Future Prospects and Public Policy
Implications for Hydrogen and Fuel Cell Technologies in Canada

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Introduction and Outline

Outline

- Strategic Context
- Overview of Canadian Hydrogen and Fuel Cell System
- Issues
- Prospects
- Conclusions

Key Messages

- Canada has enjoyed an early technological lead in FC technologies
- Future is by no means assured of reaping benefits
- Given the range of public policy issues and nature of the technology, a strong, coordinated role by governments at all levels is needed
Strategic Context

“Energy for 10 billion people”

Richard Smalley 2005

Figure 1

Share of transport in total oil consumption, OECD 1971-2030

Source IEA (2002)
International Context

Figure 2: Fuel Cell Market Focus

- Small stationary (≤50 kw), 24%
- Portable power, 18%
- Fueling infrastructure, 16%
- Large stationary (≥50 kw), 15%
- Vehicle drive, 13%
- Auxiliary power in remote sites, 13%


Figure 3: Fuel Cell Technology Focus

- Solid oxide, 13%
- Direct methanol, 12%
- Molten carbonate, 9%
- Alkaline, 2%
- Phosphoric acid, 2%
- Other, 1%

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- Alkaline, 2%
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- Other, 1%
1980s: (NRC) Hydrogen and Energy Storage Program, and University of Toronto
1983: procurement contract issued to Ballard by the Department of Defence for a small PEM fuel cell stack
1990s: Strategic alliances with DaimlerChrysler and Ford for fuel cell automotive engine development
1998: Major fuel cell bus demonstration contract by the Chicago Transit Authority
Figure 5: Fuel Cell Sector in Canada by Function

- Professional Services: 26 responses
- Supplier: 22 responses
- Research Org.: 20 responses
- Developer or manufacturer: 16 responses
- Other: 15 responses
- User: 13 responses
- Utility: 7 responses
- Distributor or agent: 4 responses

Source: Canada's Fuel Cell and Hydrogen Industry, Capabilities Guide
**Figure 6: Canadian Fuel Cell Revenues and R&D Expenditures**

- **Revenues**
  - 2001: [Bar Height]
  - 2003: [Bar Height]

- **R&D Expenditures**
  - 2001: [Bar Height]
  - 2003: [Bar Height]

*Source: Canada's Fuel Cell and Hydrogen Industry, Capabilities Guide*
Federal Support Programs

- Natural Resources Canada
  - Canadian Transportation Fuel Cell Alliance
- Technology Early Action Measures
- Industry Canada
  - Energy and Environment Industries Branch
  - Technology Partnerships Canada
- National Research Council
  - Institute for Fuel Cell Innovation
  - Industrial Research Assistance Program
- Natural Sciences and Engineering Research Council
- Networks of Centres of Excellence: Auto21
- Sustainable Development Technology Canada
## Federal Support Programs

**Deal Flow**

### Innovation
- **Fundamental Research**
- **Applied Research & Development (Bench Scale)**
- **Prototype Development**
- **Demonstration (Full Scale)**

### Commercialization
- **Product & Market Development**
- **Market Ready**
- **Market Entry**

#### Programs
- **Federal University Granting Councils**
- **SR&ED Tax Credit**
- **PERD**
- **IRAP**
- **TEAM**
- **SDTC**
- **FCM**
- **BDC**
- **EDC**
- **TPC**
- **Incentive programs REDI, WPPI, RPPI**
Issues for Canadian Fuel Cell Development – Cost - Performance

2005 Ballard Benchmarks and 2010 Targets

- **Durability** – > 2,000 hrs. Ballard on track to meet US Department of Energy goal for durability of 5,000 hrs. by 2010
- **Freeze Start** – -20°C at 100 sec; on target for -30°C at under 30 seconds by 2010
- **Power Density** – 1,400 Watts/net/litre power density. Ballard is expected to reach a of 2,500 W/net/l by 2010
- **Cost** – < $100/kW. Ballard announced a 30% reduction in platinum catalyst loading for the new stack design, the DOE goal of $30/kW by 2010
# Issues for Canadian Fuel Cell Development - Marketing

## Table 2: Fuel Cell and Hydrogen Demand Projections 2023[^1]

<table>
<thead>
<tr>
<th>Market/Scenario</th>
<th>Status Quo</th>
<th>Low Carbon Agenda</th>
<th>Hydrogen Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td># of vehicles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger</td>
<td>46,591</td>
<td>126,818</td>
<td>338,660</td>
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<tr>
<td>Fleet</td>
<td>2,303</td>
<td>4,218</td>
<td>17,436</td>
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<tr>
<td>Transit</td>
<td>164</td>
<td>433</td>
<td>1,260</td>
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<tr>
<td>Hydrogen(tones/y)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger</td>
<td>11,650</td>
<td>31,700</td>
<td>77,165</td>
</tr>
<tr>
<td>Fleet</td>
<td>5,760</td>
<td>10,545</td>
<td>43,590</td>
</tr>
<tr>
<td>Transit</td>
<td>2,990</td>
<td>8,085</td>
<td>22,995</td>
</tr>
</tbody>
</table>

Issues for Canadian Fuel Cell Development - Risk Financing

Figure 8 – Risk Financing Spectrum

Source: Sustainable Development Technologies Canada
Future Prospects and Outlook - Demonstration & Systems Integration

- Hydrogen Highway – Olympics 2010
  - British Columbia
- Hydrogen Village
  - Greater Toronto Area
- Hydrogen corridor
  - Quebec – Windsor
- Future links (?)
  - California – Vancouver Corridor
  - North East US links to Quebec Windsor
Future Prospects and Outlook – Bus Fleet Demonstrations

- There are over 2.42 billion riders per year
- The number of vehicles – approximately 12,000 across Canada – is a sizeable market
- UTSs consume over 360 million litres of diesel and 17 million cubic meters of natural gas per year
- The transit application is visible to a public sympathetic to improving air quality
- Transit properties have a centralized infrastructure that can be adapted to hydrogen
- Urban transit applications have global market relevance

Canadian Transportation Fuel Alliance, 2005
Future Prospects and Outlook - Demonstration & Systems Integration

Figure 7: Location of Demonstration projects (2003)

Source: Canada’s Fuel Cell and Hydrogen Industry, Capabilities Guide
Conclusions - FCV Rationale

- Strategic disruptive and emerging technology with a broad applications in a number of industries
- At the interface among a wide range of public policy priorities including environmental sustainability, climate change, energy use and conservation, transportation planning, industrial and regional development
- High-stakes industrial issue where the eventual securing of major market segments in the automotive, stationary and portable power markets
- A sector where close policy coordination at the municipal, provincial, federal and international levels will be of critical importance to the future success of the industry and technology
Conclusions – Policy Implications

- Research support
  - Consensus on priorities – increase international collaborations and interdisciplinary - social sciences

- Commercialization
  - Need for an open systems approach that capitalizes on both research and entrepreneurial creativity

- Risk financing:
  - Revisit the risk financing ecosystem to address disruptive technology gaps

- Demonstration and Early Adoption
  - Shift to large integrated system platforms

- Policy and Program Integration
  - Need to address policy and program fragmentation issues