

The Ballard logo is displayed in white, bold, sans-serif capital letters within a blue rectangular box in the top-left corner of the slide. The background of the slide is a scenic landscape featuring a large body of water, forested hills, and a highway with a bus in the foreground.

BALLARD™

Technology Solutions

August 2021



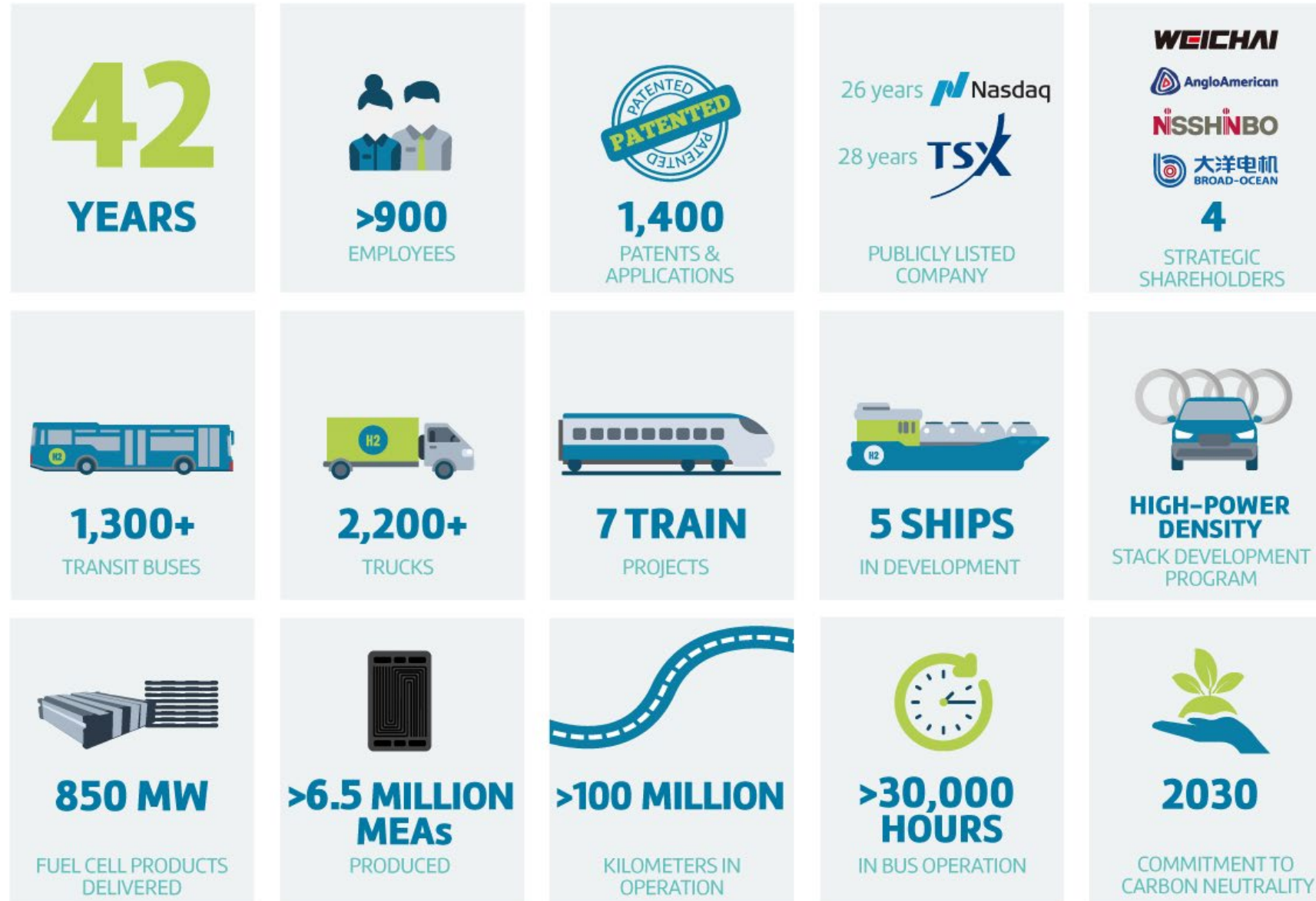
BALLARD™



Vision

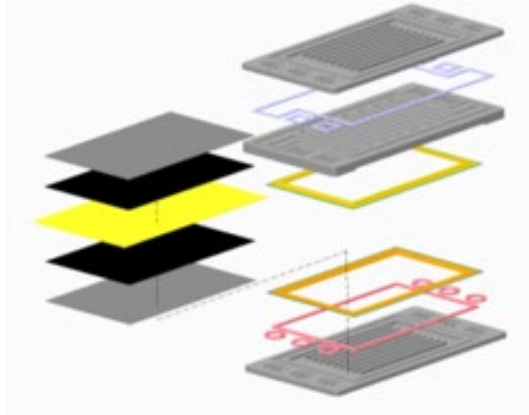
We deliver fuel cell power
for a sustainable planet

Ballard by the numbers





We continuously invest in our technology and product development



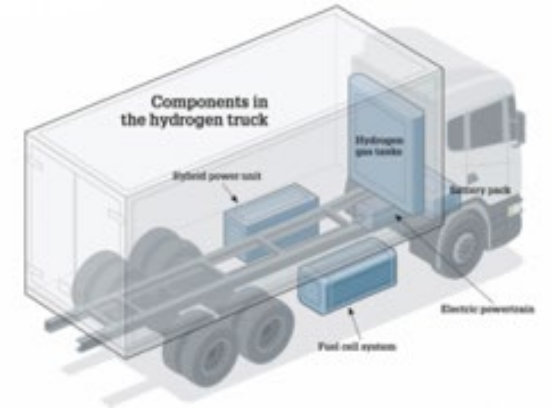
Unit cell components
MEA, bipolar plates



Fuel cell stacks
14th generation



Fuel cell modules
8th generation



Fuel cell vehicle integration
application engineering/
after sales service



Humidified and
pressurized system



Freeze-start
from -30°C



IP protection



>30,000 hours
life time

We are strategically positioned with two growth platforms

TECHNOLOGY SOLUTIONS

Solving difficult technical challenges in customers' existing PEM fuel cell programs or addressing new business opportunities



POWER PRODUCTS

Delivering high value, zero emissions fuel cell products that deliver lasting performances



Power Products Portfolio

<p>Fuel Cell Stacks</p>	<p>FCvelocity®-9SSL</p> <p>4kW to 26kW</p>  	<p>FCgen®-LCS</p> <p>2.3kW to 63.4kW</p>  	<p>FCgen®-HPS</p> <p>140 kW</p>  	<p>FCgen®-1020ACS</p> <p>400W to 3kW</p>  
<p>Fuel Cell Modules</p>	<p>FCvelocity®-MD</p> <p>30kW</p>  	<p>FCvelocity®-HD</p> <p>85kW, 100kW</p>  	<p>FCwave™</p> <p>200kW</p>  	<p>FCmove™</p> <p>70kW</p>  
<p>Complete Fuel Cell System</p>	<p>FCgen®-H2PM</p>  <p>FCgen®-H2PM Compact Enclosure • 1.7kW to 5.0kW</p> <ul style="list-style-type: none"> 1.7kW & 5kW Direct H2 Indoor and outdoor Rack-mountable Customized available 			

Today we have three platforms of liquid cooled stacks to address mobility applications



Power Level
up to 29kW/stack
Mobility Stack

- Features**
- >10,000 stacks produced
 - 15,000hrs
 - 2.2kW/L*
 - Operating 70°C



Power Level
up to 96kW/stack
Heavy-Duty Stack

- Features**
- >25,000hrs
 - 4.5kW/L*(M2)
 - Freeze start (-30°C)
 - Operating 80°C



Power Level
Up to 140 kW/stack
High Power Stack

- Features**
- Stack technology demonstration platform
 - 4.3kW/L*
 - Freeze start (-28°C)
 - Operating >90°C



Ballard's current fuel cell module offering for HD mobility

Power Level

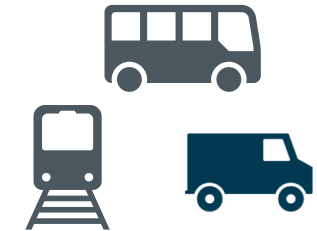
Features

Applications



30, 85 & 100kW
Legacy Mobility Platform
(7th generation)

- >1,500 modules produced
- 15,000hrs
- IP 55
- Separate air and cooling kits



70 & 100 kW
HD Mobility Engines
(8th generation)

- >25,000hrs
- Freeze start (-25°C)
- Engine bay and roof top
- IP6K9K



200kW
HD Power System
Marine & Rail

- >25,000hrs
- Marine certified
- Cabinet configuration
- Stand alone or containerized
- Multiple modules to MWs





Ballard's current fuel cell system offering for stationary

Power Level

Features

Applications

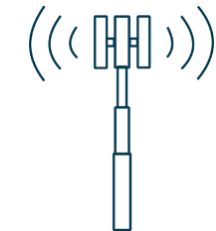


FCgen[®] – H2PM

1.7 & 5kW

Backup Power
for critical infrastructure

- 7,000hrs
- Systems can be coupled to 60kW
- High reliability

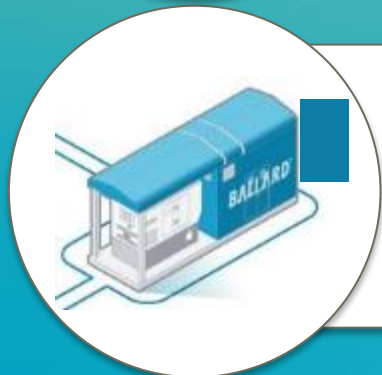


FCwave[™]

200 kW

Modular Stationary
Power System

- >25,000hrs
- Cabinet configuration
- Stand alone or containerized
- From 200kW to 1MW



ClearGen[™] II

1.5 MW

Large Scale Stationary

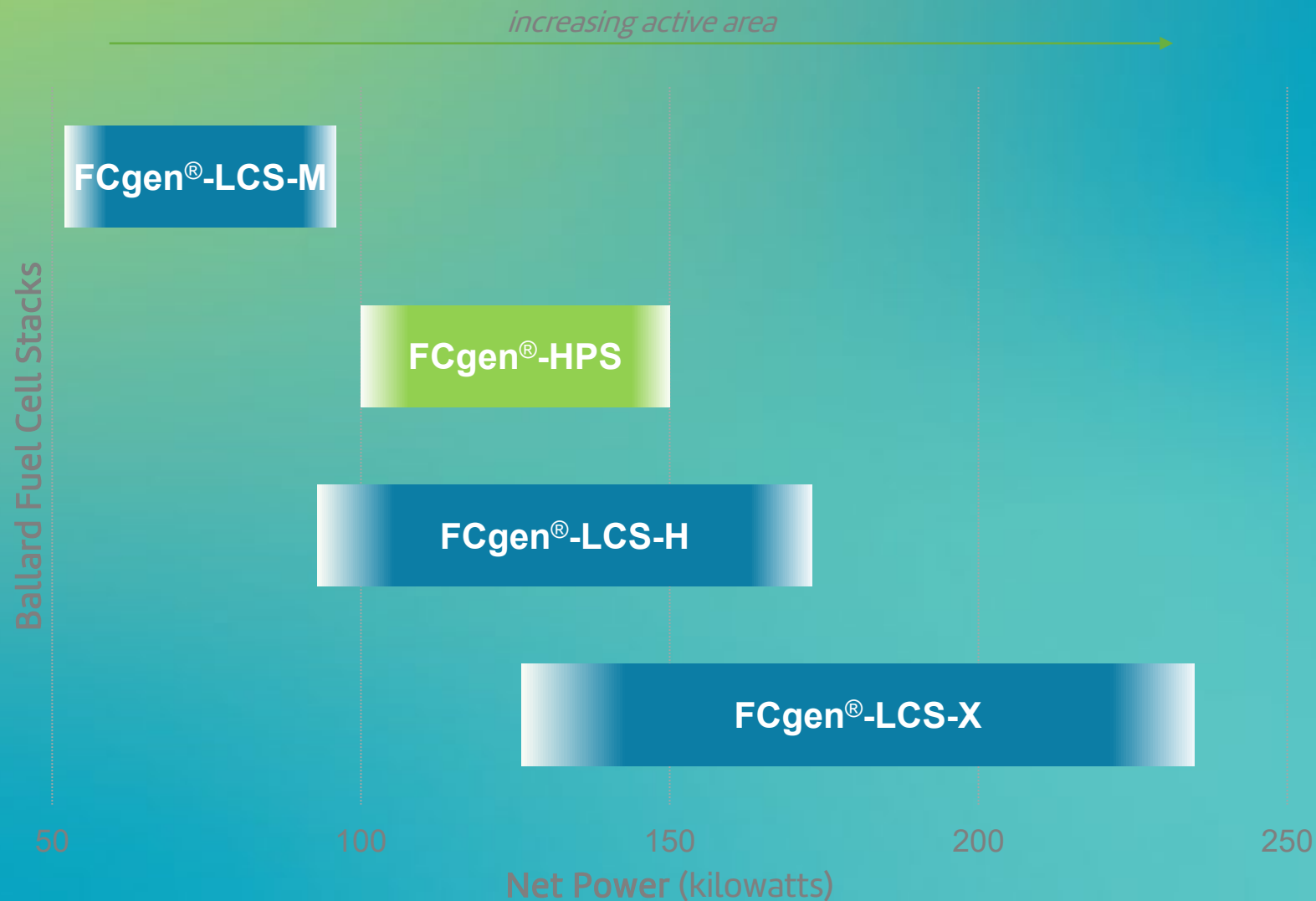
- Containerized system
- High durability
- Compact system footprint
- MW's power plant





Ballard Motive Fuel Cell Stack Product Family

A family of high power density stacks to cover the full range of bus, truck, rail and marine applications

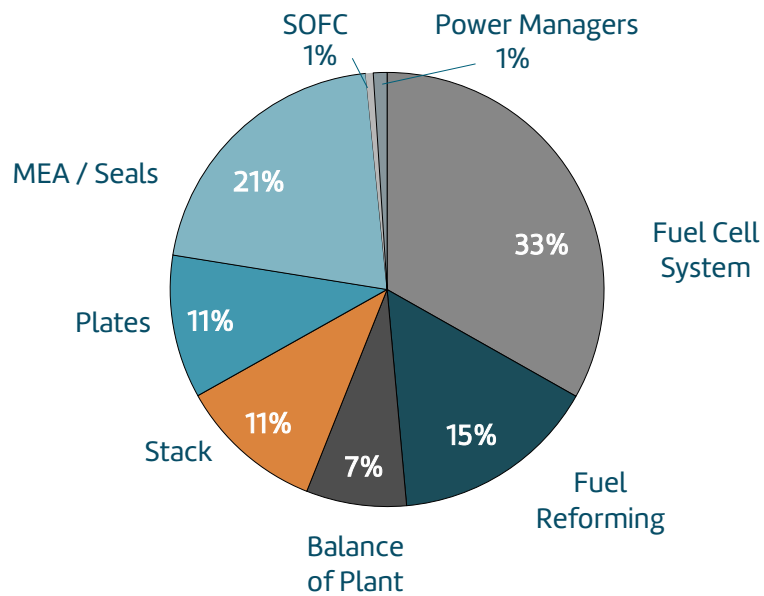
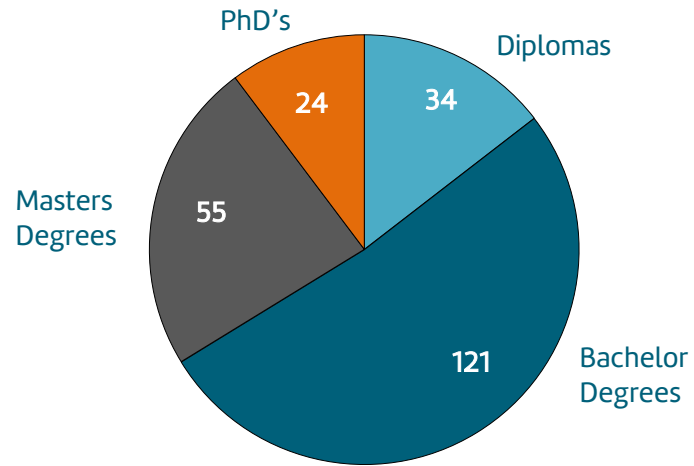


Product introduction date:

- FCgen®-LCS-M → M1- 2020
M2 – Q3/2021
- FCgen®-HPS → 2021
- FCgen®-LCS-H → 2022
- FCgen®-LCS-X → 2023

** Additional stack products are available for other applications, such as forklifts, backup and stationary power*

Value Proposition



Depth of intellectual capital

- ~900 total employees
- Completely specialized in fuel cell technology

Extensive intellectual property

- Own, license and access to ~2000 patents/applications

Comprehensive testing and prototyping

- 50+ test stations, testing <100W to 333kW
- Scalable MFG processes
 - Prototyping to high volume, rolled materials processing

Technology Solutions

- Over 30 programs, including 4 major automotive OEMs
- Audi is prime on HyMotion program; multi year \$60–100M contract extension signed until August 2022
- ‘Autonomous vehicle’ & ‘shared mobility’ trends will enhance fuel cell value proposition



Technology Solutions Case Studies

Automotive

- Access to Ballard's expertise for the design and manufacture of the next generation fuel cell stack
- Transfer of select automotive-related fuel cell IP is considered



Bus

- License and technology transfer to enable best-in-class motive products to be locally manufactured in China



Trams/Rail

- Develop advanced fuel cell modules customized for rail applications



Large Scale Marine and DG

- Support development of breakthrough catalyst technology intended to reduce manufacturing cost



Research

- Research and supply of components for a customers internal testing programs



Materials Suppliers

- Support development of breakthrough catalyst technology intended to reduce manufacturing cost





Technology Solutions Objective

Mission

Help customers solve difficult technical & business challenges in fuel cell programs through delivery of custom, bundled technology solutions

Solutions

Technical expertise, IP portfolio, supply of prototype technology to drive future opportunities

Customized Technology Solutions to support all stages of technology development



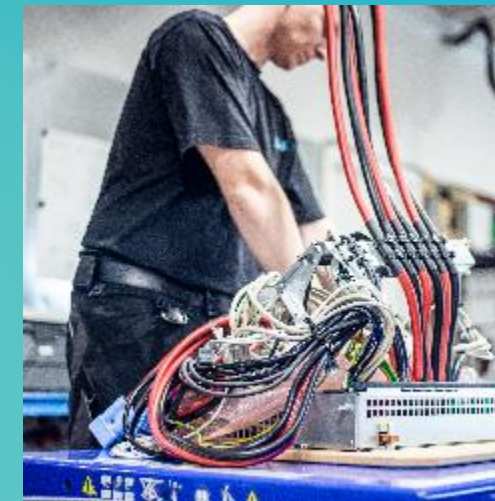
Product Development



Testing Services & Stations



Licensing & Technology Transfer



Component Design & Manufacturing



Systems Design & Integration

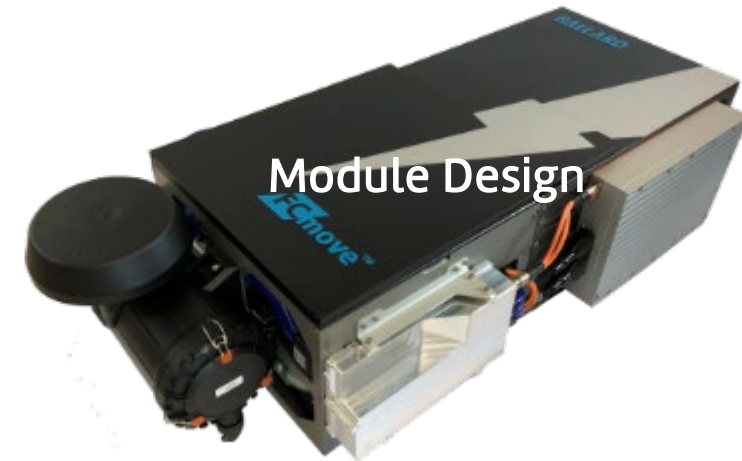
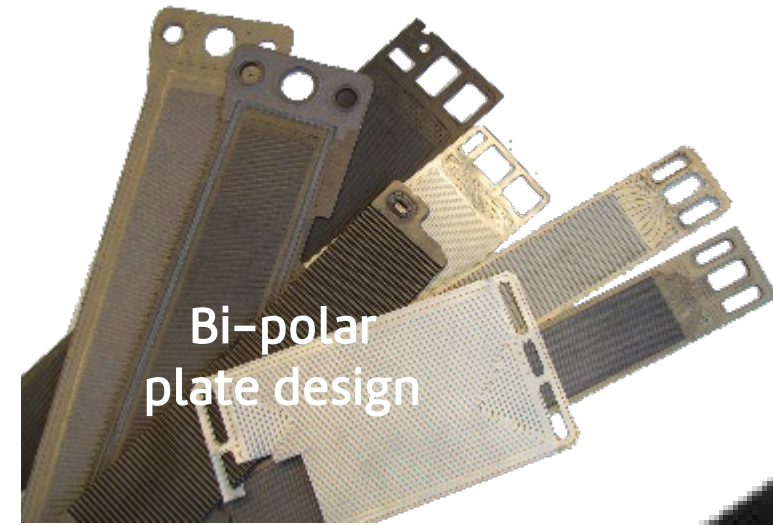
Product Development

Leverage infrastructure, experience and knowledge for custom development of modules, stacks and MEAs



Product Development

- Product design & research of components, fuel cell modules and stacks
- Deep understanding of optimising balance-of-plant components, plates, seals, membrane, catalyst and ionomers design for using multiple many materials, processes and suppliers
- Stack and system simulation and modeling to allow for investigation of a wide range of scenarios at the component, stack and module level
- Feasibility and trade-off studies related to performance, operating without CVM, freeze start, durability, cost and power density
- Prototyping and validation activities for balance-of-plant components, plates, seals, MEA and assemblies



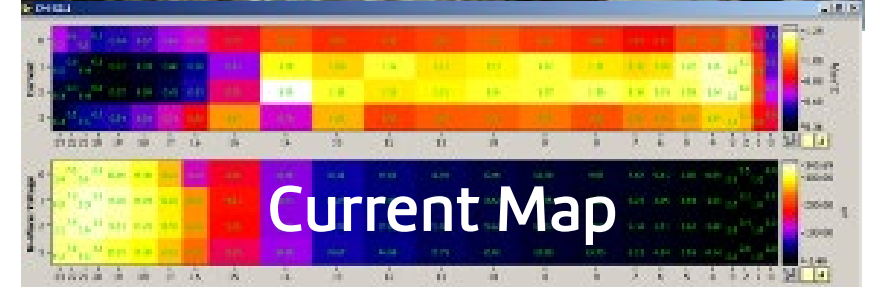
The background of the slide is a photograph of an industrial testing facility. It shows various pieces of equipment, including a control panel on a stand, a table with a blue top, and a large glass-enclosed test chamber. A multi-colored signal light is visible in the background. The room has a white wall and a grid ceiling with recessed lighting.

Test Services & Stations

- Factory Acceptance Testing
- Test products under specific customer conditions
- Test and validate products under extreme conditions

Test Services & Stations

- State-of-the-art fuel cell testing facility
 - Collect 400,000+ hours annually
 - 24/7 operation, simulate real duty cycles
 - Test station capacity < 100 W to 333 kW
- 100+ automated test stations and specialized test tools
 - Environmental: 10 temperature and humidity chambers
 - Stack diagnostics: Current mapping, reference electrodes, water management, freeze protocols, SEM
 - Accelerated stress tests (AST): Membrane durability, cell reversal tolerance, voltage cycling, start-up/shutdown, ice tolerance
- Component, stack and system level testing
 - Shock and vibration, EMC/EMI and fire protection testing



Licencing & Technology Transfer

- Two stack assembly joint-ventures in China
- FCveloCity® power module assembly with 3 Integrator Partners

- Licensing Ballard's intellectual property can accelerate a strategic partner's time to market and help overcome any technical design or manufacturing barriers

Typical licensing models include:

Design and processing intellectual property
Product licenses
Manufacturing localization

Technology transfer support from subject matter experts may include technical documentation and data transfer, on-site and remote engineering support and training programs

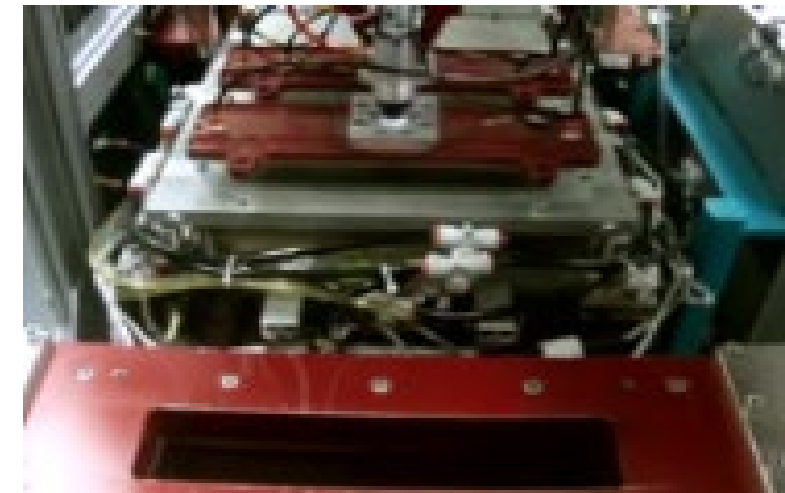


Component Design & Manufacturing

- 20,000m² facilities in Burnaby, Canada
- Current capacity of 1.5 million MEAs, 10,000 stacks and 200 modules annually

State-of-the-Art Manufacturing

- High volume manufacturing and prototyping equipment
 - Robotics, liquid injection molding and roll-to-roll processing
 - Proven yields in excess of 99%
 - SPC run charts Full traceability on raw materials
- Develop custom components to customer specifications or provide off-the-shelf components
 - Leverage Ballard or customer component technology
 - Collaborate on component development and bring advanced technology to the table
 - Ability to combine various membrane, catalyst and ionomers
- Engineering builds of stack and module until Technology Transfer and License or product scale-up is contemplated



MEA Assembly



Stack Assembly



Module Assembly

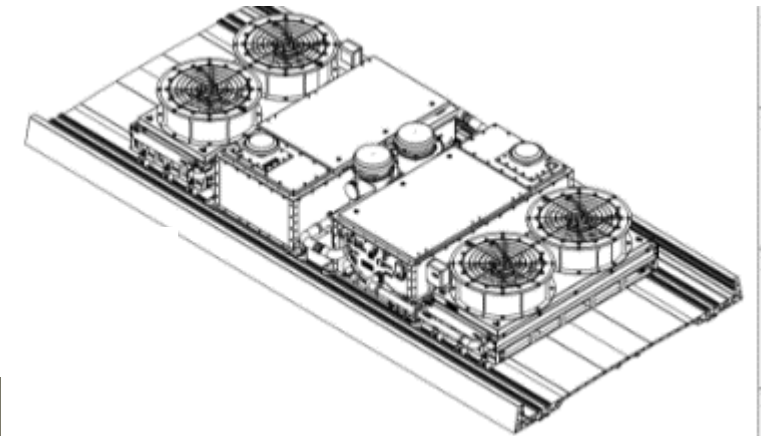
- Module integration under engineering supervision
- Supporting customer integration and function for new applications including expanding the scope as required by the customer

Systems Design and Integration

- Significant technology development
- Broad and deep internal expertise drawing on >25 years of bus integration
- Extensive proprietary design and analysis tools
- Work closely with multiple component suppliers is key to success
- Can deploy local applications engineering and service teams to support customer integration activities



On-site engineering team



Custom Integration




Integrated Module




BALLARD[™]


Summary




Ballard has a long history of leadership in fuel cell stack development and supply



Technology Solutions offers a cooperative model to partners for accelerating fuel cell development programs and builds the foundation for long term partnerships



Component prototyping and high volume production leverage existing manufacturing infrastructure



Our technology development activities position us well to work with partners to jointly develop products for all applications



BALLARD™



Here for life™

Thank you

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