BALLARD POWER SYSTEMS

PUTTING FUEL CELLS TO WORK

The Power of Fuel Cells, Simply Delivered

WWW.BALLARD.COM
We Are Ballard Power Systems

We are Ballard Power making a meaningful difference with our fuel cell technology that will continue long into the future...

- 37 years of experience
- 21 years listed on NASDAQ
- 450 employees
- 2,000 patents/applications
- 250MW of fuel cell products shipped
- 2.4 million MEAs manufactured
- 3,000 stationary systems delivered
- 10+ million kilometers in revenue service by fuel cell buses
- $80 million contract with VW/Audi
Global – Regional – Local

Global Management

- Vancouver:
  - Engineering Expert Support
  - Spare Parts Budgets
  - New Product Training
  - Technicians on call

Regional Management

- Denmark:
  - Status Reporting
  - Failure data and change requests
  - Return Parts
  - Financial reporting
  - Operational data
  - Responsibility for European bus service
  - Data Collection and Processing
  - Spare and Return Parts Mng
  - Regional Expert Support
  - Managing Local Teams
  - Local Training
  - Call for Preventive/Corrective Maintain.

Local:

- Oslo
  - 5 Busses
  - 1 Technician

- European Service Center
  - 3 Experts

- London
  - 8 Busses
  - Local Tech.

- Cologne
  - 4 Busses
  - Emcel Tech (Partner)
  - Emcel Technicians

- Solaris Bus Techn.

- VanHool Bus Techn.

- Delijn
  - 5 Busses
  - VanHool Tech.

- Hamburg
  - 2 Busses
  - Local Tech.

- Aberdeen
  - 10 Busses
  - 2 Technicians

+50 people @ Ballard Power Systems Europe:
- Sales
- Engineering
- After-Sales

85% availability - Quick response time – minimize travel costs – minimize capacity costs
Ballard Power Products

- **Mission**: Meet customers’ power needs through delivery of high value, clean energy products that reduce customer costs and risks

**MARKETS**
- Transportation
- Military
- Material Handling
- Telecom Backup

**PRODUCTS**
- Motive Modules: FCveloCity® Power Module (up to 200kW)
- Portable Systems: Squad Power Manager (SPM)
- Fuel Cell Stacks: Air-cooled FCgen®-1020ACS Liquid cooled FCvelocity®-9SSL
- Stationary Systems: Hydrogen FCgen®-H2PM Systems
Ballard offers flexible, scalable solutions for a wide range of motive application duty cycles and power requirements.
The FCveloCity® motive module product line is designed to meet all motive application power requirements from 30kW to 200kW.

<table>
<thead>
<tr>
<th>Product Series</th>
<th>FCveloCity®-MD</th>
<th>FCveloCity®-HD</th>
<th>FCveloCity®-XD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Power Levels</td>
<td>30kW</td>
<td>60kW, 85kW, 100kW</td>
<td>100kW, 200kW</td>
</tr>
<tr>
<td>Application</td>
<td>8 to 10 meter buses, battery hybrid range extenders</td>
<td>10 to 25 meter hybrid fuel cell buses</td>
<td>Rail and Marine</td>
</tr>
<tr>
<td>Availability</td>
<td>Available now</td>
<td>Available now</td>
<td>Available now / Under development</td>
</tr>
</tbody>
</table>

- Optimized for fuel cell hybrid drives
- Modular design
- High performance
- Easy installation/integration
- Safety features
- Cost reduction
Air Quality is a Worldwide Health Issue

“...Hydrogen fuel cell buses are the most promising zero local-emission powertrains”


Acquiring the knowledge for maintaining and improving air quality is one of the critical environmental challenges of the future as it is estimated that poor air quality causes several millions of premature deaths each year.
Many cities and bus operators are struggling with the currently conflicting objectives of shifting to zero emission public transport while keeping operational flexibility and maintaining service levels.
Why Fuel Cell Buses?
Zero Emissions and Performance

Fuel cell buses are the most flexible zero emissions option – unlike other electric solutions, they can be operated like diesel buses.

- **High daily ranges**
  of 300 km on average without refuelling – range extension possible

- **Performance**
  comparable to diesel buses, e.g. acceleration or gradeability, high asset utilization

- **Passenger comfort**
  due to reduced noise levels and smooth driving experience

- **Full route flexibility**
  not bound to any required infrastructure on the route

- **Fast refuelling**
  as low as 7 minutes, with several refuelling cycles per day possible

- **Mature technology**
  with more than ten years and 10M kilometres of operational experience
Fuel Cell Bus Deployment in Europe

Active Fuel Cell Buses | 62
Fuel Cell Buses in Development | 21

Current EU-funded fuel cell bus projects:
- CHIC
  - Bolzano – 5 FC buses
  - Aargau – 5 FC buses
  - London – 8 FC buses
  - Milan – 3 FC buses
  - Oslo – 5 FC buses
- Cologne* – 4 FC buses
- Hamburg* – 6 FC buses
- High V.LO-City (operation start planned for 2015)
  - Liguria – 5 FC buses
  - Antwerp – 5 FC buses
  - Aberdeen – 4 FC buses
- HyTransit
  - Aberdeen – 6 FC buses

Current EU-funded fuel cell bus projects:
- 3Emotion (operation start planned for 2016/2017)
  - Cherbourg – 5 FC buses
  - Rotterdam – 4 FC buses
  - South Holland – 2 FC buses
  - London – 2 FC buses
  - Flanders – 3 FC buses
  - Rome – 5 FC buses

Current national/regional-funded FC bus projects:
- Karlsruhe* – 2 FC buses
- Stuttgart* – 4 FC buses
- Arnhem* – 1 FC bus (operation start planned for Oct. 2015)

Legend:
- CHIC countries
- In operation
- Planned for operation
* Co-financed by regional/national funding sources

Source: CHIC project – Element Energy
142 fuel cell buses being funded through FCH-JU Program for deployment in 2018-2020.
Growing worldwide demand for FC buses

<table>
<thead>
<tr>
<th>Transit bus in service today</th>
<th>Projects in development (bus on the road by 2017)</th>
<th>New projects (bus on the road by 2020)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>26</td>
<td>20</td>
</tr>
<tr>
<td>Europe</td>
<td>62</td>
<td>21</td>
</tr>
<tr>
<td>China</td>
<td>&gt; 30</td>
<td>&gt; 300</td>
</tr>
</tbody>
</table>

- The number of FC buses deployed in next 12 months will be more than ever built
- Drastic cost reduction for FC buses in past 6 years
- Fuel cell power modules are integrated with batteries in hybrid configurations
- Strong demand from China with “New Energy Vehicle” policy and incentives
- Fuel cell technology is expanding to light rail and trucks applications
Largest FCB deployments in China

**Sept 28th 2016 Launch of initial 12 buses**
12 FCEB in commercial service on line #682 in Shanshui (Foshan)
Operator: Foshan Sanshui Guohong Public Transit Co. Ltd.

**October 18th 2016 Second Tranche of 10 buses**
10 FCEB 10 fuel cell-powered buses commissioned and deployed in the City of Yunfu, in the Province of Guangdong.
Ballard’s Market Leadership

• Over seven generations of heavy duty product development, Ballard has:
  o Partnered with over 10 bus manufacturers
  o Integrated 4 different drive systems
  o Powered more than 100 fuel cell buses in 20 cities
  o Driven over 10 million km across 12 countries with challenging climates and road conditions
  o Created 6 global service centers to ensure fleet availability
  o Achieved >20,000 hours of operation in London on a single fuel cell stack
Fuel cell cars are hitting the road...

Fuel cell technology is extending to rail & truck applications

Hybridization of FC buses
>85% availability
20,000+ hours lifetime on a single power module has been demonstrated in service at London TFL and AC Transit

300 transit buses have been deployed since the early 90’s; this number will more than double in the next 18 months. Strong demand from China.

150+ in Europe and 50+ in US new fuel cell buses are funded to be on the road before 2020
A Growing Industry

**BUS OEMs**
- New Flyer
- Wrightbus
- Van Hool
- Solaris
- EvoBus
- King Long
- Feichi Bus

**H2 Suppliers**
- Air Liquide
- ITM Power
- Linde
- Proton On Site
- McPhy Energy
- The Linde Group
- H2 Logic

**ELECTRIC DRIVE**
- BAE Systems
- Siemens
- Škoda
- Vossloh

**Other**
- SunLine
- OCTA
- MTA
- Lin
- Transport for London
- Ruter
- First
- Stagecoach
- Rigas Satiksme
- AC Transit
- SARTA
- Tower Transit
The Road is Clear for E. Fuel Cell Transports...

- GHG Health Cost Recognized
- Emission reduction targets
- Cities commitment for clean public transit
- Public Awareness (FCeV)
- Growing Urbanization: Need for Public Transit
- Fuel Cell Technology Progresses Hybridization
- Incentives for ZEB
- Regulations

CARB: California Air Resources Board
FTA: Federal Transit Administration
FCH: Fuel Cells and Hydrogen Joint Undertaking
Clean Cities
Ballard
To find out more about Zero Emission Fuel Cell Bus, participate to ...
Thank you

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