CANADA

CanmetENERGY

Natural Resources Canada

INTRODUCTION AND BACKGROUND

Canada has been a long time supporter of hydrogen and fuel cell technologies and is home to some of the world leaders in the industry. Research, development and demonstration activities are supported by both government and industry. The government of Canada has invested over $300 million since the mid-1980s and over $982M in the industry since 2001.

Canada is well positioned to be a leader in hydrogen production technology as we are the largest per capita producer of hydrogen in the OECD, producing approximately 3 million tons annually. Canada has supported the development of a variety of technologies to produce hydrogen, primarily from renewable sources and purification of waste hydrogen. The main focus of the research has been on lowering the cost of hydrogen by 50%, in order to be competitive with gasoline.

Canadian technology is used in more than 60% of all hydrogen and fuel cell demonstrations worldwide and Canada exports more than 90% of its hydrogen and fuel cell technology.

TYPE	PJ	% OF TOTAL PRODUCTION
Fossil Fuels	13180	86%
Sub-Type	PJ	% of sub-total
Coal	1379	10%
Natural Gas (dry)	5977	45%
Crude Oil	5211	40%
NGPL	613	5%
Renewables	16.109	10.636%
Sub-Type	PJ	% of sub-total
Hydro	1226	8%
Biomass	613	4%
Nuclear	306	2%

Break-down of Total Canadian Energy Production

UPDATE ON MEMBER'S ENERGY FRAMEWORK

UPDATE ON RELEVANT POLICIES

Hydrogen and fuel cell technologies represent a unique opportunity for Canada to reduce the environmental footprint from many sectors, such as transportation, which accounts for approximately 30% of total energy use and 28% of all greenhouse gas emissions in Canada.

VITAL STATISTICS

Population

34.1 Million

Territory

9.984.670 KM2

Capital

Ottawa

GDP/capita

40,457 (CAD 2011)

Average Annual GDP Growth

2.4% (2011)

Primary Energy Structure

Production

Total production

15,326 PJ

See energy production break-down to the immediate left.

UPDATE OVERVIEW ON RELEVANT PROGRAMS AND PROJECTS

Highlights of Progress

Hydrogen Production

Canada is working to increase the viability of hydrogen production and purification technologies through R, D&D that reduces costs and improves safety, durability, and efficiency.

Activities include:

- Developing cost effective technologies to collect and purify hydrogen which would normally be vented as waste from industrial processes:
- Advanced pressure swing adsorption
- New ceramic materials
- Improved economics, durability, and efficiency of water electrolysis process:
- Lower cost catalyst materials
- Increased operating pressure
- Increased durability beyond 24,000 hours
- Integrate renewable energy (wind, solar) with electrolysis, for on site (distributed) hydrogen production
- Distribution infrastructure improvements

Hydrogen Storage

Activities to design, develop, and demonstrate affordable, durable, and lightweight hydrogen storage systems for transportation are being undertaken. The vehicle applications will allow sufficient vehicle range, at a reasonable cost and efficiency, to be competitive with current gasoline internal combustion engine vehicles and other advanced vehicle technologies.

Activities include:

- Improved economics and efficiencies of gaseous hydrogen storage systems
- Low-cost high volume manufacturing methods
- Technologies which can capture some of the energy lost to compression
- Comprehensive hydrogen storage system models based on real world data
- Improved economics, capacity, durability, and operating parameters of hydrogen storage systems based on solid state materials

Utilization (Fuel Cells)

Work is being conducted to increase the viability of fuel cells in transportation, through R, D&D that reduces costs and improves safety, durability, and efficiency of PEMFCs.

Activities include:

- Improve economics, performance, and durability of PEM Fuel cells
- Reduced platinum loading
- Improved catalyst activity
- Improved water transportation in membrane electrode assembly (MEA)
- Better mass-transport in the charge transport layer
- Increased power density

- Identification and mitigation of PEM – MEA failure modes
- Development of higher temperature PEM systems
- Comprehensive fuel cell systems models based on real world data
- APU development for long-haul trucking
- Manufacturing techniques developed which are specific to fuel cell systems and components

Safety, Codes and Standards

Canada is active in the development of codes and standards pertaining to the production, quality, storage, dispensing, and refuelling infrastructure for hydrogen and fuel cells in the transportation sector. This includes the development of harmonized codes and standards with the United States.

Activities include:

- Harmonized codes, standards, and practices developed with the United States
- Models developed for complete refuelling stations, which allow safety analysis and code development
- Real world testing of the components of the fuel storage and dispensing infrastructure, to determine and confirm best practices
- Revised Canadian Hydrogen Installation Code, which takes into account indoor refuelling
- Examined impurities in the fuel produced from waste hydrogen streams, for use in fuel cells.

HYDROGEN R,D&D SPECIFICS

PROGRAMS, PROJECTS, INITIATIVES IN BRIEF

The following are examples of significant accomplishments that are helping to build Canada's hydrogen and fuel cell industry.

Hydrogenics Corporation, a Canadian company and a leader in electrolyzer technology has recently installed 4 electrolysis based hydrogen fuelling stations in Europe, including one in Hamburg, Germany, capable of delivering 750 kilograms of hydrogen per day. It is Europe's largest station and will deliver fuel for 20 fuel cell buses operated by public transport as well as making hydrogen available for fuel cell cars. One half of the hydrogen is produced on site by electrolysis of water using renewable energy and the other half is delivered.

Researchers at the Hydrogen Research Institute, located at the Université du Québec à Trois-Rivières has been included in the US Department of Energy's Hydrogen Storage Systems Center of Excellence, whose focus is developing and optimizing onboard hydrogen storage systems for fuel cell vehicles.

The 20-bus fleet operated by BC Transit in the Resort Municipality of Whistler, British Columbia and powered by Ballard FCvelocityTM-HD6 fuel cell modules recently surpassed 1 million miles (1.6 million kilometers) of revenue service. The BC Transit fleet has been the largest hydrogen fuel cell-powered bus fleet in operation anywhere since it went into service approximately 2 years

ago and is the first hydrogen fuel cell bus fleet to achieve the 1 million mile revenue service mark. By end-November 2011 a number of important results had been achieved:

- The 20-bus fleet had operated a total of 80,000 hours;
- More than 9,600 safe refuellings had been completed, by which 220,000 kilograms of hydrogen was dispensed to the fleet's buses; and
- 2,200 tons of greenhouse gas (GHG) emissions were avoided, in comparison to diesel buses, which is equivalent to removing approximately 400 passenger vehicles from the roads.

A committee draft was compiled for the development of a new ISO standard on hydrogen fuel product specification, specifically "Part 2: Proton Exchange Membrane (PEM) fuel cell applications for road vehicles." This standard involves creating a fuel quality standard for fuel cell vehicles. The committee draft will take the standard to the next level of development. Once the standard is complete and available to the public, hydrogen fuel quality will be the same at all hydrogen fuelling stations. This will increase the viability of fuel cell vehicles.

REFERENCES

MEMBER WEBSITE

CanmetENERGY:

http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/transportation/hydrogen_fuel_cells.html

OTHER IMPORTANT WEBSITES

Atlas of Canada:

http://atlas.nrcan.gc.ca/site/english/maps/economic/energy/1

- Statistics Canada: http://www40.statcan.gc.ca/l01/cst01/prim72-eng.htm
- NRCan Economist – Matthew Lam, Senior Economist, mlam@nrcan.gc.ca

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