CANADA

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CanmetENERGY

Natural Resources Canada

INTRODUCTION

Canada has been participating in the development of hydrogen and fuel cell technologies for more than two decades and is one of the largest country per capita producers of hydrogen in the world. This positions Canada as an international leader in the development of fuel cell technology and hydrogen infrastructure, and makes hydrogen and fuel cells an ideal energy option for our country.

Hydrogen and fuel cell technologies represent a unique opportunity for Canada to reduce the environmental footprint from many sectors, such as Transportation. It is Canada's plan to shift away from fossil fuels, towards low carbon fuels and zero emission technologies, using electricity and hydrogen produced from renewable energy sources.

Along with government and academia, the hydrogen and fuel cell community in Canada is comprised of highly innovative smaller companies, which are investing heavily in R&D to further commercialize hydrogen and fuel cell technology. Although many of the companies are spread out across the country in cities such as Calgary, AB; Toronto, ON; and Montreal, QC, Vancouver, BC, is said to have the largest cluster of hydrogen and fuel cell companies in the world. Canada utilized the 2010 Winter Olympics in Vancouver, BC as an opportunity to showcase its hydrogen technologies to the world.

PROGRAM STRUCTURE

Canada's program targets many areas: sustainable hydrogen production, hydrogen storage, fuel cells, demonstrations and safety, codes and standards.

Hydrogen Production: Hydrogen's value as an energy carrier stems both from its environmental benefits as well as from the wide base of primary energy sources which can be employed to produce it. These include both renewable sources such as hydro, wind, solar and biomass, and non-renewable sources such as natural gas, coal and nuclear energy, as well as from waste streams.

Historically, the main thrust of Canada's past investments has been electrolysis systems for hydrogen production from wind, hydrogen from renewable energy. Smaller program elements included purification and separation. Activities have steered away from technologies which are developed extensively in other countries and for which there was not a unique Canadian capability. Going forward, Canada's activities in the short term will focus almost exclusively on electrolytic hydrogen production integrated to renewable energy sources and the purification of waste hydrogen.

Hydrogen Storage: Hydrogen storage is a key enabling technology for the deployment of fuel cell technologies in stationary, portable, and transportation applications. The challenge for all end-uses is reversible, lower cost, lighter weight, and higher-density hydrogen storage systems. For transportation, the overarching technical challenge for hydrogen storage is how to store the amount of hydrogen required for a conventional

VITAL STATISTICS

Population
33,739,900 (2010)

Territory
9,984,670km^2

Capital
Ottawa

GDP/capita
$39,599 (2010)

GDP Growth
1.4% (2010)

Total Energy Production
15,327.8
Energy – all figures are measured in petajoules for (2009)

Petroleum
4419.8 – 29% of total

Crude Oil
5447.4 – 36% of total

Natural Gas
635.1 – 4% of total

Hydroelectric & Nuclear
1645.6 – 11% of total

Coal
1361.3 – 9% of total

Renewable and Other
1818.6 – 11% of total

Energy Imports
2,944.8

Energy Exports
7,902.0

Demand/Consumption
10,962.9

Electricity

all figures are measured in megawatt hours

Total Electricity Generation

(Utilities and Industry)

592,346,266 MWH (2010)

	MWH	%
Hydro	365,684,856	62%
Wind	**6,657,096**	**1%**
Total Thermal	219,999,777	37%
Conventional Steam Turbine	100,962,521	
Nuclear Steam Turbine	84,991,779	
Internal Combustion Engine	1,573,605	
Combustion Turbine	32,471,872	

driving range (>300 miles), within the vehicular constraints of weight, volume, efficiency, safety, and cost. Durability over the performance lifetime of these systems must also be verified and validated, and acceptable refuelling times must be achieved.

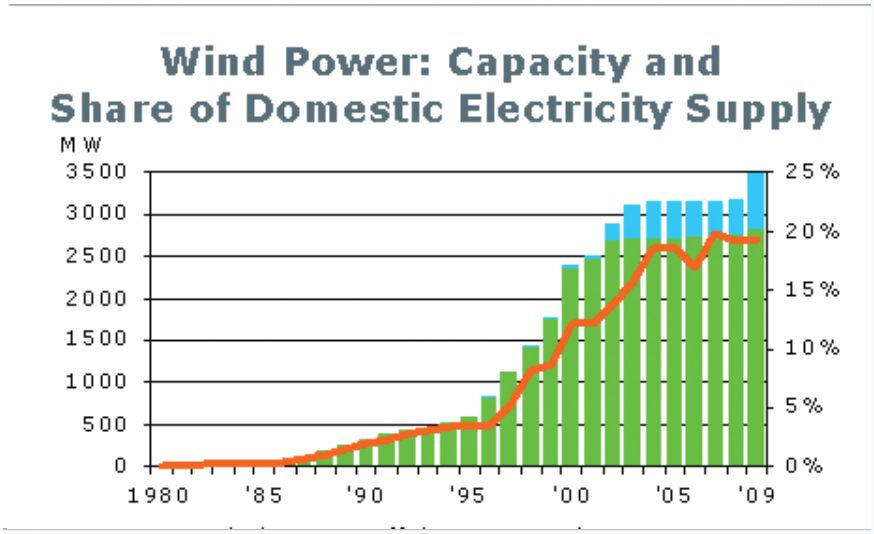
Going forward, Canada will focus on the development of new hydrogen storage materials and systems. Weight, volume and cost will be the key parameters addressed.

Fuel Cells: Canada is working to improve fuel cell technologies for transportation, stationary, and portable applications. For transportation, small-scale stationary generation (e.g. back-up power), and portable devices, the focus is on proton exchange membrane (PEM) fuel cells due to their low temperature operation and capability for fast start-up. For larger-scale distributed energy generation, the focus is on the high temperature solid oxide fuel cell (SOFC), which can use natural gas or other hydrocarbon fuels directly.

Codes, Standards and Safety: The successful global commercialization of hydrogen and fuel cells depends on internationally accepted codes and standards. These will help to increase the experience, knowledge and confidence of local, regional, and national officials in the use of hydrogen and fuel cell technology, and facilitate the development of smart regulations. R&D supports the development of performance-based, rather than product-specific, codes and standards.

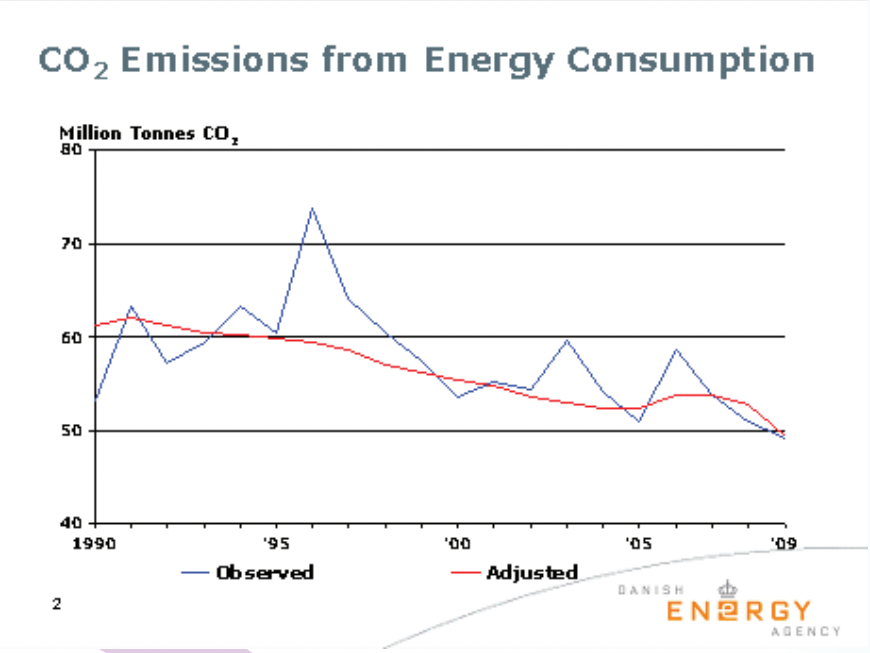
International collaboration in this area is essential. Canada has played a leading role as chair of the ISO Technical Committee 197 (Hydrogen Technologies) and as a strong contributor to the IEA Hydrogen Implementing Agreement Task 19. Task 19 participants have been working to identify the physical properties of hydrogen which impact the issue of safety.

Canada has also developed the Canadian Hydrogen Installation Code. Published by the Bureau de normalisation du Québec (BNQ) as a National Standard of Canada, the Canadian Hydrogen Installation Code (CHIC) [CAN/BNQ 1784-000] will help pave the way for a greater use of hydrogen as an energy carrier by guiding safe design and facilitating the approval process of hydrogen installations across Canada. This code has also been used as a guide for other countries and jurisdictions to develop their own codes.



Wind power capacity

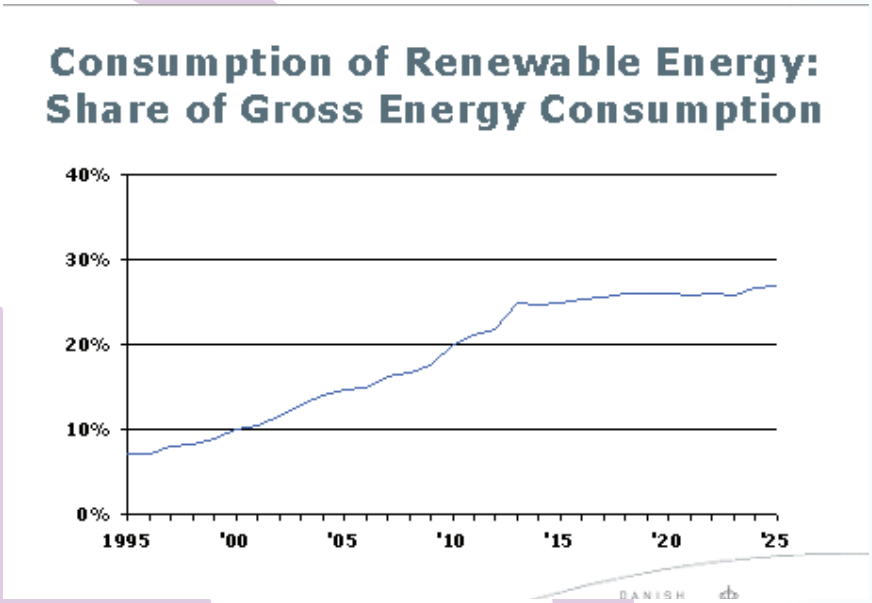
In 2009 wind power production accounted for 19.3% of the domestic electricity supply. At the end of 2009 the wind power capacity was 3,482 MW.



CO_2 emissions from energy consumption

CO_2 emissions from energy consumption fell to 49.4 million tons in 2009. Compared to 1990 the drop in CO_2 emissions have decreased by 19.2%.

During this period a significant shift in the fuel mixture to less carbon intense fuels has occurred. Gross energy consumption is reduced by 0.7% since 1990.



Renewable energy

The Energy agreement of February 21st 2008 contains an objective to increase the share of renewable energy to 20% of gross energy consumption by 2011. In the projections the share of renewable energy is 21% in 2011.

The large increase in 2013 is related to the planned offshore wind farm near Anholt, which is expected to be in operation from 2013.

UPDATE ON MEMBER'S ENERGY FRAMEWORK

UPDATE ON RELEVANT PROGRAMS AND PROJECTS

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

Highlights of Progress

Canadian Hydrogen Airports Project

The Canadian Hydrogen Airports Project is the largest multi-application hydrogen and fuel cell demonstration project in Canada. The Project takes place at the Pierre Elliot Trudeau Airport in Montréal, Quebec and at the Vancouver International Airport in British Columbia. The Project will demonstrate and field test hydrogen technologies, including portable, mobile, and stationary applications, as well as hydrogen fuelling infrastructure. The Environmental Assessments were completed; the fuelling stations are now installed and fully operational.

VFCVP

The five Ford Focus fuel cell vehicles of the Vancouver Fuel Cell Vehicle Program (VFCVP) in BC completed five years of operation and exceeded a fleet total of 350,000 kilometres. One of the VFCVP operated vehicles exceeded 95,000 kilometres and all five vehicles have had no major components fail.

Solid Oxide Fuel Cells

Solid oxide fuel cells are highly efficient, non-polluting energy devices. However, the high operating temperatures required for these fuel cells puts severe restrictions on their life and reliability. The Hydrogen and Fuel Cells Lab of Natural Resources Canada is investigating new solid oxide fuel cell materials to address these issues. In 2009 and 2010, electrolyte supported button-type fuel cells were prepared, tested, and showed promise to operate at lower temperatures.

Development of Advanced PEM Water Electrolyser

Market interest in PEM water electrolysis for backup power, renewable energy storage, and onsite hydrogen generation applications is growing rapidly. These markets require increased stack durability, lower total system cost, higher delivery pressures and hydrogen production rates up to 10 Nm^3/hr. This project is addressing technology needs for membrane durability improvements, bipolar plate manufacturing and coating, cost reductions and higher pressure stack design.

Hydrogen Storage

Hydrogen storage remains a key challenge to the large scale adoption of hydrogen as an energy carrier and transportation fuel. Current carbon-based hydrogen storage materials are a potentially viable solution; however, material costs, operation temperatures, and volumetric density issues must still be addressed. In 2009 and 2010, the Université du Québec à Trois-Rivières developed new, simplified, and cost-effective methods for preparing carbon-based Metal Organic Framework materials for hydrogen storage. These methods reduced the overall number of steps in the process, while using simple solvents (like water and ethanol) which decreased the overall cost of the processes.

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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