NATIONAL RESEARCH COUNCIL HYDROGEN PROGRAMS:

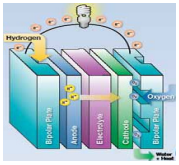
PRODUCTS, SERVICES AND CAPABILITIES

(PRESENTATION NOTES)

July 27, 2010

TABLE OF CONTENTS

1. Growing Market



Research organizations and companies around the world are in a race for solutions for an emerging global energy crisis. Today most economies depend on fossil fuels for electricity and transportation. Rising oil prices and climate change policies encourage investments in renewable sources of energy. Governments have to meet domestic and international obligations in addressing the global warming and climate change issues. The clean or green technologies are considered to be the key solution for these global problems.

A coming energy revolution is known as the “hydrogen economy” and is based on a dramatic new way of producing, delivering and using energy based on the highly efficient fuel cell. Tomorrow’s hydrogen economy can be driven by any energy source, including cleaner-burning natural gas and emissions-free renewable sources of energy. A hydrogen future promises relief from declining cheap oil supplies, climate change and local air pollution.

1.1. Global Industry

Global interest, efforts, investments and commercialization revenues in the traditional clean technologies sectors have grown considerably since coming into the spotlight around 2000. According to the United Nations *Environment Program*, only wind, solar and biofuel companies received about $150 billion in new funding in 2007. Overall, investment in clean energy and energy efficient industries rose 60 percent from 2006 to 2007. By 2020 it is forecasted that the three main clean technology sectors, solar photovoltaic, wind power, and biofuels, will generate revenues of over $300 billion.

Progress in these clean energy sectors has produced promising global opportunities for their commercialization. Solar photovoltaic have currently reached $30 billion and are projected to reach $80 billion by 2020. Wind power is projected to expand from $50 billion in 2009 to $140 billion in 2020. Wind installations represented 40% of new electricity generators brought online in 2008. Biofuels global production and wholesale reached $35 billion in 2009 and is projected to grow to $100 billion by 2020.

In the wave of the demand for the traditional clean technologies, increasing interest and expectations are associated globally with the fuel cell technology, especially in the view of recent advancements in its commercialization and cost reduction. Global fuel cell market projections are in tens of billions of dollars for various types of the fuel cells,

micro, stationary and automotive, which some estimates even going in trillions by 2020. This market is global. The power demand in the world, including China and India, is huge.

A potentially massive global market in hydrogen and fuel cell products projected for this decade. It is foreseen that by 2020, hydrogen and fuel cells would power a significant portion of and used in homes, businesses, industry and transportation. The current technology accomplishments, industry analysis and some relevant estimates predict, for instance, that the fuel cell technology could compete with current conventional technologies in the automotive sector by 2015.

1.2. Target Sectors

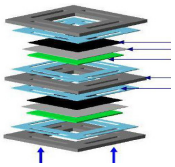
Global transportation sector and personal vehicles are considered to be the largest industry sector for hydrogen and fuel cell technologies. Energy costs in Japan and some parts of Europe are among the highest in the world, and fuel cells are gaining great interest as a possible energy source for homes. In order to offer a practical alternative to coal-fired and natural gas central power plants, fuel cells must reach extremely high levels of efficiency. So, more potential opportunities are expected in designing the more efficient fuel cell systems.

Other major markets for fuel cell products include:

- Remote sites;
- Lift trucks;
- Industrial equipment;
- Residential applications;
- Off-grid and back-up power;
- Military applications;
- Micro-applications (laptops, digital cameras, cell phones).

Canadian companies' advancements in fuel cell research and innovation placed them in exceptionally good position to take advantage of the new green technologies global demand, and hydrogen fuel cell technology in particular. The British Columbia's hydrogen fuel cell technology "cluster" is essentially in most advanced and world leading position to go after these markets.

2. Clear Vision



Through the last two decades, British Columbia and NRC-IFCI have emerged as the global leaders in fuel cell technology industry. BC energy technology companies are starting to export products and services worldwide, and hydrogen fuel will become a major part of the resource-based economy.

With a potentially massive global market in hydrogen and fuel cell products projected for this decade, the *Vision* for the fuel cell technology is to have the world's leading hydrogen economy by 2020, as reflected in the *British Columbia Hydrogen and Fuel Cell Strategy.* It is foreseen that by 2020, hydrogen and fuel cells would power a significant portion of the province, used in homes, businesses, industry and transportation.

Relevant BC *Mission* for the fuel cell technology was reflected in the BC Premier's speech at the Canadian *Hydrogen and Fuel Cell Conference*, in June 2003: "Our goal is to develop the hydrogen and fuel cell sector to make British Columbia the world's leading hydrogen economy by the year 2020." Similar conferences that followed, including the last one held in June 2009 in Vancouver, further expanded on these Vision and Mission.

2.1. Market Opportunities

Traditional clean technologies are based on hydro, wind, solar and biofuel energy sources and cover a diverse range of products, services and processes to reduce the use of natural resources and cut or eliminate emissions and wastes.

Global interest, efforts, investments and commercialization revenues in the traditional clean technologies sectors have grown considerably since coming into the spotlight around 2000. In the wave of the demand for the traditional clean technologies, increasing interest and expectations are associated globally with the fuel cell technology. Global fuel cell market projections are in tens of billions of dollars for various types of the fuel cells, micro, stationary and automotive. This market is global, based on the power demand in the world.

The NRC-IFCI advancements in fuel cell research and innovation placed it in exceptionally good position to take advantage of the new green technologies global demand, and hydrogen fuel cell technology in particular.

2.2. Excellent Positioning

The key objectives to achieve the Vision and deliver on the Mission, as defined in the *British Columbia Hydrogen and Fuel Cell Strategy,* are to be accomplished through the major streams of activities, including:

- Development of a globally leading sustainable Energy Technology Cluster that delivers products and services and secures the high-value jobs;
- Technology demonstrations in vehicles, refueling facilities and stationary power systems, including *Hydrogen Highway* for the time of the 2010 Winter Olympic and Paralympic Games;
- Building and revitalization of *Resource Heartlands* to supply the fuel and know-how for hydrogen-based communities and industries and clean hydrogen production and distribution.

To achieve this vision and objectives the following four priority areas are being championed, funded and receive policy support:

- Securing the BC global leadership through proactive steps by the governments and industry to ensure that BC remains a world centre for sustainable energy technology and expertise;
- Aggressively promoting the technology demonstrations;
- Obtaining sufficient federal, provincial and industry funding;
- Working with the federal government and other provinces to make Canada an early adopter market;
- Developing the world markets through creative partnerships and promoting BC products and services, both domestically and internationally.

3. Successful NRC Program

The Canadian and BC efforts in the fuel cell technology are based on and supported through funding, testing and research by the Federal Government and the NRC. In 2000, NRC launched the *Fuel Cell Program*. The program provides a multi-disciplinary network of NRC research institutes expertise across Canada for fuel cell and hydrogen technologies R&D, testing, evaluation, and demonstration. Federal Government provided over $415 million in 1982-2008.

3.1. Established Position

The British Columbia provincial and Vancouver-area cluster of fuel cell research companies, businesses and university labs started with Ballard Power Systems, in Burnaby in the 1980s. The company is now close to a major breakthrough of the fuel cell technology into the marketplace as its costs drop.

Through the last two decades, British Columbia has emerged as the global leader in fuel cell technology. This technological advantage has led to the development of the world's largest cluster of hydrogen and fuel cell research and development organizations and companies in BC.

The major breakthroughs in the fuel cell technology and current BC position are supported through funding, testing and research by the Federal Government and the National Research Council of Canada. In the center of this research is NRC's Institute for Fuel Cell Innovation focusing on addressing the cost, performance and reliability challenges of hydrogen and fuel cell technologies.

The current BC position is signified by the fact that the local fuel cell cluster holds nearly 70% of roughly 2,000 Canadian jobs in the hydrogen and fuel cell industry.

3.2. Success Factors

The key success factors in delivering on the fuel cell technology vision and objectives are the proven advancements in research and innovation, including those at NRC_IFCI. These advancements and BC hydrogen fuel cell technology "cluster" predetermine the world leading position and future success in the emerging industry.

The NRC-IFCI activities are aligned with the BC's *Hydrogen and Fuel Cell Strategy* and Canada's Federal *Fuel Cell Commercialization Roadmap.*

Ongoing fuel cell technology partnerships initiatives are also supported through industry R&D, demonstrations and deployments with other provinces (Ontario, Manitoba, Alberta) having significant hydrogen and fuel cell programs.

Vancouver Fuel Cell Vehicle Program is one of the initiatives. The program is about demonstration of sustainable, zero-emission based transportation technologies, including Ford Focus vehicle evaluation in the Lower Mainland, proprietary systems for hydrogen production testing, demonstration, deployment and evaluation.

Another BC initiative, the Lower Mainland and Vancouver Island *Hydrogen Highway*, is a coordinated market demonstration program designed to accelerate the fuel cell commercialization. The program was framed around the 2010 Winter Olympic and Paralympic Games and intended to showcase and demonstrate the environmental, economic and social benefits of this technology to the world.

In summary, the key success factors for NRC-IFCI business offerings are based on a strong position already achieved at the national and global market place, as well as the new opportunities for the fuel cell technology commercialization.

3.3. NRC-IFCI Offerings

The home for the *Fuel Cell Program* is the NRC-IFCI. It is premier national applied research organization dedicated to work on projects focused on the research, development, demonstration and testing of hydrogen and fuel cell systems. The critical areas of research interests are in addressing the cost, performance and reliability challenges of hydrogen and fuel cell technologies.

In collaboration with industry, universities, and other government agencies, the IFCI and program provides research and innovation support in the areas of core competencies critical to the growth of the fuel cell sector, including :

- Advanced Materials and Processing;
- Novel Architecture Design;
- Unit and Integrated System Testing;

- Sensors and Diagnostics Development;
- Modeling and Numerical Simulation.

Along with the Canada's *Fuel Cell Commercialization Roadmap*, NRC-IFCI activities are also aligned with the BC's *Hydrogen and Fuel Cell Strategy*. The BC's hydrogen fuel cell cluster is recognized as the largest concentration of expertise of its kind in the world.

NRC-IFCI is focusing on advancing fuel cell science, technology and accelerating the commercialization. With the 85 full-time staff and budget of $8.5 million per year, IFCI headquarters the NRC Fuel Cell Program. It currently funds fuel cell research with the budget of $22 million over 5 years at 5 NRC institutes, UBC Clean Energy Center, University of Victoria, SFU and BCIT, as well as 200 researchers working in BC.

3.4. Technology Showcase

The Canadian and NRC-IFCI achievements in green technologies and fuel cell research and development are being demonstrated in its own new building, which provides state-of-the art technology and hydrogen-safe laboratory space. The Institute offers testing facilities specialized for different fuel-cell sizes and different fuel-cell types, demonstration facilities to showcase new technology, incubation space for start-ups, and access to specialized information resources. In other words, the IFCI building is a living laboratory, in which green technologies that rely on fuel cell and hydrogen advances are incorporated into the building's design and construction and where most of the fuel cell program areas of core competencies are being evaluated.

A good example of a new environmental technology at work is the building-wide system of photovoltaic cells installed in skylights, roofs and walls. These cells power a hydrogen electrolyzer, which separates water into hydrogen and oxygen. The hydrogen produced by this system is being tested to determine if it can be used for laboratory experiments, as well as for combustion applications in engines and other systems.

The use of a 5KW solid-oxide fuel cell inside the building to provide heat and electricity is another technology that is being evaluated. The fuel cell is working with ground source heat pumps, transferring the heat produced to floor heating coils. This interconnected approach provides an opportunity to study the effectiveness of the fuel cell heating system in various energy demand scenarios.

Beyond allowing researchers to observe the building-integrated technologies at work in real-life conditions, the facility also serves as a testing ground for the best ways to install and integrate them. For example, many fuel cell appliances do not have installation codes and standards governing building-integrated applications. To begin the code development process, NRC-IFCI's Demonstration Program is using sound engineering principles to install the indoor fuel cell. The results will be used to remove regulatory barriers to these new sustainable technology alternatives.

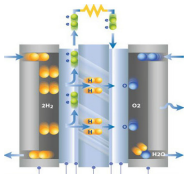
3.5. R&D Competencies at Work

Another good example of utilizing key program core competency, Modeling and Numerical Simulation, is a NRC-IFCI project completed for a Quebec's company Hyteon. The company works with the Quebec's Natural Gas Technology Centre on the green solutions that would reduce the environmental impact of natural gas heating. They have designed a complete fuel cell system that can power a home while reducing its carbon dioxide emissions by up to 40 percent. The work is being done in tandem with the electrical grid to meet all of a home's electricity needs. As an added bonus, the technology allows to recover heat in the form of hot water that can be used for the home, so homeowners also see savings on their energy bills.

The Hyteon's design of the specific proton exchange membrane fuel cells was perfected with help from the modeling group at NRC-IFCI. The fuel cell stack runs on a gas mixture called "syngas," which contains mostly hydrogen. In order for the stack to reach peak efficiency, the gas must flow uniformly throughout the stack so that each cell carries an equal share of the load. If some parts of the stack work harder than others, then the overall lifetime of the unit is shortened. The design of the unit must be finely tuned to reach this high level of performance. It's very difficult for designers to figure this out without detailed modeling and simulation.

IFCI created a 3D model of Hyteon's design and simulated the flow of gas through the stack. The designers were given the whole picture: where the gas concentration was high, where it was low, and where it was moving too quickly or slowly. The results helped Hyteon to perfect the design and surpass their goal of 90% system efficiency. Without access to a 3D model, Hyteon would have been forced to build expensive prototypes to see their design in action. Hyteon's units are attracting interest from Canadian utilities, in particular for use in remote areas where electricity cost is very high. This design is also being evaluated by prospective clients - major utilities in Europe and Japan.

4. Technology and Product Demonstrations



The BC fuel cell technology pioneer and leader is Ballard Power Systems, in Burnaby. Started in the 1980s, the company is now supplying fuel cells to the world's top automakers, including Daimler Chrysler, Ford and Honda.

4.1. Fuel Cell

A fuel cell is essentially an electrochemical conversion device. It produces electricity from fuel (on the anode side) and an oxidant (on the cathode side), which react in the

presence of an electrolyte. The reactants flow into the cell, and the reaction products flow out of it, while the electrolyte remains within it. Fuel cells can operate virtually continuously as long as the necessary flows are maintained. Many combinations of fuel and oxidant are possible. A hydrogen fuel cell uses hydrogen as fuel and oxygen (usually from air) as oxidant. Such cell converts hydrogen and oxygen into water. The process also produces electricity, but unlike a battery, fuel cells can be replenished and continue to work as long as they are supplied with fuel. Fuel sources can include clean energy sources such as natural gas, bio fuels or even nuclear energy. The fuel cell is very promising in the sense it can take any fuel that is available today and work to convert it into electricity and heat in a much more efficient manner - with a low carbon footprint.

Transportation sector and personal vehicles are considered to be the largest market for hydrogen and fuel cell technologies. Although every manufacturer has its own take on fuel cell technology, the principles are pretty much the same. The fuel, hydrogen gas is stored under pressure in a tank and feeds a fuel cell “stack”. The hydrogen reacts with electrolytes inside the stack and electricity is produced. This, in turn, is stored in a battery pack or fed to a capacitor. It powers an electric motor that, through a transmission, propels the vehicle. Most fuel-cell vehicles also have a power-drive unit to control the flow of electricity to the drive train.

4.2. Industry Participants and Challenges

Since its inception, Canadian organizations and NRC-IFCI made visible practical steps to deliver commercial fuel cell solutions through innovation. In addition to the car sector, a number of such solutions are customized for different applications, such as:

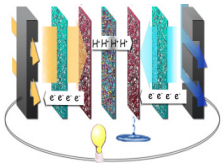
- Replacing battery packs used for forklifts in warehouses;
- Backing up power suppliers for telecommunication towers in India and taking advantage of that country's mobile phone boom, where 100,000 wireless base stations go up each year, phone towers need power, but its supply is unreliable;
- Demonstrating technology to the world and attracting prospective international customers at the Vancouver Winter Olympic Games, with the buses equipped with fuel cell modules.

The mass-market penetration may not start immediately. Along with definite accomplishments, known technology commercialization challenges are still huge. For instance, the hydrogen highway faces massive obstacles, mainly in the area of infrastructure and production costs. Hydrogen is not exactly readily available in retail outlets.

As was signified at the last technology demonstration, 2009 Hydrogen Road Tour event, making the transition to hydrogen power and putting together a business case for hydrogen-powered cars is still a great challenge. The Tour, which started in California on May 26 and wrapped up in Vancouver on June 3, 2009, saw eight automakers represented and a dozen test cars.

Sponsored in part by the California Air Resources Board, B.C. Hydro, and several fuel-cell interest groups, the Hydrogen Road Tour demonstrated that the car manufacturers and the service industry have made tremendous progress in the past few years, and the technology is essentially here. Now, the next challenge is to get the governments to participate. The refueling stations infrastructure in the right places is the key. The projections are to see 25 new hydrogen refueling stations in the Los Angeles area within the next five or six years, to service the more than 4,300 fuel-cell vehicles that are expected to be on the road by 2015.

5. Key Advantages of the NRC-IFCI Offerings



The accomplishments and recognized leadership position of NRC-IFCI and the BC fuel cell technology cluster offer exceptional opportunities for organizations and companies to benefit from the global clean technology commercialization needs.

5.1. Competitive Edge and Strategic Plan

The NRC-IFCI can help interested companies to take advantage of the competitive edge R&D and emerging global commercial opportunities. The institute's approach is aligned with the NRC *Science at Work for Canada* strategy. This strategy plays an important role in achieving the goals of the Government of Canada's Science and Technology Strategy, *Mobilizing Science and Technology to Canada's Advantage*. As such, the *NRC-IFCI Strategy* to capitalize on the global fuel cell opportunities is to:

- Support and expand a framework for advanced science and technology innovations and partnerships;
- Focus on promoting the world-class innovations addressing the global priorities;
- Set out and execute a Stratigic Plan to foster the distinct BC advantages.

The *NRC-IFCI Stratigic Plan* is to utilize and enhance the following advantages:

- Entrepreneurial - to translate the fuel cell technology knowledge into commercial applications, utilize the national and global opportunities in clean technologies;
- Knowledge - to use the leading edge know-how of important fuel cell technology developments and generate more opportunities in clean technologies;
- People - to attract highly skilled and educated people to BC workforce and compete globally.

5.2. Defined Implementation Roadmap

To meet the objectives of the NRC-IFCI's Strategic Plan and fully utilize the advantagies, relevant Implementation Roadmap is in place:

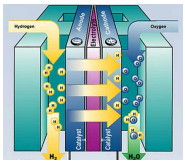
- Support the BC entrepreneurial advantage by meeting the needs of industry for targeted research and transferring its discoveries to the private sector;
- Enhance the knowledge advantage by contributing to the research priority areas, including those aligned with the Federal, NRC and BC Strategies;
- Support the knowledge advantage by engaging fuel cell sector participants in multi-stakeholder collaborations and developing key competencies that support future priorities and demands of the industry;
- Suppor the people advantage by attracting and retaining highly-skilled workers needed in fuel cell technology industry in the global economy;
- Enhance the people advantage by further expantion of the strong multidisciplinary teams of international calibre SME's to deliver leading-edge research and development.

5.3. Established Priorities and Milestones

To meet growing global opportunities, the NRC-IFCI BC Strategy and Plan are based on startegic priorities and deliver on relevant milestones. These are:

- Focus on R&D in key technology sectors and areas critical to support BC companies to take advantage of the global opportunities;
- Create value through R&D in sectors with the greatest impact on delivery to global demand in the fuel cell technology;
- Facilitate sustainability of research in areas promising faster ROI;
- Support the industry through development of relevant codes and standards;
- Strengthen BC fuel cell cluster initiatives by contributing to the growth and economic viability of the cluster community;
- Help connecting the key innovation players, information and intelligence;
- Support commercialization initiatives, technology and IP transfer;
- Enhance the sector strategic and business planning;
- Continue incorporation of the best R&D and business planning practices, including KPI's, scorecards, forecasting, modeling and assessment tools;
- Continue improvement of administrative and financial management within the fuel cell technology, government, industrial research, university communities;
- Incorporate the best qualitative and quantitative research techniques;
- Continue delivery of research breakthroughs focused on key fuel cell areas;
- Focus on the commercialization challenges for hydrogen and fuel cells, improving fuel cell reliability and durability, reducing cost, stimulating early market demand, creating supporting infrastructure.

6. Benefits Of Doing Business With NRC-IFCI



The national and global energy demand and environmental challenges created excellent business opportunities for Canada's and BC's fuel cell technology cluster and NRC-IFCI. These huge domestic and international business opportunities are based on the advancements in the development and commercialization of the hydrogen fuel cell technology. The NRC-IFCI, BC cluster and its companies and organizations represent the world's most advanced expertise focused on fuel cell and hydrogen technologies.

In the next decade, by some optimistic estimates the global industry could be over a trillion dollars annually. The properly shaped and directed NRC strategy, efforts, investments and demonstrated accomplishments placed NRC-IFCI in excellent position to offer excellent business partnership opportunities benefits in winning a significant share of the global clean technology markets.

The NRC-IFCI strategy-based business approach will insure further support of the cluster's unique opportunities and address challenges, capitalizing on the national and international resources, science and technology capabilities, networks and partnerships.

7. Appendix: Business and Financial Projections

7.1. Assumptions

See Notes.

7.2. Business Ratios

See Notes.

7.3. Financial Projections

See Notes.

Notes

Some sections of this presentation have a very limited content or are left without any actual content. Those sections are still included to illustrate that such content would be an important and essential part of a full-size effort required to prepare a detailed overview of the organizational products, services and capabilities. This document is not prepared as part of such an effort, but intended to be solely and only an illustration of a high-level summary of such full-size exercise.