

**ECONOMIC IMPACT OF  
INDUSTRIAL HYDROGEN ACTIVITY  
IN CANADA**

Prepared for the:

**Transportation Energy Technology Program  
CANMET Energy Technology Centre - Ottawa  
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FINAL REPORT**

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## EXECUTIVE SUMMARY

Offering clean and abundant power, hydrogen-based fuel cells are a viable alternative to industrial society's reliance on oil, and an opportunity to minimize greenhouse gas emissions causing pollution and global warming. High cost however has been an impediment to market penetration of this technology. Fortunately, prices have been falling recently as cost-breaking technological advances are being made. Leaps in stock market valuations of public companies like Ballard Power Systems and FuelCell Energy Inc. (USA) reflect the economic benefits of lower costs and mass-production, as well as the enormous environmental benefits.

This report tracks the trends of four measures of the economic impact of the hydrogen and fuel cell industry in Canada. These measures are revenue, research and development (R&D) expenditure, employment, and the range of product/service. The measures and their indicators span available data from twenty-eight (28) Canadian companies involved in the hydrogen and fuel cell industry for the year 2000-2001 and projections for 2002-2003. Seven (7) provinces are represented, although most of this industrial activity is in British Columbia, Quebec and Ontario. The results in the body of the report are represented in several fashions: aggregated totals; summaries by region (east / west); and by company size (SME  $\leq$  100 employees; Large  $>$  100 employees). SMEs currently represent 82% of the firms, but this drops 17%, to 68% based on the projected workforce.

Based on the data received from the twenty-eight (28) Canadian firms, which represents an 82% response rate, the current economic impact of the Canadian hydrogen and fuel cell industry is currently a \$275.9 million industry with nearly 1800 employed, and is expected to grow substantially by 2002-03.

Current R&D expenditures were \$179 million - almost as much as the \$203 million reported for total R&D expenditures by the automotive industry in Canada. R&D expenditures are expected to grow by 100% over 2000-01, total employment by 49%, and total revenue by 70%.

	Current (2000-01)	Projected (2002-03)	Growth/(Decline)
Revenue	\$ 96.9 M	\$165.1 M	70%
R&D Expenditure	\$179.0 M	\$358.2 M	100%
<b>Direct Economic Impact (Industry Size)</b>	<b>\$275.9 M</b>	<b>\$523.1 M</b>	<b>90%</b>
Direct Canadian Employment (jobs)	1701	2524	48%
Direct Out-of-country Employment (jobs)	71	115	62%
<b>Total Direct Employment</b>	<b>1772</b>	<b>2639</b>	<b>49%</b>

Direct revenues are generated through product sales, research and development, and services. Sales represent approximately seventy-five percent (75%) of the revenues while R&D represents twenty percent (20%) and services, five percent (5%). Of the total revenue, it is interesting to note that more than eighty percent (80%) is generated by exports, although domestic revenue growth (84%) exceeds export growth (68%).

Canadian R&D expenditure is expected to double by 2003, with almost 90% of the expenditure coming from firms located in western Canada.

The workforce employed by the companies surveyed who are involved in hydrogen and fuel cells are primarily located in Canada (96%), and close to 75% of the workforce are employed by firms located in western Canada. It is not surprising that the large firms employ the majority of the workforce (18% of firms employ 73% of the current workforce; 32% of the firms will employ 82% of the projected workforce).

This workforce is highly educated, with 70% of those involved in hydrogen and fuel cells having a post-secondary education. Of that, 20% have a college degree, and 50% have a university degree. The trend in the overall workforce however is moving marginally from university degree to college diploma.

Current revenue per employee is \$54,649 versus a projected \$62,595 in year 2002/03. This constitutes a 15% growth over current year. Economic impact (revenue + R&D expenditures) per employee however grows 27% from \$155,646 to \$198,345.

The primary activities within this industry seem to be engineering services, hydrogen production equipment, testing equipment, and fuel cell stacks. Fifty-one percent (51%) of the firms are involved in 2-5 activities, while twenty-one (21%) are involved in 6-10.

Overall these results demonstrate a significant commitment to the hydrogen and fuel cell industry, as well as anticipated growth and market potential.

The table below provides a summary of the key indicators:

PRODUCTS AND SERVICES				
Top four industrial activities	Engineering Services	Hydrogen Production Equipment	Testing Equipment	Fuel cell stacks
Distribution of Activity (frequency)	7 % in 0 production activities (R&D only)	21 % in 1 activity only	51 % in 2-5 activities	21 % in 6-10 activities
SMEs as % of total # of firms	82%	68%		▼ 14%
Large firms as % of total # of firms	18%	32%		▲ 14%

REVENUE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Domestic Total	\$17.1 M	\$ 31.4M	▲ \$14.3 M	▲ 84%
Export Total	\$79.8 M	\$133.7 M	▲ \$53.9 M	▲ 68%
<b>Total Revenue</b>	<b>\$96.9 M</b>	<b>\$165.1 M</b>	<b>▲ \$68.2 M</b>	<b>▲ 70%</b>
Total Domestic Revenue as a % of Total Revenue	18%	19%		▲ 1%
Total Export Revenue as a % of Total Revenue	82%	81%		▼ 1%
<b>Total Sales</b>	<b>\$74.1 M</b>	<b>\$124.8 M</b>	<b>▲ \$50.7 M</b>	<b>▲ 68%</b>
Total Sales as a % of Total Revenue	76%	76%		-
<b>Total R&amp;D</b>	<b>\$20.8 M</b>	<b>\$29.9 M</b>	<b>▲ \$ 9.1 M</b>	<b>▲ 44%</b>
R&D Revenue as a % of Total Revenue	22%	18%		▼ 4%
<b>Total Service</b>	<b>\$2.4 M</b>	<b>\$10.4 M</b>	<b>▲ \$ 8.0 M</b>	<b>▲ 333%</b>
Service Revenue as a % of Total Revenue	2%	6%		▲ 4%
<b>Total Revenue per FTE</b>	<b>\$0.055 M</b>	<b>\$0.063 M</b>	<b>▲ \$0.008 M</b>	<b>▲ 15%</b>
% Revenue by SME	53%	64%		▲ 11%
% Revenue by Large firms	47%	35%		▼ 11%

R&D EXPENDITURE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Canadian R&D Expenditure (total)	\$179.0 M	\$358.2 M	▲ \$179.2 M	▲ 100%
Western R&D Exp. as a % of Total R&D Expenditure	87%	86%		▼ 1%
Eastern R&D Exp. as a % of Total R&D Expenditure	13%	14%		▲ 1%
SME R&D Expenditure as % of Total R&D Expenditure	12%	26%		▲ 14%
Large R&D Expenditure as % of Total R&D Expenditure	88%	74%		▼ 14%

INDUSTRY SIZE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Revenue + R&D Expenditure	\$275.9 M	\$523.1 M	▲ \$247.2 M	▲ 90%
Industry size per employee	\$0.156 M	\$0.198 M	▲ \$0.042 M	▲ 27%

EMPLOYMENT	Current (2001)	Projected (2003)	Growth / Decline	Trend
Domestic jobs	1701	2524	▲ 823	▲ 48%
Out-of-country jobs	71	115	▲ 44	▲ 62%
<b>Total workforce generated by Cdn. Firms</b>	<b>1772</b>	<b>2639</b>	<b>▲ 867</b>	<b>▲ 49%</b>
% of workforce in Canada	96%	96%		-
% of workforce out-of Canada	4%	4%		-
% of workforce generated by Western firms	76%	73%		▼ 3%
% of workforce generated by Eastern firms	24%	27%		▲ 3%
% of workforce employed by SMEs	27%	18%		▼ 9%
% of workforce employed by Large firms	73%	82%		▲ 9%

EDUCATION	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
% of Total Workforce with college diploma	19%	22%		▲ 3%
% of Total Workforce with university degree	50%	48%		▼ 2%
<b>% of Total Workforce with Post-Secondary</b>	<b>69%</b>	<b>70%</b>		<b>▲ 1%</b>
% of domestic workforce with college diploma	22%	24%		▲ 2%
% of domestic workforce with university degree	55%	52%		▼ 3%
<b>% of domestic workforce with post-secondary educ.</b>	<b>78%</b>	<b>77%</b>		<b>▼ 1%</b>
% of out of country workforce with college diploma	15%	22%		▲ 7%
% of out of country workforce with university degree	44%	45%		▲ 1%
<b>% of out-of country workforce with post-secondary</b>	<b>59%</b>	<b>63%</b>		<b>▲ 4%</b>
Ratio of domestic college: university	1 : 2.6	1 : 2.2		▼ 15%
Ratio of out-of-country college: university	1 : 2.2	1 : 1.9		▼ 14%
% SME workforce with post-secondary education	51%	62%		▲ 11%
% Large firm workforce with post-secondary education	63%	63%		-





# **I. BACKGROUND**

## **A. Introduction**

Offering clean and abundant power, hydrogen-based fuel cells are a viable alternative to industrial society's reliance on oil, and an opportunity to minimize greenhouse gas emissions causing pollution and global warming. High cost however has been an impediment to market penetration of this technology. Fortunately, prices have been falling recently as cost-breaking technological advances are being made. Leaps in stock market valuations of public companies like Ballard Power Systems and FuelCell Energy Inc. (USA) reflect the economic benefits of lower costs and mass-production, as well as the enormous environmental benefits.

This report tracks the trends of four measures of the economic impact of the hydrogen and fuel cell industry in Canada. These measures are revenue, research and development (R&D) expenditure, employment, and the range of product/service. The measures and their indicators are the result of inputs from twenty-eight (28) Canadian companies involved in the hydrogen and fuel cell industry for the years 2000-2001 and 2002-2003. Seven (7) provinces are represented, although most of this industrial activity takes place in British Columbia, Quebec and Ontario.

## **B. CETC's Interest**

The Transportation Energy Program (TETP), managed by the CANMET Energy Technology Centre (CETC), supports efforts by Canadian industry to develop and commercialize technologies and fuels that permit a cleaner, more sustainable energy mix for Canadian roadways. TETP has been designed to assist industry in responding to a growing worldwide demand for more environmentally responsible transportation alternatives. By supporting R&D toward innovative new technologies, TETP is improving Canada's competitive edge in the changing transportation market place.

Alternative fuel technologies are each at a different proximity to full market penetration, which reflects their state of development. Prototype hydrogen-powered vehicles are just being introduced. Significant R&D will be required before this technology can be introduced on the commercial scale of natural gas. However, technical and market potential is enormous.

To better direct NRCan's support to the hydrogen and fuel cell industry, CETC required a baseline measure of industrial investment in this area, in terms of R&D expenditures, workforce levels and revenue projections.

## **C. Assessment Objective**

This study had three objectives:

- determination of the major products, services and R&D that industrial firms are involved in;
- determination of the current and projected revenues from domestic and export equipment sales, R&D, and services; and
- determination of the levels of employment and education for Canadian industrial players.

## **D. Assessment Approach**

### **Data Collection**

In consultation with the CETC project manager, and with feedback from the National Research Council, Sypher developed a two-page questionnaire that NRCan sent out by e-mail to thirty-four (34) Canadian Industrial firms involved in fuel cells and hydrogen. The majority (68%) of the firms surveyed operate in the provinces of British Columbia and Ontario.

- 2 in Alberta
- 13 in British Columbia
- 2 in Manitoba
- 10 in Ontario
- 5 in Quebec
- 1 in Saskatchewan
- 1 in Nova Scotia

Follow-up phone calls and e-mails were sent out to non-responsive firms requesting their input to this exercise.

The results of each organization's response are being treated as commercially confidential and are only presented in aggregated summaries with other organizations.

A list of the firms contacted as well as the questionnaire utilized is attached as Appendix A and B respectively to Report.

## Data Analysis

Raw data was received from twenty-eight of the thirty-four firms. This represents an eighty-two percent (82%) response rate. Sypher considers this an excellent response rate that provides a highly accurate picture of the industry. This data was used to estimate direct economic impacts. Data collected is for the fiscal year 2000-01 with an estimate for 2002-03.

To retain the commercial confidentiality of the respondent's information, data is presented both by national aggregates and by East/West divisions. A division as such represents a 43:57 split between respondent companies in the East (Nova Scotia, Ontario, Quebec) and companies in the West (British Columbia, Alberta, Manitoba, Saskatchewan).

Distribution of products and services is determined by the number of firms involved in each activity. Data is also sorted to determine the effects of geographical location on industrial activity.

Revenues are separated by geographical area (domestic, export), and by area of activity (product sales, R&D, services). These segregations are important in determining the source of the revenues.

R&D Expenditure was chosen as an indicator to determine Canadian commitment in the development of the hydrogen and fuel cell market.

Employment levels are separated by geographic area (within Canada and outside of Canada) to determine domestic job potential in the hydrogen and fuel cell industry. Education of the workforce is also used as an indicator of employment.

## E. Overview of Contents

This report provides the following information related to the economic impact of the Canadian hydrogen and fuel cell industry:

- Hydrogen and Fuel Cell Products and Services
- Current and Projected Revenues
- Current and Projected Employment Levels
- Current and Projected R&D Expenditures
- Education of Workforce



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## II. FINDINGS

### A. Industry Trends

Fuel cell technology, which converts hydrogen into electricity through an electro-chemical process, has wide ranging applications from electric car engines to stationary power generation units. In contrast to internal combustion engines, hydrogen fuel cells can produce zero environmental pollutants. Strong environmental pressure to reduce greenhouse gas emissions, liberalization of energy markets, and recent technological advances by companies around the world are said to be the main factors in the industry's growth potential.

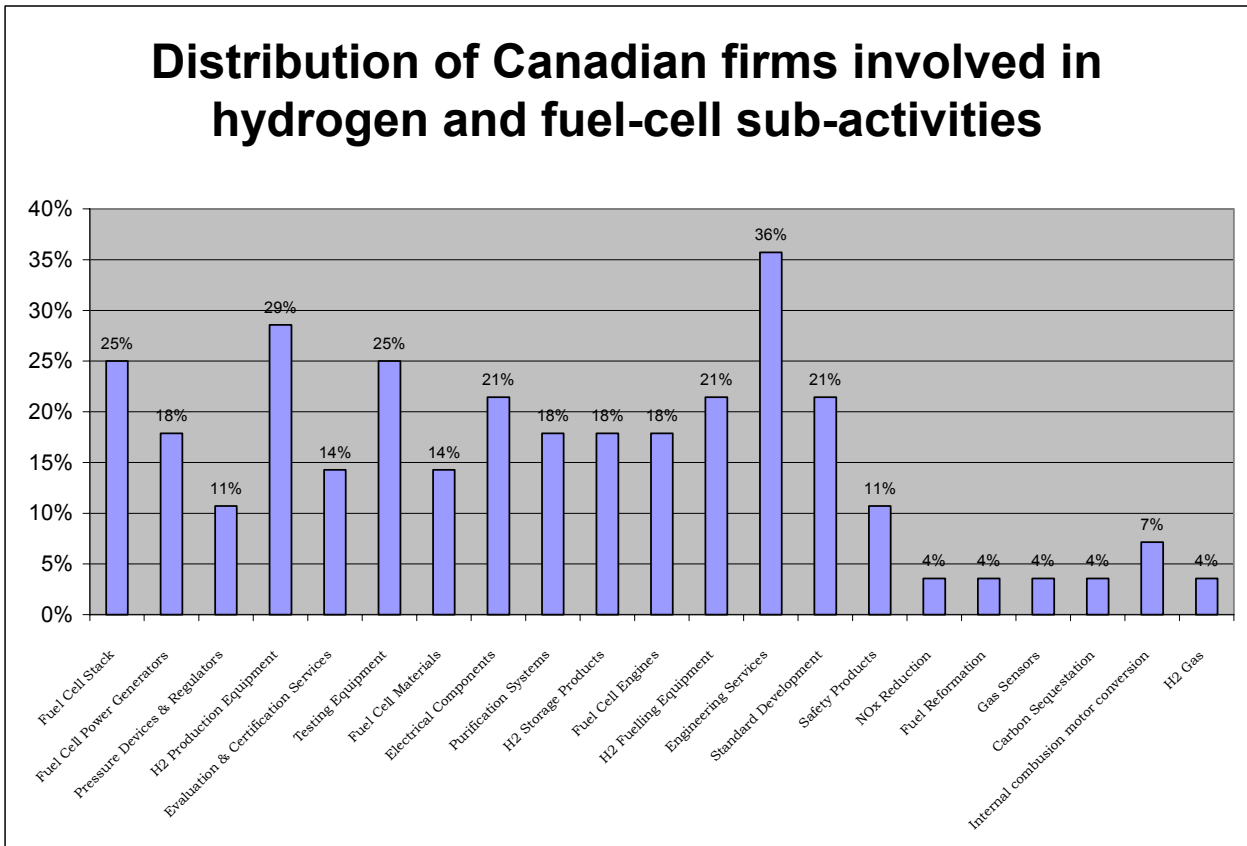
The investment community has started to get involved in the sector in the past years and although stock market confidence is poor at the moment, the confidence in the technology is still there. The technology is proven; it is now a question of timing with respect to market penetration. The Hydrogen Fuel Cell Institute has a "robust degree of confidence that coming advances in hydrogen and fuel cells can be substantial, and may make hydrogen fuel cells not just popular, but economically viable in their own right".

General Motors (GM) for example announced earlier this month, the launch of a new fuel cell stack for electric car engines, claiming that it produces sixty percent more power than any of its competitors. GM expects to start mass-producing a fuel cell car by the end of the decade. Ballard, another leading fuel cell player is working on its third generation fuel cell system for vehicles.

As governments introduce legislation promoting non-polluting and low-polluting technologies, we can expect the market for hydrogen fuel cells to explode.

### B. Products and Services Related to Hydrogen and Fuel cells

Based on the data received from twenty-eight Canadian industrial players, the Exhibit II-1 represents the distribution of Canadian firms involved in the following hydrogen and/or fuel cell products/services.



**Exhibit II-1**

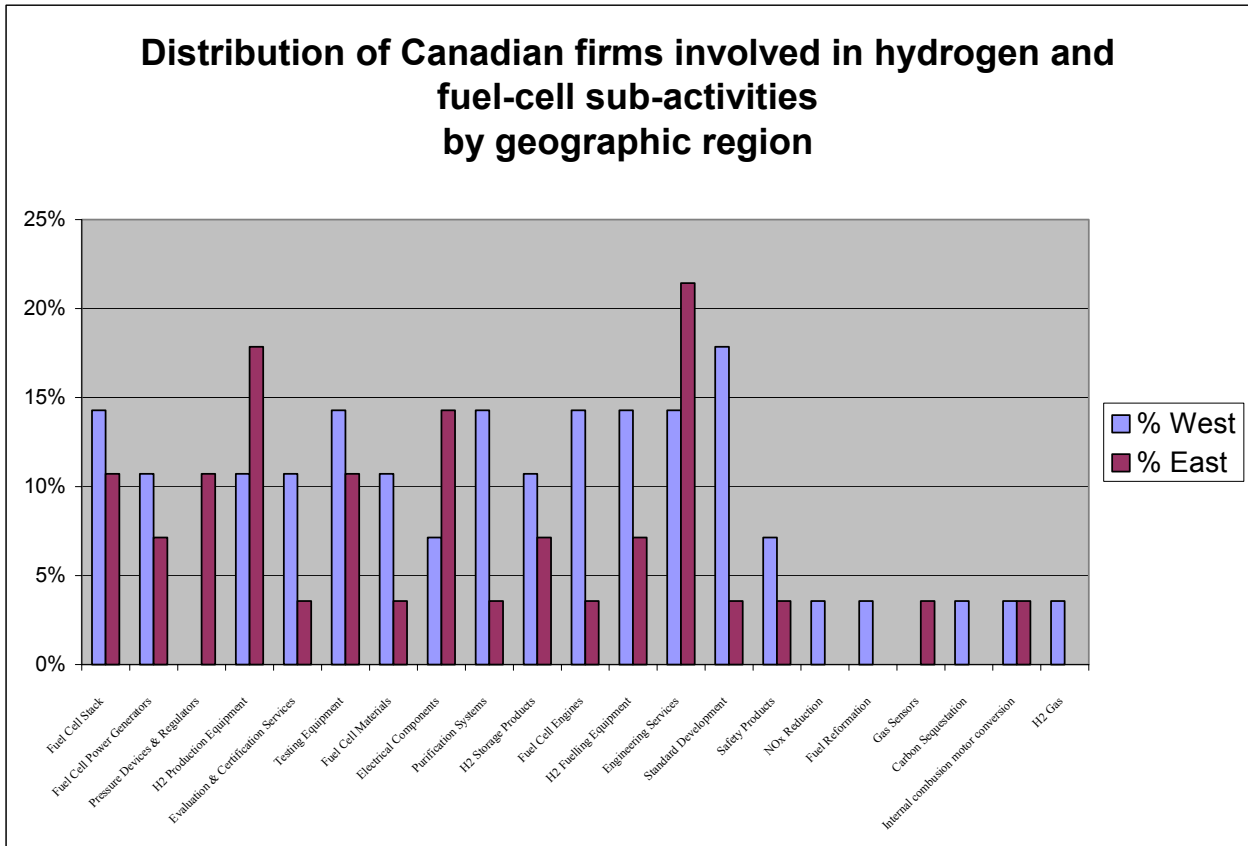
As shown, the primary areas of activity are in engineering services (36% of respondent firms), hydrogen production equipment (29% of respondent firms), testing equipment (25% of respondent firms), fuel cell stacks (25% of respondent firms), and electrical components (21% of respondent firms).

As demonstrated in Exhibit II- 2, geographical location of the firm seems to impact the type of hydrogen and fuel cell activity that the firm is involved with.

SMEs are located throughout the country, while larger firms operate only in Alberta, British Columbia and Ontario.

Seven percent (7%) of the respondents are not involved in the production of any of the above mentioned product and service areas although they are involved in R&D, while twenty-one percent (21%) are involved in only

one area, fifty-one percent (51%) are involved in 2-5 areas, and twenty-one percent (21%) are involved in 6-10.

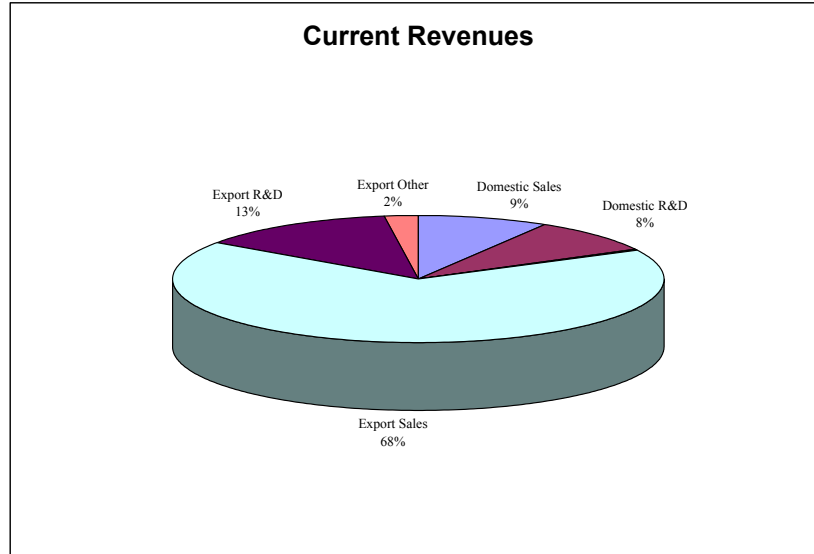


**Exhibit II-2**

SMEs are primarily involved in engineering services, hydrogen production equipment, testing equipment, and electrical components. Large firms however are primarily involved in fuel cell engines, fuel cell stacks, fuel cell power generators, and purification systems.

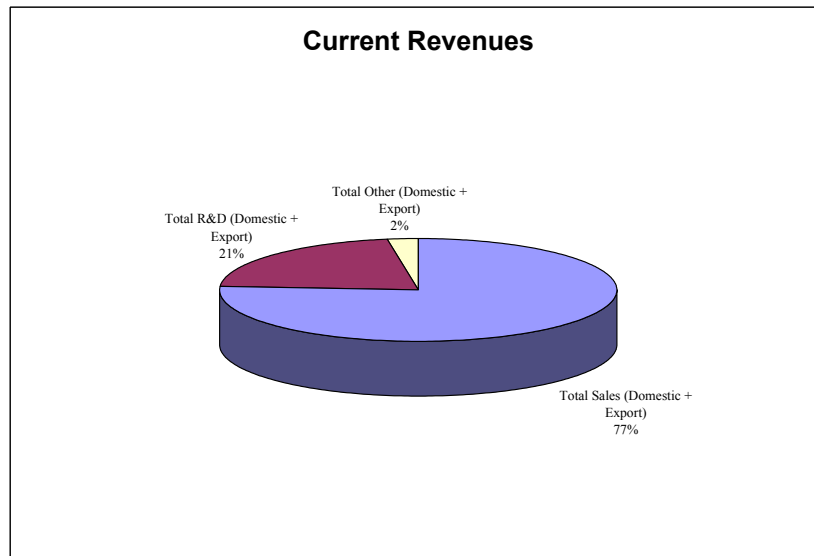
## C. Revenues

Current revenues (2000-01) of the twenty-eight Canadian firms are approximately \$96.9M. As can be seen in Exhibit II-3, eighteen percent (18%) of the current revenue is domestic, while eighty-two percent (82%) is based on exports.



**Exhibit II-3**

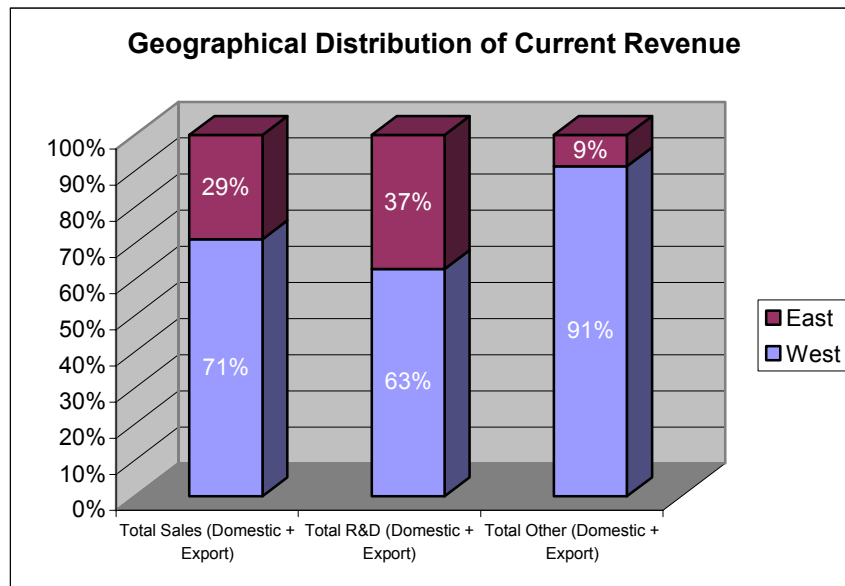
Exhibit II-4 demonstrates that current revenue is predominately earned from equipment sales (77%), while 21% is from R&D and 2% from Other Services.



**Exhibit II-4**



Exhibit II-5 clearly demonstrates that the western region, with \$67.5M (or 70% of total revenue) dominates the revenue generation in this market. The results are expected given that the majority of the respondents (57%) are from the west.

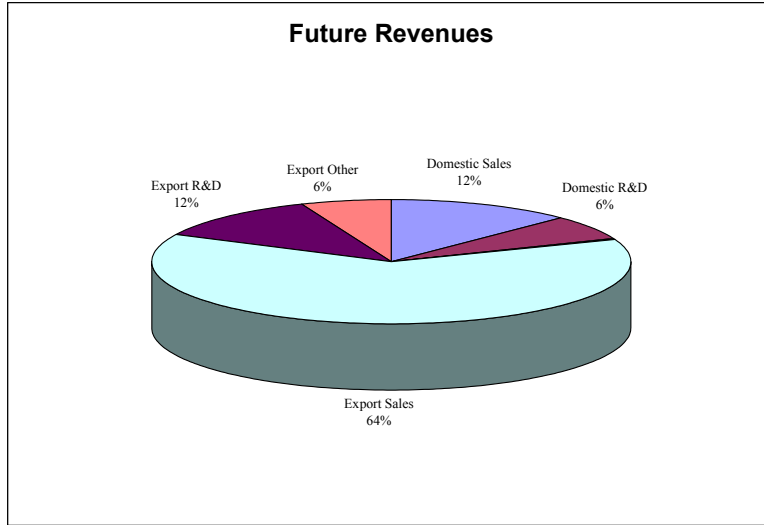


**Exhibit II-5**

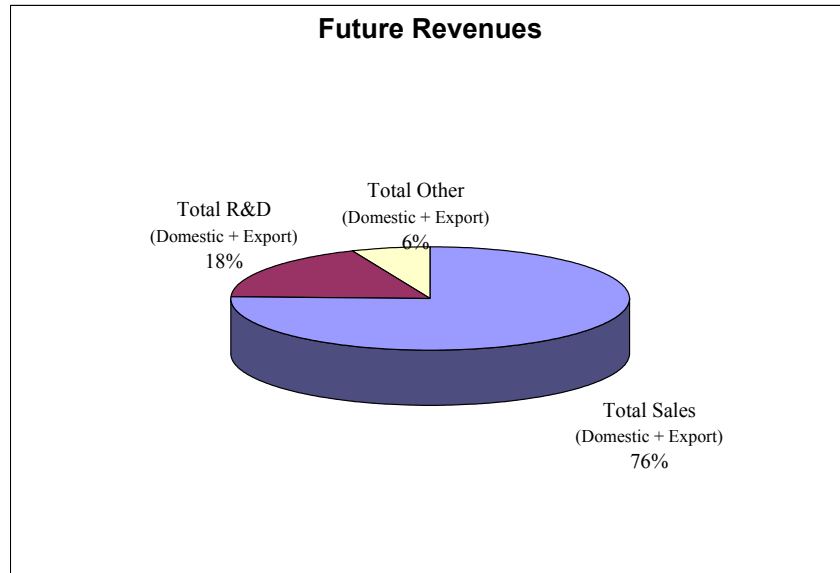
SMEs generate the majority of the current revenue, with 53% of the total.

Using the same methodology as for current revenues, Exhibit II-6 demonstrates that future (2002-2003) revenues in the hydrogen and/or fuel cell industry are projected at approximately \$165.2M. Nineteen percent (19%) of the projected revenue is domestic, while eighty-one percent (81%) is based on exports.

As can be seen in Exhibit II-7, projected revenues are predominately earned from equipment sales (76%), while 18% is from R&D and 2% from other services.



**Exhibit II-6**



**Exhibit II-7**

Exhibit II-8 clearly demonstrates that the western region, with \$103.9 M or (63% of total revenue) dominates the revenue generation in this market. These results are expected given that the majority of the respondents (57%) are from the west.

SMEs will generate 64% of the total projected revenue. This is an increase of 11%.

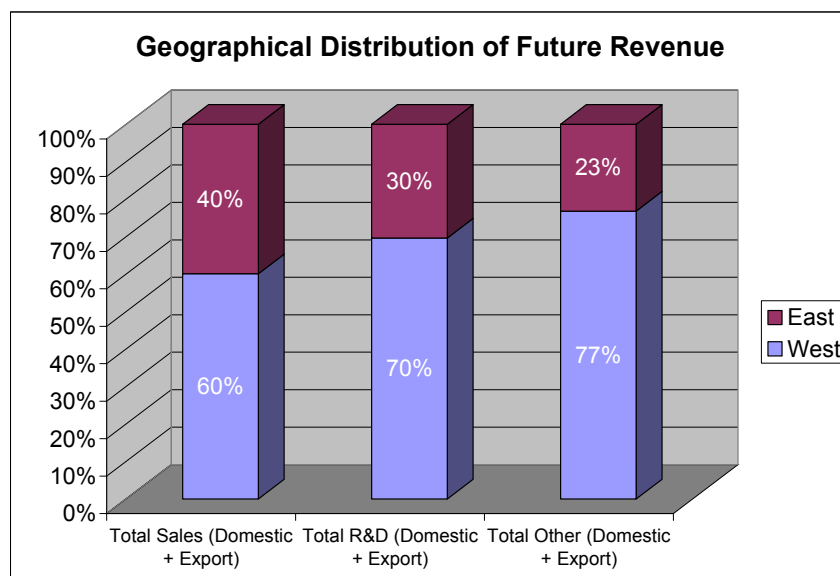


Exhibit II-8

Exhibit II-9 summarizes the trends in revenue growth.

Exhibit II-9

		Current (2001) \$	Projected (2003) \$	Growth / (Decline) \$	Growth / (Decline) (%)
<b>Revenue</b>	Domestic Revenue	\$17.1 M	\$ 31.4 M	\$14.3 M	84%
	Export Revenue	\$79.8 M	\$133.7 M	\$53.9 M	68%
	<b>Total Revenue</b>	<b>\$96.9 M</b>	<b>\$165.1 M</b>	<b>\$68.2 M</b>	<b>70%</b>
<b>Sales</b>	Domestic Sales	\$ 8.5 M	\$ 20.4 M	\$11.9 M	140%
	Export Sales	\$65.6 M	\$104.4 M	\$38.8 M	59%
	<b>Total Sales</b>	<b>\$74.1 M</b>	<b>\$124.8 M</b>	<b>\$50.7 M</b>	<b>68%</b>
<b>R&amp;D</b>	Domestic R&D	\$ 8.2 M	\$10.6 M	\$ 2.4 M	29%
	Export R&D	\$12.6 M	\$19.3 M	\$ 6.7 M	53%
	<b>Total R&amp;D</b>	<b>\$20.8 M</b>	<b>\$29.9 M</b>	<b>\$ 9.1 M</b>	<b>44%</b>
<b>Services</b>	Domestic Services	\$ 0.3 M	\$ 0.4 M	\$ 0.1 M	33%
	Export Services	\$ 2.1 M	\$10.0 M	\$ 7.9 M	376%
	<b>Total Services</b>	<b>\$ 2.4 M</b>	<b>\$10.4 M</b>	<b>\$ 8.0 M</b>	<b>333%</b>

## D. R&D Expenditures

Respondents were requested to quote both current and future R&D expenditures.

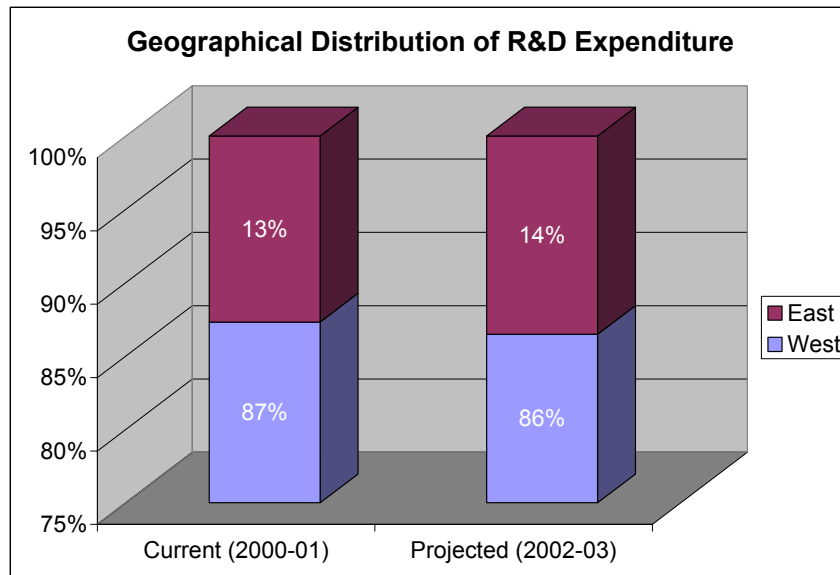
Based on the data received from the twenty-eight respondents, the current R&D expenditures in the hydrogen and/or fuel cell industry were

approximately \$179M; while future R&D expenditures are projected to be \$358M. As a point of reference, total R&D expenditures by the automotive industry in Canada in 2000 were \$203 million.<sup>1</sup>

**Exhibit II-10**

R&D	Current (2001)	Projected (2003)	Growth/ (Decline) (\$)	Growth/ (Decline) (%)
Canadian \$ spent	\$179 M	\$358 M	\$179 M	100%

Exhibit II-11 demonstrates that the distribution of R&D expenditure between east and west remains relatively constant at 13:86.



**Exhibit II-11**

Larger firms, as expected, account for the majority of the R&D expenditure (88:12), however SMEs spending on R&D is expected to increase by 2002-03 (74:26).

## E. Employment Levels

Respondents were requested to identify current and future employment levels, with the workforce being broken out by geographical location (domestic and outside of Canada).

<sup>1</sup> Statistics Canada - Cat. No. 88-202XIB.

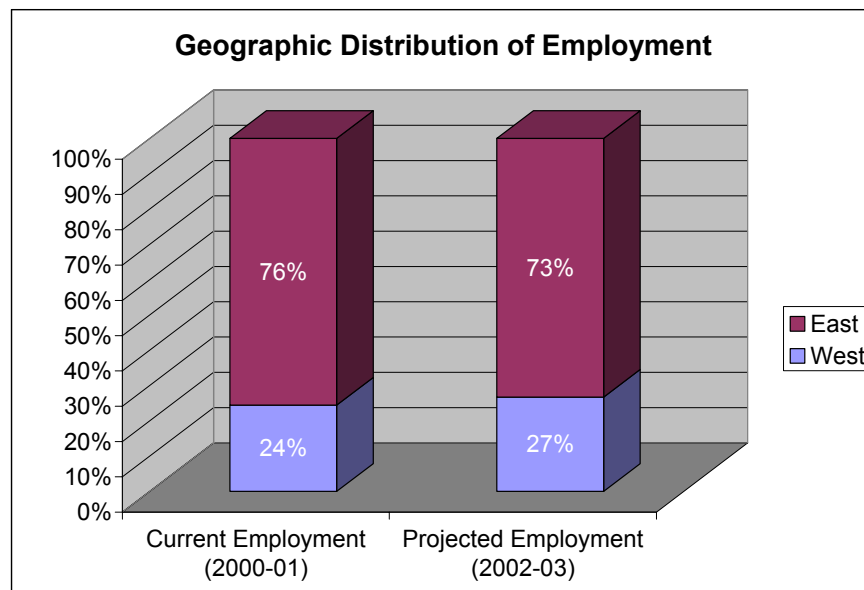
Results indicate a current total employment level of 1,772 full-time equivalents (FTEs) in the hydrogen and/or fuel cell industry, and forecasted future employment of 2,639 FTEs.

For both current and future employment levels, 96% of employment in the hydrogen and fuel cell industry occurs domestically within Canada, while 4% are employed outside of Canada.

**Exhibit II-12**

DIRECT EMPLOYMENT	Current (2001)	Projected (2003)	Growth/ (Decline) (\$)	Growth/ (Decline) (%)
Domestic	1,701.25	2,523.50	822.25	48%
Out-of-Canada	71.00	115.00	44.00	62%
<b>Total</b>	<b>1,772.25</b>	<b>2,638.50</b>	<b>866.25</b>	<b>49%</b>

Exhibit II-13 shows that seventy-six percent (76%) of the current employment is located in the western region of the country, with twenty-four percent (24%) in the east. Seventy-three percent (73%) of the future employment will be located in the western region with twenty-seven percent (27%) in the east.



**Exhibit II-13**

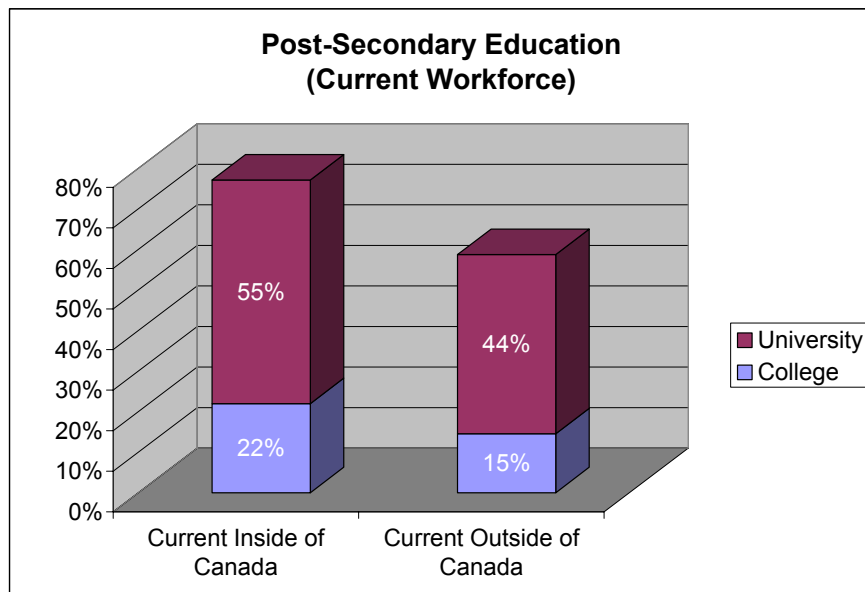
SMEs employ 27% of the current workforce, and 18% of the projected workforce. Larger firms however, employ 73% of the current workforce and 82% of the projected workforce.

## F. Education Levels

Respondents were requested to identify the education levels of those employees involved in the hydrogen and/or fuel cell industry. For those employees with a university education, it was requested that the totals be broken down by degree achieved (undergraduate, Masters, Doctorate), although not all respondents chose to provide this level of detail. Some respondents also chose to provide data based on their entire workforce rather than that in the hydrogen and/or fuel cell industry. Data was therefore extrapolated.

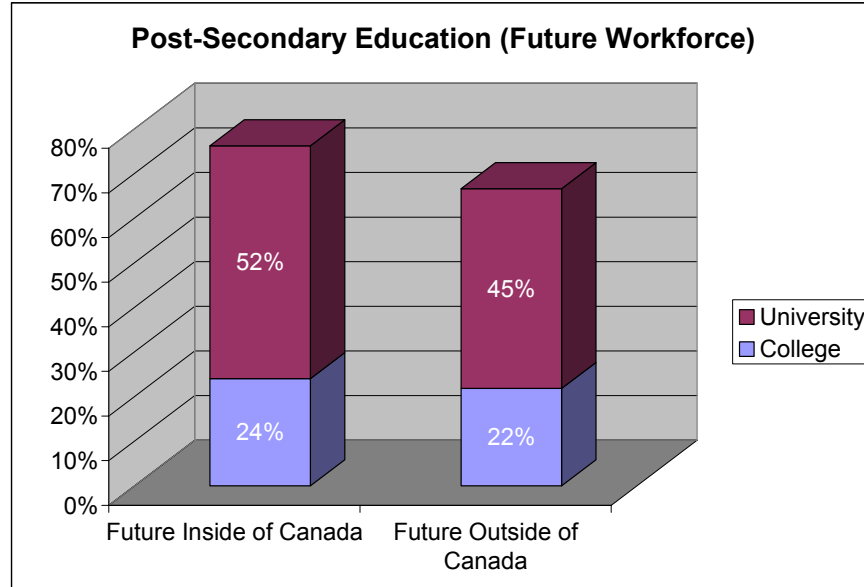
Exhibit II-14 demonstrates that 78% of their current Canadian workforce involved in hydrogen and or fuel cells, have a post-secondary education, while 59% of the workforce in this industry currently employed outside of Canada are educated at post-secondary level.

Sixty-seven percent (67%) of the SME current workforce has a post-secondary education, while 73% of the larger firms' workforce is educated at the same level.



**Exhibit II-14**

Based on future employment levels, it is expected that 77% of the future Canadian workforce in this industry will have a post-secondary education while 63% of the future out-of-Canada workforce will have a post-secondary education, as demonstrated in Exhibit II-15.



**Exhibit II-15**

Sixty-nine percent (69%) of the SME current workforce has a post-secondary education, while 71% of the larger firms' workforce is educated at the same level.

Exhibit II-16 summarizes the trends with respect to education levels of the workforce employed in the hydrogen and fuel cell industry.

**Exhibit II-16**

EDUCATION	Current (2001)	Projected (2003)	Growth/ (Decline) (%)
Domestic – College	22%	24%	1%
Domestic -University	55%	52%	(3%)
<b>Total Domestic Post-Secondary</b>	<b>78%</b>	<b>77%</b>	<b>(1%)</b>
Outside of Canada – College	15%	22%	7%
Outside of Canada – University	44%	45%	1%
<b>Total Post-Secondary Outside of Canada -</b>	<b>59%</b>	<b>63%</b>	<b>4%</b>
<b>Total Post-Secondary</b>	<b>69%</b>	<b>70%</b>	<b>1%</b>





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## III. CONCLUSIONS

### A. Products and Services

Of all the products and services, most firms are involved in providing engineering services. The distribution of firms providing equipment sales versus hydrogen related services however, indicates that most firms provide equipment sales.

### B. Revenues

Revenue growth is estimated at \$68.2M or 70% over the current year. This is quite significant and demonstrates a positive commitment by industry towards the hydrogen and fuel cell industry. Domestic revenue accounts for only 20% of the total revenue, whereas exports are significantly higher at 80%. However, at 84%, domestic revenues are growing faster than exports at 68%.

Although sales and R&D revenues are both growing at very respectable rates (68% and 44% respectively), the provision of services is the mainstay of the revenue growth at 333%. Of that growth in services, the majority of it is in exports (376% growth), while domestic services are growing at a modest 33%. Almost all of the services revenue is from exports (96%), and although this is the predominant growth area, the majority of the revenue continues to be generated by equipment sales. Of note is that although the significant sales revenue is comprised predominantly of exports (80%) the growth rate of domestic sales revenue is more than double that of exports.

Using the employment figures provided in Section II, current revenue per employee is \$54,657 while future revenue per employee is expected to be \$62,595. This represents a 15% growth over current levels.

The majority of the revenue is earned by firms located in the western region of Canada although the eastern region is becoming more active. Of interest are the geographical trends from current year to the projected future year of 2003. The geographical ratio of total equipment sales drops from 71:29 (West/East) to 60:40. Whereas R&D Revenue has increased from 63:37 (West/East) to 70:30, and Services Revenue has dropped from 91:9 (West/East) to 77:23. Previously noted was the dramatic growth in services revenue. We can conclude that although the firms in the west continue to dominate the Services sector, firms in the east are realizing the potential in this area and are switching focus to follow suit.

Also of note is that SMEs account for the majority of the revenue generation in this industry. SMEs currently generate 53% of the revenue, and this trend rises to 64% based on projected revenues. SME Revenue/FTE rises from \$0.1M to \$0.2M while larger firm revenue/FTE declines from \$0.04/\$0.03. SMEs are therefore deemed to be more productive in terms of revenue/FTE than larger firms.

## C. R&D Expenditures

By 2003, R&D expenditure is expected to double. Current R&D expenditures (\$179 million) represent 185% of revenues, and future R&D expenditures represent 217% of revenues. This represents a significant increase in investment in R&D.

Current R&D expenditures of \$179 million compare with \$203 million in total R&D expenditures by the automobile industry in Canada.

R&D expenditure per employee has increased \$34,761 or 34% from \$100,989 to \$135,750

The distribution of R&D expenditure between east and west remains relatively constant at 14:86 (east/west). This demonstrates the continued commitment of western firms to grow the hydrogen and fuel cell industry.

Larger firms account for the majority of the R&D expenditure (88% of total current R&D expenditures). This is not surprising as larger firms have more available resources than do SMEs. Projected R&D expenditures demonstrate that larger firms continue to account for the majority of the R&D expenditure, although a drop to 74% indicates that SMEs are expected to spend more in future years.

## D. Industry Size

The size of the Canadian hydrogen and fuel cell industry is captured by summing the Total Revenues and Total R&D Expenditures, and is demonstrated in Exhibit III-1.

**Exhibit III-1**

	<b>Current Year (2000-01)</b>	<b>Next Year (2002-03)</b>	<b>Growth / (Decline)</b>	<b>Growth / (Decline) (%)</b>
Total Revenue	\$ 96.9 M	\$165.1 M	\$ 68.2 M	70%
Total R&D Expenditure	\$179.0 M	\$358.0 M	\$179.0 M	100%
<b>Total Industry Size</b>	<b>\$275.9 M</b>	<b>\$523.1 M</b>	<b>\$247.2 M</b>	<b>90%</b>

The industry is growing at a rate of 90% from \$275.9M to \$523.1M. This is quite significant and demonstrates potential.

Using the industry totals provided in Section III E (above), current direct economic impact (revenue + R&D expenditure) per employee is \$155,625 while future direct economic impact per employee is \$198,345. This represents a 27% growth over current levels.

## **E. Employment**

Employment levels are expected to grow at 49% over current levels.

The 96:4 split between domestic employment and that outside of Canada is not expected to change.

Of note is that currently, 76% of the employment is located in the western region of Canada, which generates 70% of the current revenue. Projections for future revenues indicate that 63% is generated in the West while 73% of the employment is located in this same region. This is a reduction indicating that although employment levels are dropping slightly in the West, revenues for that region are dropping more, and more revenue per employee is being generated in the eastern region.

Not surprisingly, a small percentage of the firms (larger firms) employ the majority of the workforce. Large firms currently employ 73% of the workforce, and it is projected that they will employ 82% of the workforce by 2002-03. Both large and SME firms however, predict increased employment generation.

## **F. Education**

Approximately 78% of the Canadian workforce holds a post-secondary education, whereas 61% of the non-domestic workforce holds the same credentials. This indicates that although the workforce as a whole is highly educated (70%), the domestic workforce in this industry is more educated than that outside of Canada

This level does not vary significantly when comparing the current versus future workforce.

For every community college educated employee in Canada, 2.6 university graduates are currently hired. This number drops to 2.2 university graduates in 2003. In the out-of-Canada market, for every college graduate, 2.2 university graduates are currently hired. This

number also drops, to 1.9 in 2003. This demonstrates a trend toward hiring more college graduates as a percentage of the workforce.

For every community college educated employee employed by a Canadian based SME, 1.63 university graduates are hired. This number increases to 2.26 in 2003. Large firms however indicate ratios of 1:1.3 to 1:1.96. This demonstrates a trend in both SMEs and larger firms, to hiring more university graduates as a percentage of their respective workforces.

The trend in the out-of-Canada market however is not the same as within Canada. For every community college educated out-of-Canada SME employee, 8.5 university graduates are hired. In 2002-03 however, only 2.23 university graduates are hired. Large firms however employ 0.8 university graduates for every college employee, but this number increases to 1.5 in 2002-03. This indicates that SMEs will be hiring more college graduates than university graduates for posting outside of Canada, while the reverse is expected for larger firms.

As a total workforce, SMEs indicate an 11% growth in post-secondary educated staff while the percentage within larger firms is expected to remain constant.

## G. SUMMARY OF INDICATORS

### Exhibit III-2

PRODUCTS AND SERVICES				
Top four industrial activities	Engineering Services	Hydrogen Production Equipment	Testing Equipment	Fuel cell stacks
Distribution of Activity (frequency)	7 % in 0 production activities (R&D only)	21 % in 1 activity only	51 % in 2-5 activities	21 % in 6-10 activities
Distribution of Firms surveyed by geographic area	6% of firms in Alberta; 38% in British Columbia, 6% in Manitoba; 29% in Ontario; 15% in Quebec; 3% in Saskatchewan; 6% in Nova Scotia			

REVENUE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Domestic Total	\$17.1 M	\$ 31.4M	▲ \$14.3 M	▲ 84%
Export Total	\$79.8 M	\$133.7 M	▲ \$53.9 M	▲ 68%
<b>Total Revenue</b>	<b>\$96.9 M</b>	<b>\$165.1 M</b>	<b>▲ \$68.2 M</b>	<b>▲ 70%</b>
Total Domestic Revenue as % of Total Revenue	18%	19%		▲ 1%
Total Export Revenue as a % of Total Revenue	82%	81%		▼ 1%
Western Revenue as % of Total Revenue	70%	63%		▼ 7%
Eastern Revenue as % of Total Revenue	30%	37%		▲ 7%
Domestic Sales	\$ 8.5 M	\$ 20.4 M	▲ \$11.9 M	▲ 140%
Export Sales	\$65.6 M	\$104.4 M	▲ \$33.8 M	▲ 59%
<b>Total Sales</b>	<b>\$74.1 M</b>	<b>\$124.8 M</b>	<b>▲ \$50.7 M</b>	<b>▲ 68%</b>
Domestic Sales as a % of Total Sales	11%	16%		▲ 5%
Export Sales as a % of Total Sales	89%	84%		▼ 5%

### Exhibit III-2 (Cont'd.)

REVENUE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Total Sales as a % of Total Revenue	76%	76%		-
Western Sales as a % of Total Sales Revenue	71%	60%		▼ 11%
Eastern Sales as a % of Total Sales Revenue	29%	40%		▲ 11%
Domestic R&D	\$ 8.2 M	\$10.6 M	▲ \$ 2.4 M	▲ 29%
Export R&D	\$12.6 M	\$19.3 M	▲ \$ 6.7 M	▲ 53%
<b>Total R&amp;D</b>	<b>\$20.8 M</b>	<b>\$29.9 M</b>	<b>▲ \$ 9.1 M</b>	<b>▲ 44%</b>
Domestic R&D as a % of Total R&D	39%	35%		▼ 4%
Export R&D as a % of Total R&D	61%	65%		▲ 4%
R&D Revenue as a % of Total Revenue	22%	18%		▼ 4%
Western R&D Revenue as a % of Total R&D Revenue	63%	70%		▲ 7%
Eastern R&D Revenue as a % of Total R&D Revenue	37%	30%		▼ 7%
Domestic Service	\$0.3 M	\$ 0.4 M	▲ \$ 0.1 M	▲ 33%
Export Service	\$2.1 M	\$10.0 M	▲ \$ 7.9 M	▲ 376%
<b>Total Service</b>	<b>\$2.4 M</b>	<b>\$10.4 M</b>	<b>▲ \$ 8.0 M</b>	<b>▲ 333%</b>
Domestic Service as a % of Total Service	13%	4%		▼ 9%
Export Service as a % of Total Service	87%	96%		▲ 9%
Service Revenue as a % of Total Revenue	2%	6%		▲ 4%
Western Service as a % of Total Service Revenue	91%	77%		▼ 14%
Eastern Service as a % of Total Service Revenue	9%	23%		▲ 14%
Domestic Revenue per FTE	\$0.010 M	\$0.012 M	▲ \$0.002 M	▲ 20%
Export Revenue per FTE	\$0.045 M	\$0.051 M	▲ \$0.006 M	▲ 13%
<b>Total Revenue per FTE</b>	<b>\$0.055 M</b>	<b>\$0.063 M</b>	<b>▲ \$0.008 M</b>	<b>▲ 15%</b>

R&D EXPENDITURE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Canadian R&D Expenditure (total)	\$179.0 M	\$358.2 M	▲ \$179.2 M	▲ 100%
R&D Expenditure as a % of Total Revenue	185%	217%		▲ 32%
R&D Expenditure as a % of Total Sales	242%	287%		▲ 45%
R&D Expenditure per FTE	\$0.101 M	\$0.136 M	▲ \$0.035 M	▲ 34%
Western R&D Exp. as a % of Total R&D Expenditure	87%	86%		▼ 1%
Eastern R&D Exp. as a % of Total R&D Expenditure	13%	14%		▲ 1%

INDUSTRY SIZE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Revenue + R&D Expenditure	\$275.9 M	\$523.1 M	▲ \$247.2 M	▲ 90%
Industry size per employee	\$0.156 M	\$0.198 M	▲ \$0.042 M	▲ 27%

EMPLOYMENT	Current (2001)	Projected (2003)	Growth / Decline	Trend
Domestic jobs	1701	2524	▲ 823	▲ 48%
Out-of-country jobs	71	115	▲ 44	▲ 62%
<b>Total workforce generated by Cdn. Firms</b>	<b>1772</b>	<b>2639</b>	<b>▲ 867</b>	<b>▲ 49%</b>
% of workforce in Canada	96%	96%		-
% of workforce out-of Canada	4%	4%		-
% of workforce generated by Western firms	76%	73%		▼ 3%
% of workforce generated by Eastern firms	24%	27%		▲ 3%
Western Revenue per FTE	\$0.038 M	\$0.039 M	▲ \$0.006 M	▲ 16%
Eastern Revenue per FTE	\$0.017 M	\$0.023 M	▲ \$0.006 M	▲ 35%

EDUCATION	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
% of Total Workforce with college diploma	19%	22%		▲ 3%
% of Total Workforce with university degree	50%	48%		▼ 2%
<b>% of Total Workforce with Post-Secondary</b>	<b>69%</b>	<b>70%</b>		<b>▲ 1%</b>
% of domestic workforce with college diploma	22%	24%		▲ 2%
% of domestic workforce with university degree	55%	52%		▼ 3%
<b>% of domestic workforce with post-secondary educ.</b>	<b>78%</b>	<b>77%</b>		<b>▼ 1%</b>
% of out of country workforce with college diploma	15%	22%		▲ 7%
% of out of country workforce with university degree	44%	45%		▲ 1%
<b>% of out-of country workforce with post-secondary</b>	<b>59%</b>	<b>63%</b>		<b>▲ 4%</b>
Ratio of domestic college: university	1 : 2.6	1 : 2.2		▼ 15%
Ratio of out-of-country college: university	1 : 2.2	1 : 1.9		▼ 14%

### Exhibit III-3. Firms with Current Employment Levels of Less than or Equal to 100 (SMEs)

SME FIRMS	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
# of SME firms	23	19	▼ 4	▼ 17%
% of SME firms as a % of total number of firms	82%	68%		▼ 17%

PRODUCTS AND SERVICES				
Top four industrial activities	Engineering Services	Hydrogen Production Equipment	Testing Equipment	Electrical Components
Distribution of Activity (frequency)	9% in 0 activities	17% in 1 activity only	52% in 2-5 activities	22% in 6-10 activities
Distribution of Firms surveyed by geographic area	Current: Alberta 4%; BC 35%; Manitoba 9%; Nova Scotia 4%; Ontario 35%; Quebec 9%; Saskatchewan 4% Projected: Alberta 5%; BC 32%; Manitoba 11%; Nova Scotia 5%; Ontario 32%; Quebec 11%; Saskatchewan 5%			

REVENUE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Domestic SME Total Revenue	\$10.0 M	\$16.7 M	▲ \$6.7 M	▲ 67%
Export SME Total Revenue	\$41.6 M	\$85.2 M	▲ \$43.6 M	▲ 105%
<b>Total SME Revenue</b>	<b>\$51.6 M</b>	<b>\$101.9 M</b>	<b>▲ \$50.3M</b>	<b>▲ 97%</b>
Total Domestic SME Revenue as % of Total SME Revenue	19%	16%		▼ 3%
Total Export SME Revenue as a % of Total SME Revenue	81%	84%		▲ 3%
Domestic SME Sales	\$1.9 M	\$8.2 M	▲ \$6.3 M	▲ 332%
Export SME Sales	\$27.3 M	\$60.1 M	▲ \$32.8 M	▲ 120%
<b>Total SME Sales</b>	<b>\$29.2 M</b>	<b>\$68.3 M</b>	<b>▲ \$39.1 M</b>	<b>▲ 134%</b>
Domestic SME Sales as a % of Total SME Sales	7%	12%		▲ 5%
Export SME Sales as a % of Total SME Sales	93%	88%		▼ 5%
Total SME Sales as a % of Total SME Revenue	57%	67%		▲ 10%
SME Sales as a % of Total Sales Revenue	40%	55%		▲ 15%
Domestic SME R&D	\$7.8 M	\$8.0 M	▲ \$0.2 M	▲ 3%
Export SME R&D	\$12.1 M	\$15.1 M	▲ \$3.0 M	▲ 25%
<b>Total SME R&amp;D</b>	<b>\$19.9 M</b>	<b>\$23.1 M</b>	<b>▲ \$3.2 M</b>	<b>▲ 16%</b>
Domestic SME R&D as a % of Total SME R&D	39%	35%		▼ 4%
Export SME R&D as a % of Total SME R&D	61%	65%		▲ 4%
SME R&D Revenue as a % of Total SME Revenue	39%	23%		▼ 16%
SME R&D Revenue as a % of Total R&D Revenue	95%	77%		▼ 18%
Domestic SME Service	\$0.3 M	\$0.4 M	▲ \$0.1 M	▲ 33%
Export SME Service	\$2.1 M	\$10.0 M	▲ \$7.9 M	▲ 376%
<b>Total SME Service</b>	<b>\$2.4 M</b>	<b>\$10.4 M</b>	<b>▲ \$8.0 M</b>	<b>▲ 333%</b>
Domestic SME Service as a % of Total SME Service	12%	4%		▼ 8%
Export SME Service as a % of Total SME Service	88%	96%		▼ 8%
SME Service Revenue as a % of Total SME Revenue	4%	10%		▲ 6%
SME Service Revenue as a % of Total Service Revenue	100%	100%		-
Domestic SME Revenue per SME FTE	\$0.021 M	\$0.036 M	▲ \$0.015 M	▲ 71%
Export SME Revenue per SME FTE	\$0.086 M	\$0.189 M	▲ \$0.103 M	▲ 120%
<b>Total SME Revenue per SME FTE</b>	<b>\$0.106 M</b>	<b>\$0.220</b>	<b>▲ \$0.115 M</b>	<b>▲ 109%</b>
SME Revenue as a % of Total Revenue	53%	64%		▲ 11%

R&D EXPENDITURE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Canadian SME R&D Expenditure	\$21.8 M	\$92.1 M	▲ \$70.3 M	
SME R&D Expenditure as a % of Total R&D Expenditure	12%	26%		▲ 14%
SME R&D Expenditure as a % of Total SME Revenue	42%	90%		▲ 48%
SME R&D Expenditure as a % of Total SME Sales	75%	135%		▲ 60%
SME R&D Expenditure per SME FTE	\$0.045 M	\$0.199 M	▲ \$0.154M	▲ 342%

### Exhibit III-3. Firms with Current Employment Levels of Less than or Equal to 100 (SMEs) (Cont'd.)

INDUSTRY SIZE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
SME Revenue + SME R&D Expenditure	\$73.4 M	\$194.0 M	▲ \$120.6 M	▲ 164%
SME Industry size per SME employee	\$0.132 M	\$0.208 M	▲ \$0.076 M	▲ 576%
SME % of Total Industry	26%	37%		▲ 11%

EMPLOYMENT	Current (2001)	Projected (2003)	Growth / Decline	Trend
% of total workforce employed by SMEs	27%	18%		▼ 9%
SME Domestic jobs	475.25	456.50	▼ 18.75	▼ 4%
SME Out-of-country jobs	11.00	7.00	▼ 4.00	▼ 36%
<b>Total workforce generated by SME Cdn. Firms</b>	<b>486.25</b>	<b>463.50</b>	<b>▼ 22.75</b>	<b>▼ 5%</b>
% of SME workforce in Canada	98%	98%		-
% of SME workforce out-of Canada	2%	2%		-
% of total domestic workforce employed by SMEs	28%	18%		▼ 10%
% of total out-of country workforce employed by SMEs	15%	6%		▼ 9%
Average SME jobs per SME firm	21.14	24.39	▲ 3.25	▲ 15%
Ratio of SME firms to total workforce (% SME firms : % workforce) ie 82% of firms generate 27% of total jobs	82:27 or 1:0.33	68:18 or 1:0.26		▼ 21%

EDUCATION	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
% of Total SME Workforce with college diploma	13%	23%		▲ 10%
% of Total SME Workforce with university degree	41%	51%		▲ 10%
<b>% of Total SME Workforce with Post-Secondary</b>	<b>67%</b>	<b>69%</b>		<b>▲ 2%</b>
% of SME domestic workforce with college diploma	19%	23%		▲ 4%
% of SME domestic workforce with university degree	31%	52%		▲ 21%
<b>% of SME domestic workforce with post-secondary education</b>	<b>77%</b>	<b>76%</b>		<b>▼ 1%</b>
% of SME out of country workforce with college diploma	6%	22%		▲ 16%
% of SME out of country workforce with university degree	51%	49%		▼ 2%
<b>% of SME out-of country workforce with post-secondary</b>	<b>51%</b>	<b>62%</b>		<b>▲ 11%</b>
Ratio of SME domestic college: university	1:1.63	1:2.26		▲ 39%
Ratio of SME out-of-country college: university	1:8.5	1:2.23		▼ 74%

### Exhibit III-4. Firms with Current Employment Levels of More than 100 (Large)

SME FIRMS	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
# of Large firms	5	9	▲ 4	▲ 80%
% of Large firms as a % of total number of firms	18%	32%		▲ 14%

PRODUCTS AND SERVICES				
Top four industrial activities	Fuel Cell Engines	Fuel Cell Stack	Fuel Cell Power Generators	Purification Systems
Distribution of Activity (frequency)	0% in 0 activities	40% in 1 activity only	40% in 2-5 activities	20% in 6-10 activities
Distribution of Firms surveyed by geographic area	Current: Alberta 20%; BC 60%; Ontario 20% Projected: Alberta 11%; BC 56%; Ontario 33%			

REVENUE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Domestic Large Total Revenue	\$7.1 M	\$14.8 M	▲ \$7.7 M	▲ 108%
Export Large Total Revenue	\$38.7 M	\$48.6 M	▲ \$9.9 M	▲ 26%
<b>Total Large Revenue</b>	<b>\$45.8 M</b>	<b>\$63.4 M</b>	<b>▲ \$17.6M</b>	<b>▲ 38%</b>
Total Domestic Large Revenue as a % of Total Large Revenue	16%	23%		▲ 7%
Total Export Large Revenue as a % of Total Large Revenue	84%	77%		▼ 7%
Domestic Large Sales	\$6.6 M	\$12.2 M	▲ \$5.6 M	▲ 85%
Export Large Sales	\$38.2 M	\$44.4 M	▲ \$6.2 M	▲ 16%
<b>Total Large Sales</b>	<b>\$44.8 M</b>	<b>\$56.6 M</b>	<b>▲ \$11.8 M</b>	<b>▲ 26%</b>
Domestic Large Sales as a % of Total Large Sales	15%	22%		▲ 7%
Export Large Sales as a % of Total Large Sales	85%	78%		▼ 7%
Total Large Sales as a % of Total Large Revenue	98%	89%		▼ 9%
Large Sales as a % of Total Sales Revenue	60%	45%		▼ 15%
Domestic Large R&D	\$0.5 M	\$2.6 M	▲ \$2.1 M	▲ 420%
Export Large R&D	\$0.5M	\$4.2 M	▲ \$3.7 M	▲ 740%
<b>Total Large R&amp;D</b>	<b>\$1.0 M</b>	<b>\$6.8 M</b>	<b>▲ \$5.8 M</b>	<b>▲ 580%</b>
Domestic Large R&D as a % of Total Large R&D	50%	38%		▼ 12%
Export Large R&D as a % of Total Large R&D	50%	62%		▲ 12%
Large R&D Revenue as a % of Total Large Revenue	2%	11%		▲ 9%
Large R&D Revenue as a % of Total R&D Revenue	5%	23%		▲ 18%
Domestic Large Service	\$0.01 M	\$0.02 M	▲ \$0.01 M	▲ 100%
Export Large Service	\$0 M	\$0.01 M	▲ \$0.01 M	
<b>Total Large Service</b>	<b>\$0.01 M</b>	<b>\$0.03 M</b>	<b>▲ \$0.02 M</b>	<b>▲ 200%</b>
Domestic Large Service as a % of Total Large Service	100%	67%		▼ 33%
Export Large Service as a % of Total Large Service	0%	33%		▲ 33%
Large Service Revenue as a % of Total Large Revenue	0%	0%		-
Large Service Revenue as a % of Total Service Revenue	0%	0%		-
Domestic Large Revenue per Large FTE	\$0.006 M	\$0.007	▲ \$0.001 M	▲ 17%
Export Large Revenue per Large FTE	\$0.030 M	\$0.022 M	▼ \$0.008 M	▼ 27%
<b>Total Large Revenue per Large FTE</b>	<b>\$0.036 M</b>	<b>\$0.029</b>	<b>▼ \$0.007 M</b>	<b>▼ 19%</b>
Large Revenue as a % of Total Revenue	47%	36%		▼ 11%

R&D EXPENDITURE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Canadian Large R&D Expenditure	\$157.2 M	\$266.1 M	▲ \$108.9 M	▲ 69%
Large R&D Expenditure as a % of Total R&D Expenditure	88%	74%		▼ 14%
Large R&D Expenditure as a % of Total Large Revenue	343%	420%		▲ 77%
Large R&D Expenditure as a % of Total Large Sales	351%	470%		▲ 119%
Large R&D Expenditure per Large FTE	\$0.122 M	\$0.122 M	-	-



### Exhibit III-4. Firms with Current Employment Levels of More than 100 (Large) (Cont'd.)

INDUSTRY SIZE	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
Large Revenue + Large R&D Expenditure	\$203.0 M	\$329.5 M	▲ \$126.5 M	▲ 62%
Large Industry size per Large employee	\$0.158 M	\$0.151 M	▼ 0.007 M	▲ 4%
Large % of Total Industry	73%	63%		▼ 10%

EMPLOYMENT	Current (2001)	Projected (2003)	Growth / Decline	Trend
% of total workforce employed by Large firms	73%	82%		▲ 9%
Large Domestic jobs	1226	2067	▲ 841	▲ 69%
Large Out-of-country jobs	60	108	▲ 48	▲ 80%
<b>Total workforce generated by Large Cdn. Firms</b>	<b>1286</b>	<b>2175</b>	<b>▲ 889</b>	<b>▲ 69%</b>
% of Large workforce in Canada	95%	95%		-
% of Large workforce out-of Canada	5%	5%		-
% of total domestic workforce employed by Large firms	72%	82%		▲ 10%
% of total out-of country workforce employed by Large firms	85%	94%		▲ 9%
Average Large jobs per Large firm	257.2	229.7	▼ 27.5	▼ 11%
Ratio of Large firms to total workforce (% Large firms : % workforce) ie 18% of firms generate 73% of jobs	18 : 73 or 1:4.055	32 : 82 or 1:2.563		▼ 37%

EDUCATION	Current (2001)	Projected (2003)	Growth / (Decline)	Trend
% of Total Large Workforce with college diploma	36%	25%		▼ 11%
% of Total Large Workforce with university degree	38%	48%		▲ 10%
<b>% of Total Large Workforce with Post-Secondary</b>	<b>73%</b>	<b>71%</b>		▼ 2%
% of Large domestic workforce with college diploma	36%	27%		▼ 9%
% of Large domestic workforce with university degree	47%	53%		▲ 6%
<b>% of Large domestic workforce with post-secondary education</b>	<b>83%</b>	<b>79%</b>		▼ 4%
% of Large out of country workforce with college diploma	35%	22%		▼ 13%
% of Large out of country workforce with university degree	28%	42%		▲ 14%
<b>% of Large out-of country workforce with post-secondary</b>	<b>63%</b>	<b>63%</b>		-
Ratio of Large domestic college: university	1:1.3	1:1.96		▲ 51%
Ratio of Large out-of-country college: university	1:0.8	1:1.5		▲ 88%







**APPENDIX A**  
**COMPANIES SURVEY WAS SENT TO**



**APPENDIX A**  
**Canadian Companies Survey Was Sent To**

1. Agile Systems	Ontario
2. Armstrong Monitoring	Ontario
3. ASA Automated Systems	British Columbia
4. Ballard Power Systems	British Columbia
5. BC Hydro	British Columbia
6. Cellex Power Products Inc.	British Columbia
7. Du Pont Canada	Ontario
8. Dynetek Industries Ltd.	Alberta
9. Fuel Cell Technologies Ltd.	Ontario
10. Fuel Maker Corp.	Ontario
11. General Hydrogen	British Columbia
12. GFI Control Systems	Ontario
13. Global Thermoelectric	Alberta
14. Les Entreprises H (H Power)	Quebec
15. Hydro Quebec	Quebec
16. Hydrogen Systems	Quebec
17. Hydrogenics Inc.	Ontario
18. K. B. Electronics	Nova Scotia
19. Kinectrics Inc.	Ontario
20. Kraus Group Inc.	Manitoba
21. Lightyear Technologies	British Columbia
22. Manitoba Hydro	Manitoba
23. Methanex Corporation	British Columbia
24. NEXCEL Power Systems	British Columbia
25. Ontario Power Generation	Ontario
26. PALCAN Fuel Cell Co. Ltd.	British Columbia
27. Powertech Labs Inc.	British Columbia
28. Questair Industries	British Columbia
29. SHEC Labs	Saskatchewan
30. Stuart Energy Systems	Ontario
31. TEKTREND	Quebec
32. Tisec Inc.	British Columbia
33. Xantrex	British Columbia
34. XCELLSiS	British Columbia









**APPENDIX B**  
**COVER LETTER AND QUESTIONNAIRE**



Dear XXX.

Natural Resources Canada's (NRCan's) CANMET Energy Technology Centre (CETC) has for many years supported and promoted the development of a hydrogen and fuel cell industry. In partnership arrangements, we have assisted many companies in the shared funding of R&D, the exchange of scientific information, and the development of federal policies supporting this new industry. We are now conducting a study to determine the economic benefits that hydrogen and fuel cell companies are contributing to Canada. The information will be used by NRCan to assess the impacts of its R&D program and to provide input into future policy development, potentially leading to increased government support in this area.

We have retained Sypher:Mueller International (Sypher) to conduct a brief evaluation of Canadian industrial firms to determine their current and projected levels of revenue and employment. Their evaluation questionnaire is attached.

We would appreciate your time and effort to complete the 2-page questionnaire and return it to Sypher at [dmillar@sypherintl.com](mailto:dmillar@sypherintl.com) by the 15<sup>th</sup> of May. All information that is submitted to Sypher will be treated in strict confidence. Sypher will only prepare aggregate summaries and will not release individual company information to anyone including CETC.

If you have any questions please do not hesitate to contact either Sypher or CETC as shown below.

Your cooperation and contribution is very much appreciated.

Yours sincerely,

Nick Beck, Chief  
Transportation Energy Technology  
CANMET Energy Technology Centre

CETC Contact:

Rodney Semotiuk  
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Fax: 613-996-9416  
Email: [rsemotiu@nrcan.gc.ca](mailto:rsemotiu@nrcan.gc.ca)

Sypher Contacts:

Matthew Bol;  
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[dmillar@sypherintl.com](mailto:dmillar@sypherintl.com)









## NRCan Evaluation of the Economic Benefits of the Hydrogen and Fuel Cell Industry

### 1. Products and Services

Please check off all products and/or services related to hydrogen and/or fuel cells provided by your company.

<input type="checkbox"/> Fuel Cell Stack	<input type="checkbox"/> Testing Equipment	<input type="checkbox"/> Fuel Cell Engines
<input type="checkbox"/> Fuel Cell Power Generators	<input type="checkbox"/> Fuel Cell Materials	<input type="checkbox"/> H <sub>2</sub> Fuelling Equipment
<input type="checkbox"/> Pressure Devices and Regulators	<input type="checkbox"/> Electrical Components	<input type="checkbox"/> Engineering Services
<input type="checkbox"/> H <sub>2</sub> Production Equipment	<input type="checkbox"/> Purification Systems	<input type="checkbox"/> Standard Development
<input type="checkbox"/> Evaluation & Certification Services	<input type="checkbox"/> H <sub>2</sub> Storage Products	<input type="checkbox"/> Safety Products
<input type="checkbox"/> Other (specify):	<input type="checkbox"/> Other (specify):	<input type="checkbox"/> Other (specify):

### 2. Current Revenues (related to hydrogen and/or fuel cells)

Please indicate your revenues for 2000, or for your most recent fiscal year, in the box below. If exact figures delineating your total revenues are not readily available, please provide percentage estimates.

Current Revenues	Sales of Products (\$ or % of total)	R&D (\$ or %)	Other Services (\$ or %)	Total (\$ or %)
Domestic				
Export				
Total				\$

### 3. Projected Future Revenues (related to hydrogen and/or fuel cells)

Please indicate your company's estimated future level of revenues in 2002, in the box below. If dollar estimates are not available, please provide your best estimates of percentage change from 2000.

Future Revenues	Sales of Products (\$ or %)	R&D (\$ or %)	Other Services (\$ or %)	Total (\$ or %)
Domestic				
Export				
Total				\$

**4. R&D Expenditures** (related to hydrogen and/or fuel cells)

Please indicate your Canadian R&D expenditures for 2000 or for your most recent fiscal year, as well as an estimate for 2002.

	Previous Year (2000)	Next Year (2002)
Dollars Spent (Cdn \$)		

**5. Employment** (related to hydrogen and/or fuel cells)

Please provide the number of full time employees, and part-time equivalents, with your firm currently and your best estimate of employment levels in 2002. If exact figures are unavailable, please provide your best estimate in terms of percentage of total workforce.

	Current Employment			Estimated Employment in 2002		
	In Canada	Outside of Canada	Total	In Canada	Outside of Canada	Total
Total (no. employees)						
%			100%			100%

**6. Education Level of Workforce**

We would also appreciate knowing the breakdown of university and community college-educated staff as a percentage of the workforce.

	Current Employment (No. Employees)		Estimated Employment in 2002 (No. Employees)		TOTALS %
	In Canada	Outside of Canada	In Canada	Outside of Canada	
College Diploma or equivalent					
University Degree - Undergraduate - Masters - Ph.D.					

Please forward your response by e-mail to [dmillar@spherintl.com](mailto:dmillar@spherintl.com). Thank you.

Dianna Millar can also be reached by telephone at (613) 236-4318 (tel) or by fax at (613) 236-4850