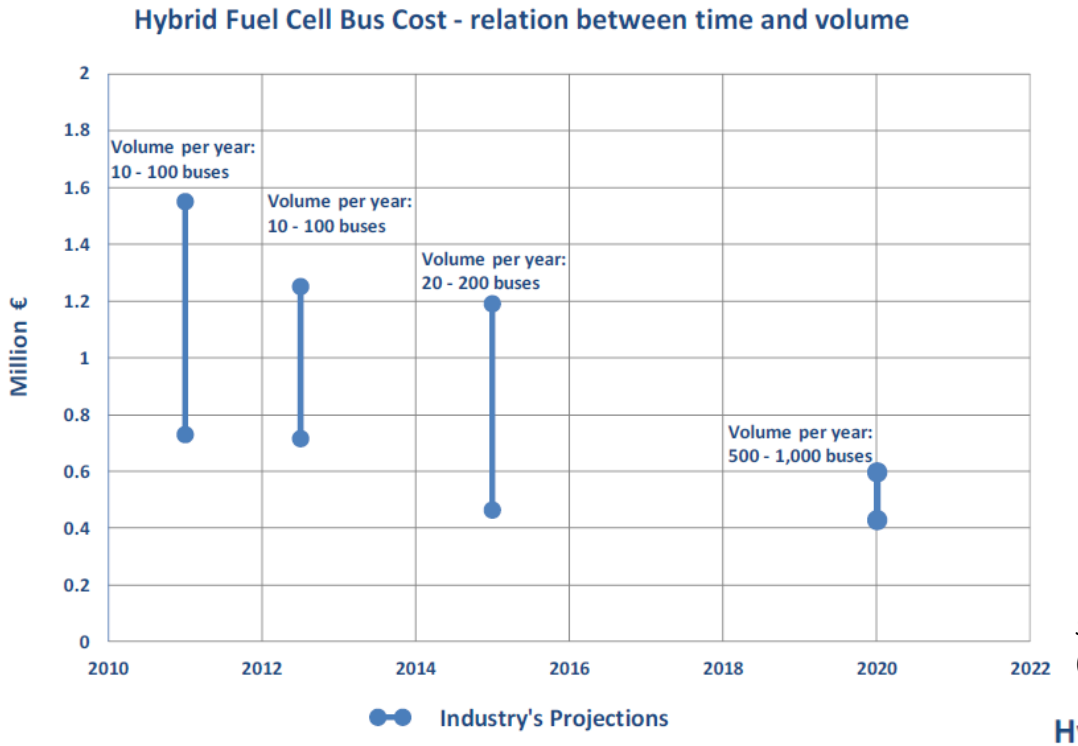
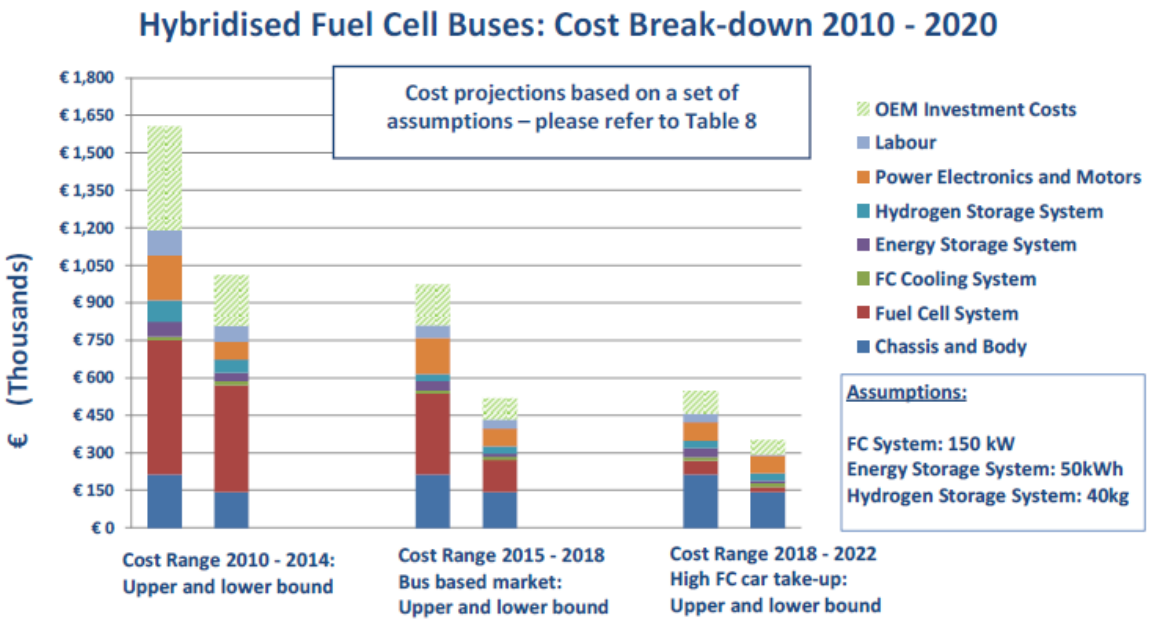


- Volume can have significant effects on cost today but in the future it is expected to have less impact.

Source: Hydrogen Fuel Cell Bus technology State of the Art Review (R. Zaetta, B. Madden (Element Energy), 2011)

- This study suggests fuel cell cost is approximately 35% of the fuel cell bus cost.
- We cannot rely solely on volume increases and there are still opportunities to reduce fuel cell cost.



Addressing Fuel Cost - Key Changes & Target Cost Reductions for HD7

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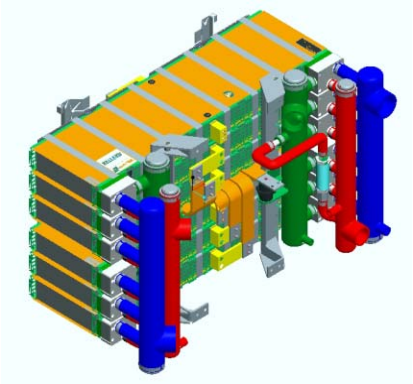
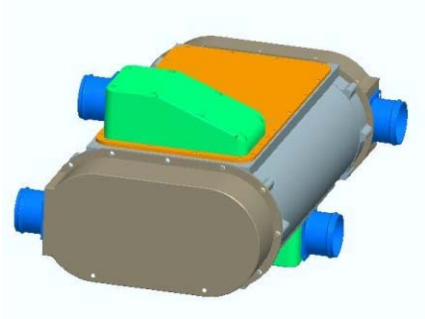


- **DM / DL Cost reduction target of 48% (HD6 vs. HD7)**
  - Mainly comes from stack change to 9SSL (due to production efficiency)
  - Running higher current densities (70% more power per cm2; tradeoff with max power efficiency, but majority of drive cycle at lower current densities)
- **Total Cost reduction**
  - 9SSL has a shorter life but impact on overall on warranty cost is positive
  - Warranty 15% reduction
  - Overhead 75% reduction

- **Switch to off-the-shelf, proven controller**
  - Lowered cost per module
  - More capability (more I/O channels, integrated remote data transmitter, memory, better service interface, etc.)



- **Switch to gas-to-gas humidifier**
  - Lower cost (35% reduction)
  - Lower weight & tighter packaging
  - Less procurement overhead, shorter lead time for supply
  - Better reliability (no moving parts)

Addressing Fuel Cell Cost - Increased Scope of Supply for HD7

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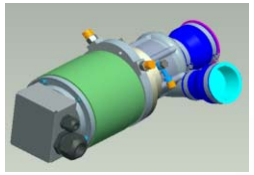
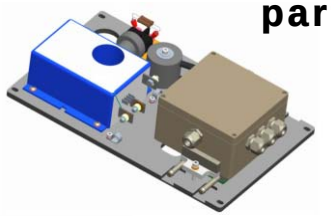
- Air compressor and coolant pump included.
- Integrated HRB motor controller (internally mounted)
- Reduction in preventative maintenance activities

Integrator Scope



Packaging by coach partner

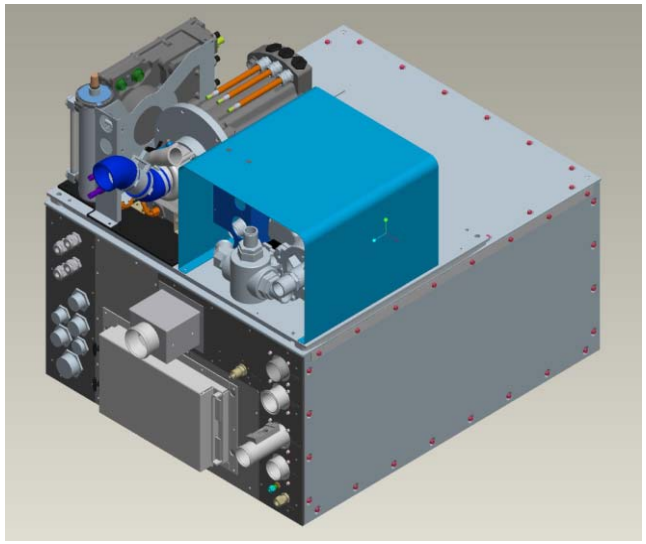


HD6

Integrator Scope

Integrator Scope

HD7



Addressing Fuel Cell Cost - Fuel Cell Bus Research

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- Development of Next Generation Heavy Duty (Bus) Fuel Cells with Enhanced Durability
  - Objective:
    - Improve membrane durability of next-generation Ballard fuel cells for buses (targeting 2 to 3x improvement in 3 yrs; transformational)
    - Develop on-board diagnostics system & examine improved system operating conditions to extend current bus lifetimes
  - 3 year project, $4.5M funding from Automotive Partnership Canada (APC)/NSERC, $11M project
  - Collaboration between Ballard, SFU, UVic
  - >30 students annually

Addressing Fuel Cell Cost - Similar Bus Design Serves Many Markets

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	European Fuel Cell Bus	North American Fuel Cell Bus
Bus Chassis/Model	Van Hool A330 Fuel Cell Hybrid	El Dorado National, Axess
Curb Weight	~43,000 lbs	34,800 lbs
Length	43 ft	41 ft
Passenger Capacity	34 seated, 47 standees	39 seated, 19 standees
Power Plant	Ballard 150kW FCvelocity®-HD6	Ballard 150kW FCvelocity®-HD6
Hybrid System	Van Hool hybrid system	BAE Systems series hybrid system
Electrical Energy Storage	Li-Ion Energy Storage	Nanophosphate Li-Ion
Fuel Storage	Gaseous hydrogen: 40kg at 350 bar	Gaseous hydrogen: 50kg at 350 bar
Range	400 km	400 km

Addressing Fuel Cell Cost – Next Generation (FCvelocity®-HD7)

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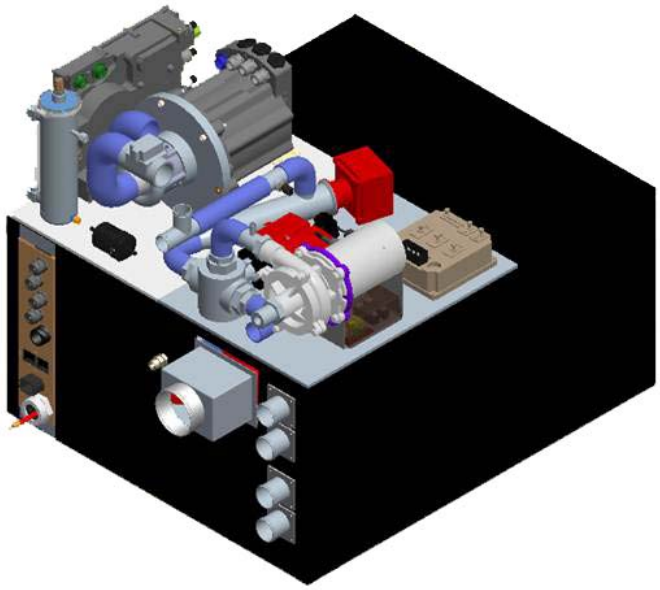
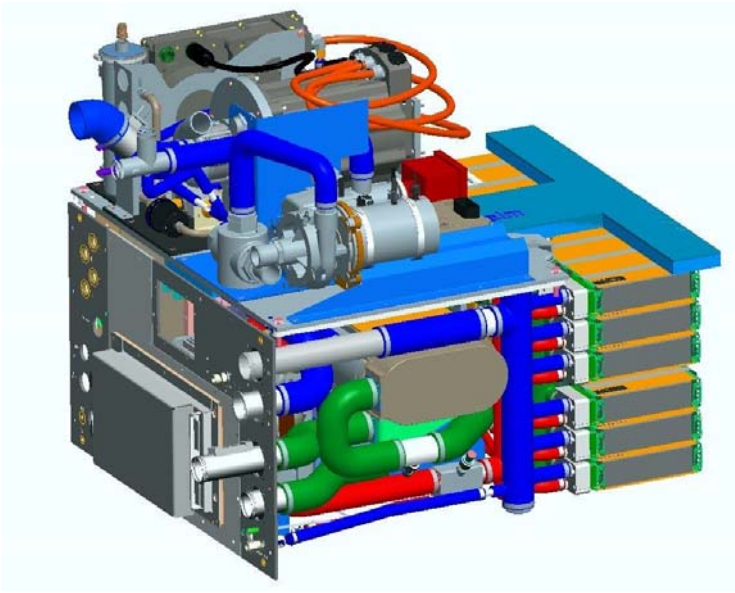
NASDAQ:BLDP • TSX:BLD

- **Next generation fuel cell bus module:**
  - 100kW configuration available mid-2014
  - 30-40% cost reduction
    - Latest generation fuel cell stacks – automated manufacturing and assembly processes
    - Reduced parts count – simplified humidification and resulting balance of plant
  - Higher durability
  - Fully integrated power module
    - Air compressor and coolant pump included
    - Integrated HRB motor controller (internally mounted)
    - Reduced preventive maintenance activities
  - Module lifetime 10+ years
  - Offered with a 15,000-hour warranty



FCvelocity®–HD7



Addressing Fuel Cell Cost - Bus Power Module Product Evolution

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2003: P5	2008: HD6	2011: HD6 V2	2014: HD7	201X: HD7 V2
Fuel Cell Lifetime: 4,000 hours demonstrated in service	10,000 hours demonstrated in BC Transit fleet	12,000 hours	>12,000 hours	>18,000 hours
Product Cost Reductions:	30% reduction •Leverages automotive volumes •Production environment •Direct material savings	15-20% reduction •Enhanced MEA to reduce warranty accrual costs	30-40% reduction •Automated MEA production •Common unit cell platform across products	

Summary

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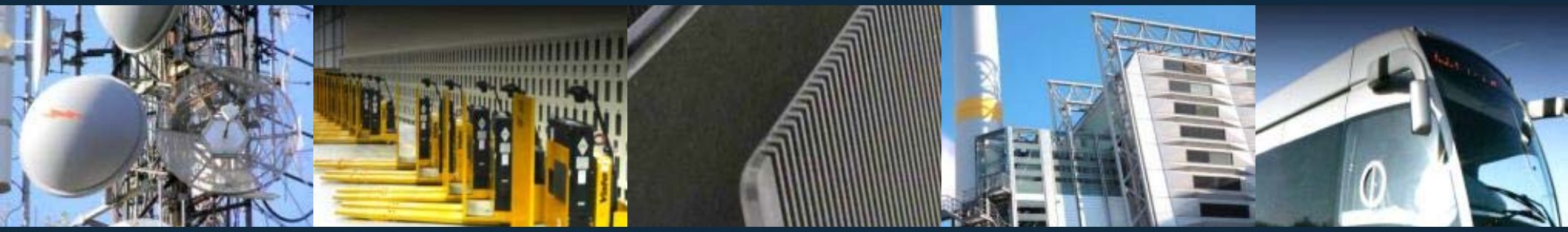
- Ballard's heavy-duty technology is now at TRL8
- Future volumes will eventually bring the price of fuel cell module in competitive range of the incumbent technology
- Ballard continues to reduce cost and improve the durability of the fuel cell stacks, thus in turn giving better value to our customers
- The technology is market ready……



BALLARD®

PUTTING FUEL CELLS TO WORK

NASDAQ:BLDP • TSX:BLD

Thank You