

Hydrogen & Fuel Cell Applications: A Canadian Perspective



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Introduction: Why are hydrogen and fuel cells important to Canada?



- World leader in critical fuel cell and hydrogen technologies
- Nearly \$200 million annual sector revenues
- Nearly 2,000 clean, high-paying tech jobs
- Significant export activity; but, increasing domestic opportunities
- Domestic Opportunity Increase adoption of clean gas technologies for energy storage, zero-emission power generation, cleaner oil refining and electricity conservation in material handling and telecom sectors
- Global leadership; Canadians producing fuel cells for 2015 auto models



Canadian Product Leadership: Stationary Power



- Hydrogen fuel cell solutions for a variety of essential services, including communication networks and data centres, provide highly reliable back-up power for mission critical applications. (Specific examples will be provided in Ballard's presentation).
- Customers include telecommunications providers such as Vodacom, China Mobile, Nokia Solutions and Networks, municipalities in Germany, South Africa, Indonesia and India as well as the Danish Emergency Service Network.
- Large stationary refers to multi-megawatt units providing primary power. These units are being developed to replace the grid, for remote areas where there is little or no grid infrastructure, and can also be used to provide grid expansion nodes.





Canadian Product Leadership: Stationary Power Cont'd

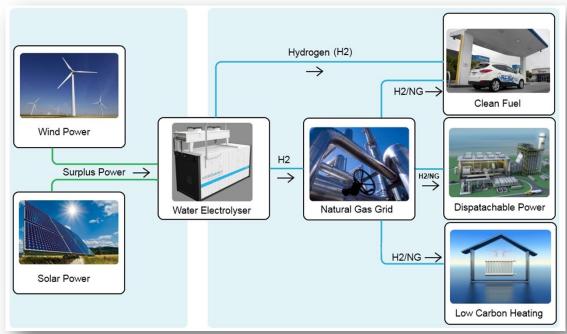
- Ballard recently launched a standardized fuel cell backup power cabinet solution suitable for outdoor deployment as part of the ElectraGen™ product portfolio for telecom network operators.
- New outdoor enclosures are designed to accommodate Ballard's direct hydrogen backup power systems, and provide backup power solutions for wireless telecom providers operating in temperatures as low as -40 degrees.
- Ballard Power Systems will be supplying ElectraGen[™]-ME fuel cell systems for a
 pilot project in Idea Cellular's India telecom network. The fuel cell systems will be
 utilized in combination with solar technology to generate continuous power at five
 wireless base station sites.





Canadian Product Leadership: Power-to-Gas Energy Storage

Converts surplus non-emitting energy into renewable fuel, heat or power *when and* where it is needed







Canadian Product Leadership: Power-to-Gas Energy Storage Cont'd

- Hydrogenics Corporation continues to win major Power- to-Gas contracts in Europe (5 out of 7 contracts with E.On in Germany)
- Power-to-Gas (P2G) facility in Falkenhagen—The plant uses wind power and Hydrogenics' electrolysis equipment to transform water into hydrogen, which is then injected into the existing regional natural gas transmission system.
- The hydrogen, as part of the natural gas mix, can be used in a variety of applications including: space heating, industrial processes, mobility, and power generation.
- Hydrogenics in January 2014 was awarded \$3.8 million for an energy storage contract in Canada.





Canadian Product Leadership: Materials Handling



- Global brands like FedEx, Sysco, Coca Cola and BMW are using fuel cell-powered forklift truck solutions – for pallet jacks, reach trucks and large counterbalanced trucks – to dramatically improve productivity in warehouse operations.
- Strong economic and environmental returns, including payback in under 1-year and ROI of 20%+.



Canadian Product Leadership: Transit Buses



- Canadian-made fuel cell stacks for bus applications are featured in transit fleets in Germany, the US, the UK, Brazil, and China.
- Ballard recently announced the signing of multi-year agreements to support Azure Hydrogen's zero emission fuel cell bus program in China.
- A true zero emission public transportation solution benefits of electric trolley buses without the trolley wires!

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Canadian Product Leadership: Hydrogen Production







- Hydrogenics Corporation is a world leader in the production of electrolysers for hydrogen production.
- Earlier in 2013, Hydrogenics won a Power Systems order worth up to \$90 million, the largest single contract in the company's history.
- Electrolysers deployed in renewable energy, hydrogen fuelling and industrial hydrogen applications.

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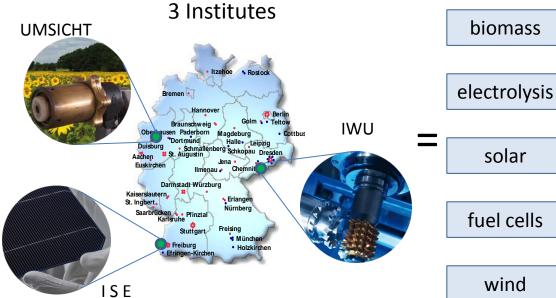
Recent International partnerships (Germany)





C E R C

Clean Energy Research Centre



solar

wind



International collaborations (Korea)



- During the BC Premier's Jobs and Trade Mission (November 2013), the Clean Energy Research Centre at the University of British Columbia signed a statement of cooperation with the Korean Gas Corporation (KOGAS)
- The areas of collaboration: fuel cell technology and the production, processing and liquefaction of natural gas



Recent Canadian Advancements (Canetique)

- Canetique (Varennes, Quebec): Developed the first and only non-precious metal catalyst generating power levels comparable to platinum-based PEM fuel cells.
- Replaces platinum-based catalysts in PEM fuel cells with lower-cost highperformance iron-based catalysts, offering a compelling value proposition for fuel cell OEMs and users, and enables expansion of the PEM fuel cell market in numerous sectors.
- Canetique is currently in its product development phase and is supported by provincial and federal government grants and the automotive industry.
- Advantages of Canetique's technology:
 - contains no expensive raw material of any kind;
 - drop-in replacement to existing fuel cell component manufacturing processes
 - can be adapted to alkaline fuel cells, microbial fuel cells and metal-air batteries





Canada is an global automotive R&D player thanks to hydrogen and fuel cells



- Automotive Fuel Cell Cooperation Inc (AFCC) is Daimler and Ford's JV in Vancouver working on their generation III fuel cell electric vehicle (FCEV).
- Employing 225 people, AFCC is the largest automaker R&D centre in Canada.
- Daimler announced \$70 million dollar investment to set up its global automotive fuel cell manufacturing facility in Burnaby, BC. Since then, Nissan and Ford has joined and has 30 engineers and manufacturing experts joining existing 50

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Notable Projects in Canada: Walmart Canada Forklifts



- Walmart Canada is fuel cell-powered forklift trucks at its new distribution center near Calgary, which opened in 2010.
- Walmart estimates lower operating costs of \$150,000 annually and up to 72% fewer greenhouse gas emissions than would otherwise be the case at this site.



Notable Projects in Canada: Renewable Gas Production

The project, "Quadgeneration using landfill gas at Village Farms," will coproduce renewable electricity, heat, hydrogen, and greenhouse-quality CO2 as part of a technology demonstration.



- More efficient and less costly renewable supply option
- Flexible delivery of renewables for heating, power generation and transportation



Renewable Pipeline Gas



Quadrogen®

Notable Projects in Canada: Hydrogen Production



- Western Hydrogen has reached a major milestone in their piloting of an innovative hydrogen production technology called Molten Salt Gasification (MSG).
- The MSG process uses a combination of molten sodium salts (sodium carbonate and sodium hydroxide) to convert a carbon feedstock and water into hydrogen.
 The technology allows the production of high-pressure hydrogen without the need for compression and can use a variety of feedstocks, including renewables.





Notable Projects in Canada: Ramea Island Wind to H2



- The Ramea Island Project in Newfoundland/Labrador is producing hydrogen from wind during off-peak demand and then converting it to electricity through hydrogen internal combustion engines when demand increases.
- There are 27 other island communities in that province that can use this hydrogen production, storage and conversion system.



Hydrogen and fuel cell sector can provide significant economic impact for Canada



<u>Year 2020</u>	<u>Projection</u>
Revenues (\$mm)	\$1,232
Direct Employment	6,291
Indirect Employment	8,178
Total Jobs Impact	14,469
Wages Paid (\$mm)	\$650

Source: Ference Weicker, March 2010

Federal and BC Governments, CHFCA



Thank you!

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