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# **A VISION FOR GROWING A WORLD-CLASS POWER TECHNOLOGY CLUSTER IN A SMART, SUSTAINABLE BRITISH COLUMBIA**

**Report to the Premier's Technology Council**

**Prepared by Mossadiq Umedaly**

## **Building the Future**

**British Columbia can be a world leader in Power Technology. Government and Industry can create high-value jobs in profitable businesses by supplying smart, sustainable power solutions to British Columbia, to Canada and to the world.**

March 3, 2005

To the Premier, the Premier's Technology Council and to British Columbians interested in sustainability and the growth of the Power Technology Industry:

I accepted, on behalf of the Premier's Technology Council, a challenge from the Premier to craft a vision and strategy to grow the power technology industry in British Columbia. I thank him for having the vision and the faith that with Government and Industry working together, we can create strong companies and great jobs while maintaining our clean environment. We can build on British Columbia's reputation for sustainability and become providers of smart power solutions to British Columbia, Canada and the world.

But we are at a crossroad—we have the assets and the opportunity, and now need the vision and energy to make it happen. We can't focus on what we don't have or can't do. We need to keep our eyes on what can be and will get done.

The vision in the document that follows outlines a *Targeted Innovation* strategy. If thoughtfully and consistently implemented, we will become one of the leaders in the world for Power Technologies because we will be seen as a place where companies can innovate and get their expertise, products and services to world markets faster with a higher probability of success. We must focus on key issues and solutions, and therefore we have recommended five opportunity areas that address real BC needs and represent large worldwide markets: Remote Power, Sustainable Urban Practices, Smart Urban Transport, Smart Grid, and Large-Scale Clean, Green Power Production. We will grow these opportunities through strategies that focus on Leadership, Commercialization, Growth and Innovation.

The document is a compilation of many thoughts and opinions of the best and brightest minds in BC and elsewhere. I would personally like to thank all of the Government officials, company and utility executives, industry association leaders, academic professionals, NGO experts, our consultant the Center for Smart Energy, and many others who all contributed ideas, research reports and further connections across the industry to aid in producing this document.

So now let us go forward. With the leadership of the Premier, a clear vision and collaboration across the Province, we are in a position to build an industry with critical mass that can bring many high-value jobs and much more in revenue to the region—all while ensuring that British Columbia remains one of the best places in the world to live and work.

With thanks,

Mossadiq Umedaly  
Chairman, Xantrex Technology  
Member, Premier's Technology Council

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The full report outlines the framework and opportunity areas, and provides more details around the strategies necessary to advance the industry.

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Each of these appendices provides more information to define the opportunity area, describe the world market, establish its relevance to British Columbia, identify local assets and outline strategies to go forward.

**Power Technology Industry in British Columbia**

This matrix outlines the major technologies where British Columbia currently has a presence. It includes brief definitions and a list of sample companies and organizations involved in that area.

**Profiles of Selected Companies**

This appendix provides short summaries of just a few of the many power technology companies working in British Columbia today.

# EXECUTIVE SUMMARY

British Columbia can be a world leader in Power Technology—innovations that improve the way power is created, delivered, and used. Government and Industry can create high-value jobs in profitable businesses that supply smart, sustainable power solutions to British Columbia, Canada and the world.

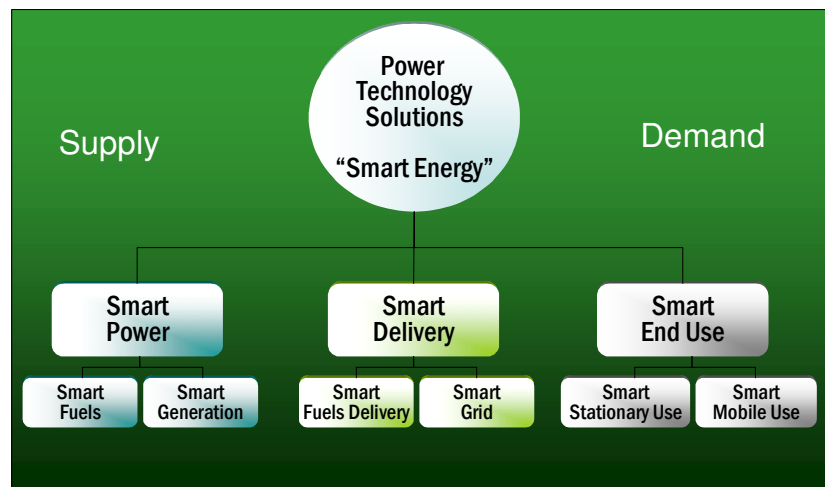
British Columbia is poised on the edge of the next big market growth opportunity. Worldwide, the Power Technology Industry is a “sleeping giant,” with a total market size today of US\$170B and more<sup>1</sup>. Even niches represent hundreds of millions in projected annual revenue growth over the next decade as the world’s power systems are enhanced and modernized. Locally, Power Technology already comprises more than 60 companies that employ more than 3,000 people worldwide and generate in excess of CAN\$700 million revenue per year<sup>2</sup>. We can work together to accelerate this sector by retaining and growing existing companies, encouraging new start-up activity, and attracting additional companies large and small from outside the region. Over the next decade we stand to more than triple our Power Technology revenues from export and bring thousands of new jobs to the region—at the same time securing our reputation as a clean, smart place to live and work.

*Figure 1:  
The Power Technology Sector  
2005 and Beyond*

*The diverse areas where energy  
technology innovations are  
leading to smart, sustainable  
solutions.*

*Each area represents world  
markets worth billions of dollars  
(and growing). Taken as a group,  
Power Technology Solutions  
represent a “sleeping giant.”*

*Source: Center for Smart Energy*



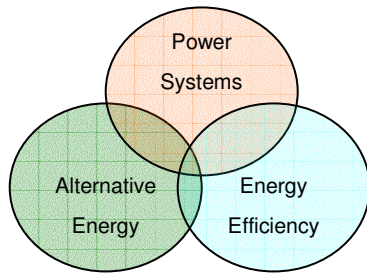
This report outlines a vision to grow the Power Technology sector through targeted innovation and commercialization—a plan that requires leadership at all levels and collaboration between government, industry, academia and NGOs. This vision will leverage a wide range of existing provincial and federal initiatives that are positioning Canada as a leader in sustainability and Power Technology.

## WORLD DEMAND FOR POWER TECHNOLOGIES IS RISING

Regions are turning to power technology to improve the way energy is generated, transported, and used. Supply side technologies move beyond the traditional oil and gas energy sources to focus on advances in alternative power production and fuel options to increase efficiencies and reduce emissions. Enhanced grid and delivery technologies make energy systems smarter, more cost effective and reliable and enable these innovative supply choices. End-use technologies make our buildings, transportation, and equipment more efficient and provide tools to manage our energy use.

### Sidebar 1 – What is Power Technology?

Power Technology (a.k.a. “energy technology” or “smart energy”) uses advanced materials, digital technology and other innovations to improve the creation, delivery and use of power, making the whole energy system cleaner, greener, and more efficient. It merges alternative energy, power systems, and energy efficiency into smarter choices across the energy value chain.



**Smart Power.** *Smart Fuels* includes new fuel approaches (e.g. biomass, geothermal, hydrogen etc.) that provide alternatives to fossil fuels, cleaner approaches to traditional sources (e.g. clean coal) as well as technologies to extract and process these in cleaner, more efficient ways. *Smart Generation* includes alternative generation approaches, offers cleaner and greener ways to produce electricity with centralized and distributed power generation to serve primary, remote, back-up, portable and auxiliary needs

(e.g. renewables, fuel cells, microturbines, efficient low-emission combustion generation) and the storage necessary for such systems.

**Smart Delivery.** *Smart Grid* includes technologies to automate and optimize the wires and substations, making it possible to monitor and control electricity in real time to increase capacity, reliability and flexibility of the system. It also includes the electronics to invert, control, condition, and connect distributed generation (e.g. balance of system, energy routers, micro-grid devices) and the storage necessary for effective grid operations. *Smart Fuels Delivery* includes technologies to control and deliver advanced fuels to the place where they are needed for generation or end-use.

**Smart End Use.** *Smart Stationary Use* includes the technologies to support better decision-making and management of consumption (e.g. energy information systems, measurement devices), and technologies designed to make buildings and processes require less energy (e.g. green building practices, variable speed drives). *Smart Mobile Use* includes the technologies used to help make transportation solutions smarter, more environmentally friendly and less dependent on fossil fuel sources (e.g. fuel cells, hybrid motors, electric and natural gas vehicles).

We can attribute rising world demand for these technologies to several key issues driving the need for better energy optimization:

- **Environment Impacts and Sustainability Concerns.** Concerns over climate change and other challenges in the globe’s energy footprint are leading to collaborative efforts (e.g. Kyoto Protocol, World Business Council for Sustainable Development) and increased attention to alternative energy, power systems advances, new transport solutions and energy efficiency as ways to reduce future emissions and demand on the world’s fossil fuel supplies.

- **Demand is Outpacing Capacity.** In the areas of fuels and power production, long term demand is outstripping supply. As countries like China and India modernize their economies, the impact on the world's fossil fuel supplies will push this imbalance further. In transmission, historic under investments are creating capacity constraints and the possibility for large market uptakes of new grid technologies.
- **Energy Security Issues.** Countries who are net importers of oil are evaluating strategies that include alternative energy, conservation, and grid security measures to better secure their energy resources and reduce dependence on foreign oil supplies.
- **Cost Competitiveness of Energy Intensive Industries.** Traditional industries with high energy demands (e.g. pulp and paper, food processing, agriculture, etc.) are investing in energy management and efficiencies that reduce energy expenses and increase competitiveness.
- **Need for High-Quality Power.** The digital economy is creating demand for high-quality, high-reliability power and all of the supply and power conditioning technologies that ensure it.
- **Quality of Life Issues Tied to Clean, Available Energy.** Clean power improves health and increases quality of life benefits (e.g. universal Internet access). Governments are leveraging infrastructure investments in power resources and advanced grid technologies to bring power and digital communication capacity to improve communities.

*"The old mentality that is always opposing the environment and the economy is over... More than ever now Canada will be involved in the fight to be a leader, a champion of the sustainable economy."*

**Environment Minister  
Stephane Dion 2005**

Advanced economies such as Germany, Japan, Denmark, Spain, U.K. and the United States are leading the way towards better energy optimization with incentives for conservation, efficiency, and renewable resources. Canada has been slower to respond, but has implemented a number a measures and has just recently announced its commitment to a sustainable economy.

Beyond these drivers, many regions are seeing the Power Technology sector and sustainability more broadly as an economic development growth opportunity.

## THE POWER TECHNOLOGY ECONOMIC DEVELOPMENT OPPORTUNITY

For regions that provide smart, sustainable technologies to the world, Power Technology's biggest benefits are often the economic development impacts from jobs and revenues. Although a specific calculation of

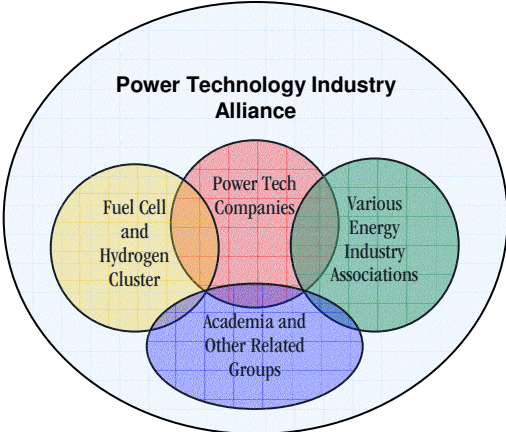
economic impact is beyond the scope of this initial effort, there is significant evidence that the Power Technology Industry is already—and will continue to be—a strong source of jobs and revenues for those regions that provide smart, sustainable solutions to the world. Working together, we stand to triple the revenues and add thousands of new jobs to the region.

**Industry Poised for Growth.** Worldwide, Power Technology is already one of the biggest technology industries. Going forward, the opportunity is enormous. In a report released in 2000, experts projected that the global market for clean energy products and services would exceed \$3.5T from 2000 to 2020. Power systems and clean energy production technologies are projected to exceed \$500B over this time period. Much of the remaining market will be in energy efficiency products and services.<sup>3</sup> There are literally dozens of subsectors in the Power Technology industry that represent market sizes worth hundreds of millions, even billions or more in annual revenues over the next decade.

**Sidebar 2 – British Columbia’s Power Technology Industry Alliance**

The Power Technology Industry Alliance in British Columbia has a plan to build from the strengths of the existing fuel cell and hydrogen cluster, various industry associations (e.g. wind, solar, ocean energy) and the depth of power technology companies and expertise in the region.

A subset of British Columbia Technology Industry Association (BCTIA), the Alliance’s vision is to grow the industry through collaboration. Members will coordinate across broad sectors to overcome industry challenges and reach key market opportunities. The Alliance builds from efforts like the Fuel Cell and Hydrogen Strategy, OREG report, that outline visions for moving their technologies forward. The Alliance aims to integrate the needs and opportunities from all groups and companies in the Power Technology Industry to move the whole industry forward.



The diagram is a Venn diagram titled "Power Technology Industry Alliance" enclosed in a large oval. It features four overlapping circles: a yellow circle on the left labeled "Fuel Cell and Hydrogen Cluster", a red circle at the top labeled "Power Tech Companies", a green circle on the right labeled "Various Energy Industry Associations", and a blue circle at the bottom labeled "Academia and Other Related Groups". All four circles overlap in a central area.

**High Value Jobs.** British Columbia has already seen significant economic development from the Power Technology cluster and is poised for more. Power Technology can create high-paying jobs for scientists, researchers, engineers, professors, lab technicians and other knowledge workers. It also holds the potential for family-wage jobs, including technicians, assemblers, trainers, operators, and programmers along with field sales, installation, repair and support.

As a cluster opportunity, Power Technology offers the chance to build a group of companies that are highly diverse yet very synergistic. Power

Technology companies draw from many core sciences that also enable other industries: advanced materials, power electronics, embedded systems, telecommunication, and many more. Developing products in this sector involves support industries (e.g. plastics, sheet metal, circuit electronics, etc.) increasing the positive impact on the economic diversity of a region.

No published estimate of revenues and jobs covers the breadth of the Power Technology Industry and such modeling of direct and indirect jobs is beyond the scope of this initial work. However, previous estimates generated on just a few of the emerging technology subsectors represented in British Columbia (e.g. clean production, fuel cells, ocean energy, and smart grid) put industry potential for direct employment at tens of thousands in this region alone over the next decades. The total benefits (including indirect job impacts) have been calculated by some as a factor of 5 jobs per million dollars in revenue<sup>4</sup> (in the renewables sector), by others as 36 jobs per million dollars in revenue<sup>5</sup> (in the energy efficiency sector) making this a rich opportunity indeed.

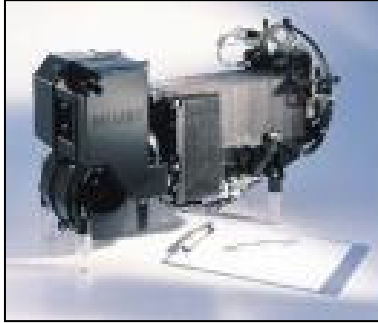
## **BRITISH COLUMBIA HAS THE ASSETS TO BE A WORLD LEADER**

Our local industry stands at the crossroads to grow into a key world player and bring more of those jobs and revenues to the Province with a number of advantages to support growth:

**Pioneering Companies and Innovation.** We are home to leading innovators in fuel cells and hydrogen (e.g. Ballard Power Systems, Questair), natural gas engines (e.g. Westport), electric hybrids (e.g. Azure, Railpower), power electronics and measurement (e.g. Xantrex, Power Measurement) and green buildings (e.g. Busby, Perkins and Will; Keen Engineering) and many more. (See a sample of company profiles in Appendix G: Profile of Selected Companies) We have several respected institutions that conduct research to develop or promote key technologies for sustainable energy systems and clean energy alternatives (e.g. Powertech, University of Victoria, Simon Fraser University, University of British Columbia, David Suzuki Foundation).



### Sidebar 3 – Ballard Power Systems Lays the Foundation for Regional Fuel Cell Strengths



Ballard Power Systems is a recognized leader in fuel cells and anchors a cluster of Vancouver companies in fuel cells and hydrogen. The FC and H<sub>2</sub> industry has approximately 1,800 employees, 35 companies and recognized world leaders.

Ballard continues to play a significant role in the community through technology creation, wealth generation and the addition of talent to management pool. Ballard now has facilities in Burnaby, BC, Dearborn, Michigan and Lowell, Massachusetts and in Germany (Nabern).

**Natural and Geographic Advantages.** We have important natural ingredients for many key renewable power sources (e.g. ocean wave, tidal current, run-of-river, wind, biomass). We have access to and key relationships with large growth international markets. We are part of a large and growing western power production market in North America. We have good proximity to high growth Asian markets—and a port system to ship people and goods efficiently. Our proximity in the Pacific Northwest creates multiple cross-border partnership opportunities. We have a reputation as a clean community and centre of excellence for sustainability that we can reinforce to support the growth of the Power Technology cluster.

**Regional Demonstrations of Smart, Sustainable Power Technology and Exposure in 2010 Sustainable Olympics.** We have a number of existing and proposed showcases for sustainability and Power Technology. Plans for regional implementations of innovative power technologies abound; examples include the Hydrogen Highway, the UniverCity at Simon Fraser University, and smart building technologies at Whistler. We have unique opportunities in the 2010 Sustainable Olympics, 2006 Globe, 2006 World Urban Forum and the World Natural Gas Vehicle Congress to showcase a variety of technology solutions to key market needs.

**Progressive Utility and Government Leadership.** Although utilities have sometimes been seen as a barrier to technology adoption, locally we have utilities that have expressed more willingness to innovate. The leadership of BC Hydro, for instance, has put in place a series of twenty-year goals and strategies for both supply choices and demand management that—if implemented—represent more local market opportunities for power technologies. These strategies require a supportive policy framework to

facilitate decision-making in alignment with their goals. We have a supportive government that has implemented initiatives to increase the number of electrical, electronics and software engineers and established research programs and technology funds to further sustainability.

#### Sidebar 4 – Xantrex leads the Way in Market Growth



Xantrex Technology Inc. is a world leading developer, manufacturer and marketer of advanced power electronics products focused on the high growth distributed, mobile and

programmable power markets. Xantrex's products convert and control electricity from any source to provide cost effective, reliable, high-quality electricity as part of an integrated system.

With 2004 revenue of US\$143.1 million, Xantrex is one of the largest, fast growing and most profitable Canadian companies in the clean, renewable power technology sector. Xantrex has played a leading role in establishing the Power Technology Industry Alliance and looks to help the broader industry grow. The company has more than 500 employees worldwide, including more than 300 at its headquarters and factory in Burnaby. Xantrex is headquartered in Burnaby BC and has facilities in Arlington, WA; Livermore, CA; Elkhart, IN; Barcelona, Spain; Reading, UK; and Beijing, China.

**Power Technology Funding Resources.** We have a number of private equity firms that have invested in Power Technology in the past (e.g. Ventures West, Growthworks, Chrysalix, Cyprus Capital, Yellowpoint Capital Partners, Yaletown Ventures) and institutional investors (e.g. Royal Bank, HSBC, VanCity, Business Development Bank of Canada, Bank of Montreal). Government departments and agencies, including Sustainable Development Technology Canada (SDTC), Technology Partnerships Canada (TPC), Natural Resources Canada (NRC) and Western Diversification (WD).

While the opportunity is great and the Province has assets to work with, British Columbia faces some challenges in growing this Power Technology cluster. Some of these are self-imposed, as in our:

- **Limited Industry Definitions.** Although particular technology areas such as fuel cells have good cohesion, a broader definition of the Power Technology would exploit real synergies that only become apparent through sector-wide self-awareness and coordination.
- **Low Awareness of Value.** Governments often overlook the economic development opportunity the industry represents—through both direct growth from high paying jobs and revenues in their communities, as well as positive impact on the competitiveness of other traditional industries and tourism.

- **Lack of a Unifying Sustainability Vision in Governments and Crown Corporations.** Many individual efforts across government related to sustainability and power technology are not being coordinated in a way that makes it easy for industry to work well with Government. Also, utility regulations and processes that emphasize least cost planning without enough regard to true costs and sustainability impacts can stymie investments in innovations—many which would ultimately *lower* costs to energy users.

Other issues arise as a function of the size and make-up of our region:

- **Small Local Markets.** Our local markets are small, hard to access and we don't always use them strategically to grow industry.
- **Mass-Manufacturing Costs.** We don't have inherent mass-manufacturing advantages, and in this industry manufacturing costs are a key issue going forward.

So although California, China, and other areas can attract a cluster with the promise of access to massive local markets or low-cost labor, companies with those needs will not automatically be drawn British Columbia.

To effectively compete in global markets and build a sustainable cluster in British Columbia, we need to leverage our strengths to build a world reputation as a centre of targeted innovation in key world challenges and the smart, sustainable power technologies to solve them. **We must be seen as a place where companies can innovate and get their expertise, products and services to world markets faster with a higher probability of success.**

It may be that as companies in some subsectors grow, we ultimately give up (or never get in the first place) low value assembly, mass manufacturing, packaging and distribution. But depending on the sector, we *can* effectively develop capacity and competencies in (and compete with other countries for) high-value research and development, pilot manufacture and assembly, sales and marketing, and system integration. And we shouldn't overlook service-based businesses—consulting, architects, engineering, etc.—that represent high value jobs and are aligned with our strong university system, good standard of living and easy airport access to the world.

Long-term, we must build a region that has strength because of its collective expertise about how to develop and use power technologies to solve key energy related problems. This is a *Targeted Innovation* strategy,

and requires a focus on key world challenges where British Columbia can develop a long-term competitive advantage across a number of technologies.

## **FIVE MARKET OPPORTUNITIES WITH WORLDWIDE MARKETS FOR BRITISH COLUMBIA**

For this vision to grow the Power Technology Industry to be effective, this *Targeted Innovation* strategy requires that the British Columbia Power Technology Industry is market driven and focused on opportunities that are both 1) meaningful to British Columbia and 2) represent world-wide market demand where British Columbia could build a sustainable competitive advantage. From the existing research and discussions with industry experts, five areas emerged that are both key for the Province and also represent some of the biggest opportunities world-wide where the industry can collaborate to design and sell smart Power Technology solutions:

### **REMOTE POWER SOLUTIONS**

Integrated power systems that combine renewables, storage solutions and efficiency measures to meet the power needs (electricity, heating and cooling) of remote communities and single off-grid applications. British Columbia has Power Technology companies that provide off-grid distributed systems, inverters and other balance of system components to countries all around the world and could serve a point of integration. We have advanced development underway in areas such as fuel cells, solar, ocean wave, tidal current, run-of-river and biomass that could be used to off-grid village power needs in remote communities. We also have original research into hydrogen production and purification from renewables that could be used to firm up renewable off-grid solutions of various sizes.

### **SUSTAINABLE URBAN PRACTICES**

Approaches that optimize energy sources and use in dense urban settings: sustainable community planning, green building design, grid-tied distributed solutions, demand-side management and tools to manage energy consumption of industrial/commercial processes. British Columbia has some of the world's leading experts in sustainable community planning, green building design and development, and industrial energy measurement and management. The region has progressive utility leadership that has made a strong commitment to meeting a third or more of new load growth through demand side management innovation and a building industry aggressively pursuing sustainability standards. There are a number of strong academic and professional programs in sustainable urban practices, and key showcase opportunities in the Sustainable

Olympics and elsewhere. Local companies have core technologies either commercial-ready or under development to meet these needs in distributed generation, building efficiency and much more.

### **SMART URBAN TRANSPORT**

A portfolio of solutions that solve high-energy urban power system challenges—public transport, urban hauling, and personal transport—and enable the infrastructure for fuels and transportation power sources of the future. British Columbia has the world’s leading firms in smart urban transport solutions developing motors, engines and other vehicle systems that are leveraging new approaches to fuels. We are taking the lead in the fueling infrastructure of the future with world-class research and some of the world’s high profile Hydrogen Highway showcase opportunities at the upcoming Sustainable Olympics and World Urban Forum.

### **SMART GRID SOLUTIONS**

A set of hardware, software, and power electronics to update and automate the world’s power grids. These tools facilitate system-wide optimization and integration of renewables, distributed generation, and demand-side management measures. British Columbia has leading researchers in grid optimization, and as part of the Pacific Northwest is already a recognized centre of excellence for leading grid technology companies and innovation. The geographic diversity, installed base, and strong facilities and labs give the Province an opportunity to be a leader in the testing and certification of new grid technologies.

### **LARGE SCALE CLEAN, GREEN POWER PRODUCTION**

A robust energy market of alternative power production (e.g. wind, biomass, ocean energy, etc.) from independent power producers and other sources that meet our region’s needs to convert to cleaner, greener resources and provide surplus to sell into the western power market. British Columbia could use its hydro system (with its dams acting as vast batteries) to integrate with renewables to provide continuous clean power production capability. British Columbia has the natural resources that could be leveraged into robust production in ocean wave and tidal current, geothermal, wind and other large centralized renewables. British Columbia also has the leading company in power electronics supplying inverters to large scale production. In some cases, regional companies’ innovations in large-scale clean and green production (e.g. new solar technologies, ocean energy, run of river) could lead to a strong export market for local technology providers and developers to aid other regions who want to install production inside their control systems.

These five areas represent numerous technologies, product and service vendors. The table on the next page outlines some (but certainly not all) of the representative technologies. It also highlights regional strengths, and key requirements to move ahead in that opportunity area. More details on each of the five market opportunities can be found in Appendices A - E.

**TABLE 1 – FIVE OPPORTUNITY AREAS WITH WORLDWIDE MARKET POTENTIAL**

	Remote Power	Smart Urban Transport	Sustainable Urban Practices	Smart Grid	Large Scale Clean, Green Power Production
<b>Definition</b>	<ul style="list-style-type: none"> <li>Integrated village power solutions</li> <li>Remote off-grid single applications</li> </ul>	<ul style="list-style-type: none"> <li>Vehicle systems—public transport, short-haul, personal transport</li> <li>Fueling Infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Planning</li> <li>Building design &amp; build</li> <li>Grid-tied distributed systems</li> <li>Demand response technologies/demand management (overlap with smart grid)</li> </ul>	<ul style="list-style-type: none"> <li>Transmission-level solutions</li> <li>Distribution-level solutions</li> </ul>	<ul style="list-style-type: none"> <li>Production of electricity that is sold into the Western Market</li> <li>Local IPP owned production facilities outside the region</li> <li>Exports of technologies to large scale generation firms</li> </ul>
<b>Example Technology Solutions in the Industry</b>	<ul style="list-style-type: none"> <li>Services—planning, mediation, and other services designed to find the right solution for each situation</li> <li>Solutions—wind, solar, fuel cells, ocean wave, tidal current, run of river, biomass systems, microgrid systems</li> <li>Components—solar cell and modules, wind turbines, power electronics, batteries, flywheels, hydrogen production and storage</li> </ul>	<ul style="list-style-type: none"> <li>Services—research and development services for large OEMs</li> <li>Systems—electric and natural gas vehicles, hybrid motors, biofuels, charging systems</li> <li>Components—fuel cells, fuel cell stacks, hydrogen production, electrolysers, pressurized gas</li> </ul>	<ul style="list-style-type: none"> <li>Services—community planning firms, Green architect firms and engineers</li> <li>Solutions—fuel cells, DC lighting systems, campus-level optimizers, networked energy platforms, energy information systems building automation, advanced meters/gateways, etc.</li> <li>Components—windows, lighting, solar cell and modules, fuel cell stacks, hydrogen production, catalyzers, inverters, batteries, controls</li> </ul>	<ul style="list-style-type: none"> <li>Services—grid design and construction</li> <li>Systems—grid monitoring and optimizing solutions, wide-area management systems voltage regulators, substation automation, advanced metering platforms</li> <li>Components—power factor controls, reclosers, protective relays, substation controllers, wireless/ wired telecom infrastructure, powerline carrier, Superconductivity materials</li> </ul>	<ul style="list-style-type: none"> <li>Services—plant design and construction, power marketing</li> <li>Systems—large scale solar, wind, ocean, tidal, biomass, production, generation plant design and construction</li> <li>Components— wind turbines and components, solar cells and components, ocean energy components</li> </ul>
<b>Local Assets</b>	<ul style="list-style-type: none"> <li>Relationships with key markets (e.g. China)</li> <li>Key Companies in DG, power electronics and lighting</li> <li>Research into hydrogen production to shore-up off-grid</li> <li>Battery advances</li> </ul>	<ul style="list-style-type: none"> <li>Key companies and market relationships</li> <li>BC Hydrogen and Fuel Cell strategy, including Hydrogen Highway Initiative</li> <li>Research in and facilities for fuel cells and hydrogen production</li> </ul>	<ul style="list-style-type: none"> <li>Showcase opportunities</li> <li>Key companies across most areas</li> </ul>	<ul style="list-style-type: none"> <li>World class testing facilities</li> <li>Key innovators</li> <li>Part of larger PNW strength</li> </ul>	<ul style="list-style-type: none"> <li>Wind, ocean wave and tidal current natural resources</li> </ul>
<b>Needs to Move Forward</b>	<ul style="list-style-type: none"> <li>Collaboration among industry to build integrated solutions</li> <li>Demonstration opportunities</li> <li>Research and development support for technologies not yet commercial-ready</li> </ul>	<ul style="list-style-type: none"> <li>Research and development funding for fuel cells</li> <li>Testing opportunities</li> <li>Government procurement</li> </ul>	<ul style="list-style-type: none"> <li>Strategy to leverage Sustainable Olympics to build brand</li> <li>Government procurement</li> <li>More collaboration among industry</li> </ul>	<ul style="list-style-type: none"> <li>Better relationships with North American grid efforts</li> <li>Build high profile testing effort in British Columbia</li> </ul>	<ul style="list-style-type: none"> <li>Adjustments to utility framework to support regional net export</li> <li>More analysis of opportunity</li> <li>Expansion/creation of green programs to fund further investment in production</li> </ul>

## REGIONAL ACTION PLAN TO GROW THE POWER TECHNOLOGY CLUSTER

**We have the need. We have the opportunity. We have the assets.**

**We also have competition.** Other regions will be happy to sell the world Power Technology for modern, smart electric systems and transportation solutions. Our *Targeted Innovation* strategy requires that we recast our focus in terms of the previous five needs and then craft a strategy to become the best and the brightest at solutions for those market opportunities. With this focus, we can grow the sector through collaboration among industry, government, First Nations and academia and leverage current assets to put key elements in place:

1. **LEADERSHIP—Establish leadership, targets and resources for the five key world-wide opportunities** and let the most suitable technologies rise to the right challenges.
2. **COMMERCIALIZATION—Speed early commercialization in power technologies in the five key opportunity areas** with support for testing, demonstrations, and pilots; incentives for local demand; and removal of utility barriers to help British Columbia companies get products to market faster.
3. **GROWTH—Access world markets in the five key opportunity areas** through regional branding, industry coordination, and targeted outreach that establish the image of British Columbia as a world leader in power technologies and give local companies the relationships and opportunities they need to grow.
4. **INNOVATION—Develop streams of research in the five opportunity areas** with support for Centres of Innovation that collaborate with company research and development, and education programs that give local companies access to the best talent and development opportunities to maintain the region's value proposition as the world market grows.

Within each of these four strategies, key actions will move the industry forward. (Summarized in Table 2 below.)



**TABLE 2 – STRATEGIES TO GROW THE POWER TECHNOLOGY SECTOR**

Targeted Market Opportunities	
Five Areas with Worldwide Markets and British Columbia Needs	<ol style="list-style-type: none"> <li>1. Remote Power Solutions</li> <li>2. Sustainable Urban Practices</li> <li>3. Smart Urban Transport</li> <li>4. Smart Grid Solutions</li> <li>5. Clean, Green Exports</li> </ol>
Strategy	Actions
1. <b>LEADERSHIP:</b> Establish Clear Targets for the Industry	<ol style="list-style-type: none"> <li>1.A. <b>Goals.</b> Promote Economic Development Goals for the Power Technology Sector</li> <li>1.B. <b>Leadership.</b> Establish Leadership and Working Teams to Coordinate Industry Collaboration</li> <li>1.C. <b>Plans.</b> Build a Full Implementation and Resource Plan that Prioritizes, Schedules and Coordinates Around the Vision</li> </ol>
2. <b>COMMERCIALIZATION:</b> Speed Innovations to Local Markets in the Five Opportunity Areas	<ol style="list-style-type: none"> <li>2.A. <b>Local Demand.</b> Grow Local Demand Through Increased Government Procurement, Mandates and Incentives, and Supportive Utility Policy</li> <li>2.B. <b>Commercialization Fund.</b> Establish a Fund for Targeted Commercialization Through Demonstration and Pilots of Previously Tested Power Technologies to Now Prove the Business Value</li> <li>2.C. <b>Testing and Showcasing.</b> Increase the Attention and Resources that Utilities and Key Industries Have Available to Test the Engineering Capability of Specific Technologies.</li> </ol>
3. <b>GROWTH:</b> Access World Markets in the Five Opportunity Areas	<ol style="list-style-type: none"> <li>3.A. <b>Industry Partnerships.</b> Collaborate to Tailor Solutions and Leverage Marketing Channels to the Five Opportunity Areas</li> <li>3.B. <b>Branding the Region.</b> Brand the Region as a Leader in the Five Areas of Opportunity</li> <li>3.C. <b>Outreach to Markets.</b> Outreach to World Markets with Coordinated Efforts Across the Region</li> </ol>
4. <b>INNOVATION:</b> Build Streams of Research in the Five Areas of Opportunity	<ol style="list-style-type: none"> <li>4.A. <b>Targeted Research.</b> Support Centres of Innovation in Key Markets and Technology Areas and Coordinate with Corporate R&amp;D Efforts to Target These Opportunities</li> <li>4.B. <b>Human Capital.</b> Connect Existing Efforts in Basic Sciences to Power Technology Applications</li> </ol>

**LEADERSHIP: ESTABLISH CLEAR TARGETS FOR THE INDUSTRY**

Government and Industry should collaborate to set out clear goals, strategies and initiatives to move the sector forward:

- **1.A. Promote Economic Development Goals for the Power Technology Sector and the Sustainable Economy.** Industry and Government need to reinforce the link between the Power Technology sector and the value in economic development, communicating objectives for the sector around economic growth, job creation, competitiveness and environmental protection.
- **1.B. Establish Leadership to Move the Vision for the Cluster Forward.** The Premier should establish a vision team to carry

forward the discussions and design of future initiatives and efforts across these recommendation areas.

- **1.C. Create an Implementation Plan that Clearly Identifies Priorities and Resources.** This team should build and coordinate with other groups a plan for implementation, including a resource plan for how to support these initiatives.

## **COMMERCIALIZATION: SPEED INNOVATION TO LOCAL MARKETS IN THE FIVE OPPORTUNITIES**

British Columbia should enhance its existing strengths to become a place where new technologies in these five opportunity areas get to market—faster, better armed, and with a higher probability of success:

- **2.A. Grow Local Demand with Government Procurement, Mandates and Incentives, and Supportive Utility Policy.** Government ministries and Crown corporations should be reducing their energy footprints and making better supply choices with specific targets and timeframes—using local providers wherever possible. Specific policies at all levels of government should encourage and enable others to do the same. Local Utilities have progressive goals to be more innovative around new energy technologies; they must now engage regulators and stakeholders to gain support for them.
- **2.B. Establish a Fund that Closes the Commercialization Gap for Commercial Ready Technology.** A significant commercialization fund should provide a source of bridge financing for technologies that have been tested and found reliable, but now need a larger installation with a real customer to prove the business value. The fund would leverage Provincial and Federal funds to provide resources at an acceptable rate of return and open up more pilot opportunities for commercial-ready system solutions in the five opportunity areas, both locally and elsewhere.
- **2.C. Increase the Attention and Resources to Testing and Demonstrating Leading Edge Technologies.** Utilities and others should partner with industry and apply resources to support targeted development, testing, and demonstration of the engineering functionality of near-commercial technologies in the five areas.

## **GROWTH: ACCESS WORLD MARKETS IN THE FIVE OPPORTUNITIES**

All over the world, Silicon Valley stands for innovative software. British Columbia must create a similar image around Power Technology in particular and outreach to world markets:

- **3.A. Industry Partnerships to Develop Solutions and Leverage Market Connections.** The Power Technology Industry Alliance should be convening industry, governments, NGOs and others to find common ground where companies could jointly pursue opportunities into these five areas and provide solutions to the world—integrated either on a product level, a marketing level, or both.
- **3.B. Brand the Region as a Leader in the Five Areas of Opportunity.** British Columbia should message itself as a leader in smart, sustainable technologies to the world. The Sustainable Olympics, the World Urban Forum, Globe and related events can provide ongoing media coverage to the Power Technology cluster.
- **3.B. Outreach to World Markets.** Industry and Government should build connections to China, India and other areas of opportunity in the world targeted around the five opportunity areas and the regional branding. Outreach includes trade missions, events, shared cost marketing, cross-border partnerships, and leveraging economic development outreach.

## **INNOVATION: DEVELOP STREAMS OF RESEARCH IN THE FIVE OPPORTUNITY AREAS**

For BC to strengthen its position in the world as the market demand for power technologies in these five opportunity areas grow, we need to develop ongoing sources of innovation:

- **4.A. Support Centres of Innovation in Key Market and Technology Areas.** Centres should collaborate with corporate R&D efforts to generate innovation with commercial potential in the five opportunity areas. This means enhancing some of the existing Centres, supporting some that are under proposal, and identifying additional needs.
- **4.B. Connect Existing Efforts in Basic Sciences to Power Technology Applications.** We should continue to strengthen the foundation sciences that are important to this industry (advanced materials, power electronics, embedded hardware/software systems, etc.) and create applied courses to bring more talent into the local power technology industry (and to the five opportunity areas in particular).

## NEXT STEPS

To implement this vision, we recommend the following immediate steps:

- **Establish a Taskforce** to shape the overall strategy and plan
- **Build the Implementation and Resource Plan** in a document that outlines priorities, action steps, roles and responsibilities, budget requirements and sources, and schedule
- **Establish the Ongoing Vision Team, Working Groups and Coordination** to implement the overall strategies and its subcomponents.
- **Hold a Launch Event** to announce the commitment to the strategy and major initiatives

Properly implemented, this strategy leads to company growth in a number of ways—by retaining and growing existing companies, encouraging new start-up activity, and attracting additional companies large and small from outside of the region.

As more communities around the world look for smart energy choices, they must buy those products and services from somewhere. British Columbia is poised at the edge of opportunity. We can (and should) be the providers of leading-edge Power Technology to the world.

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# **A VISION FOR GROWING A WORLD-CLASS POWER TECHNOLOGY CLUSTER IN A SMART, SUSTAINABLE BRITISH COLUMBIA**

## **Full Report**

**Report to the Premier's Technology Council  
Prepared by Mossadiq Umedaly**

## **Building the Future**

**British Columbia can be a world leader in Power Technology. Government and Industry can create high-value jobs in profitable businesses by supplying smart, sustainable power solutions to British Columbia, to Canada and to the world.**

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# INTRODUCTION

**Our Need:** To foster economic development in British Columbia—building high-value jobs and revenue while preserving and enhancing the sustainability (economic, environmental and social) of our region. British Columbia and Canada must find new sources of growth and opportunity, while managing the impact of that growth. Like other countries around the world, we must build a society that uses resources wisely going forward, while also replenishing the environment. We must foster communities that are healthy and secure today, but are also able to adapt to tomorrow’s changes. We need to be sustainable—economically, environmentally and socially.

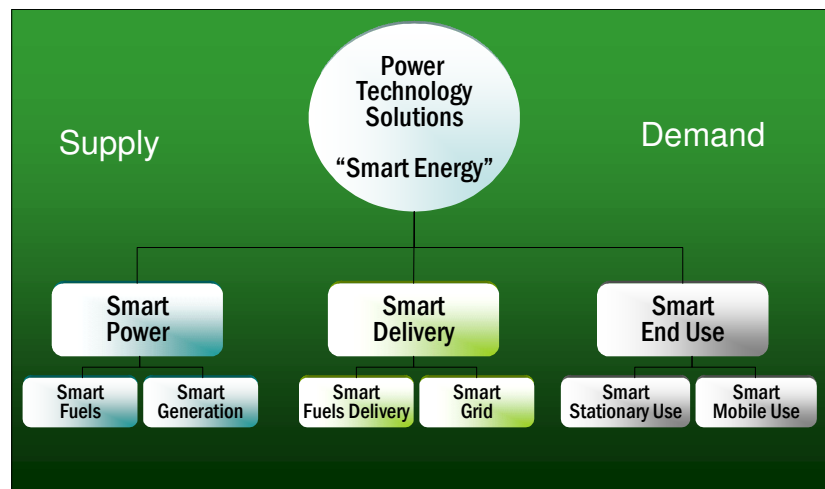
**Our Opportunity:** British Columbia can be a world leader in Sustainable, Smart Power Technology—innovations changing the way power is created, delivered, and used. British Columbia is poised on the edge of the next big market growth opportunity. Worldwide, the Power Technology Industry is a “sleeping giant,” a sector of hundreds of billions ready for explosive growth, where even niches represent hundreds of millions in projected annual revenue growth over the next decade. Locally, Power Technology already comprises more than 60 companies that employ more than 3,000 people worldwide and generate in excess of CAN\$700 million revenue per year<sup>6</sup>.

*Figure 2:  
The Power Technology Sector  
2005 and Beyond*

*The diverse areas where energy technology innovations are leading to smart, sustainable solutions.*

*Each area represents world markets worth billions of dollars (and growing). Taken as a group, Power Technology Solutions represent a “sleeping giant.”*

*Source: Center for Smart Energy*



Government and Industry can create profitable businesses and high-value jobs by supplying sustainable, smart power solutions to British Columbia, Canada and the world. If we work together to accelerate this sector by retaining and growing existing companies, encouraging new start-up activity, and attracting additional companies large and small from outside of the region, over the next decade we stand to more than triple our Power

Technology revenues from export and bring thousands of new jobs to the region—all while securing our reputation as a clean, smart place to live.

**Our Challenge:** Other regions are moving forward rapidly in response to the emerging power sector. To capitalize on this historic opportunity, British Columbia must have a vision to leverage our unique assets into a global centre of innovation in the industry and a cluster with a longer term competitive advantage.

With strong leadership, a clear vision and collaboration we will establish British Columbia and Canada as a leading provider of smart, sustainable power technologies to the world. The Premier has already begun providing the leadership by commissioning this investigation; this document now lays out the vision. This report integrates the ideas and opinions all across the region, and represents the kind collaboration that will be necessary for success.

This report outlines a vision to grow the Power Technology cluster through a *Targeted Innovation* strategy with a focus on some of the fastest growing markets market needs with world targeted innovation and commercialization—a plan that requires leadership at all levels and collaboration between government, industry and academia. This report is laid out in the following sections:

- A **Framework for the Power Technology Opportunity** section where we define the Power Technology Industry, identify market drivers, outline the economic development opportunity in British Columbia, describe the region’s competitive advantage and assets, and introduce the five market opportunities that make up the *Targeted Innovation* strategy.
- A **Recommendations** section where we outline the major strategies and actions that need to occur in parallel across the region in the areas of *Leadership, Commercialization, Growth* and *Innovation*.
- A **Next Steps** section where we outline the immediate next steps to begin moving this vision forward.
- Appendices for each of the Five **Market Opportunity** sections for each of the market opportunities (Sustainable Urban Practices, Smart Urban Transport, Remote Power Solutions, Smart Grid Solutions, and Clean/Green Power Exports) that clearly define the market needs and technologies involved, outline the world growth expectations for the segment, analyze British Columbia’s needs



and assets for the opportunity, and describe what's necessary to move that opportunity forward.

- An Appendix of the **Power Technology Sector in British Columbia** that outlines and defines major technology areas, provides sample companies and organizations in British Columbia in each area.
- An Appendix with **Select Company Profiles** that provide more information on select firms in the sector.

## A FRAMEWORK FOR THE POWER TECHNOLOGY OPPORTUNITY

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The definition of Power Technology in this vision is broad and inclusive by design, and is key to the success of the industry. One of the challenges that has faced the Power Technology Sector (a.k.a Smart Energy or Energy Technology) has been the tendency of industry and government to define the sector too narrowly in a way that marginalizes the industry and ignores its breadth (e.g. renewable alternative energy supplies), or to focus too closely on one particular technology or another (e.g. solar, wind, fuel cells) while neglecting the strengths that might come from exploiting the synergies between them.

A narrow industry definition and cluster focus ignores one of the strengths of the Power Technology Industry—its diversity of technologies and markets. There are numerous market needs across supply, delivery and use. And the technologies to meet each of these needs are just as numerous and diverse. Some are mature with large volumes of customers and established distribution channels, others are a decade or more from reaching their full market potential, and still others are somewhere in between. Customers for all of these technologies run from individuals, to companies, to utilities, to governments and other institutions. This diversity makes the sector a strong economic development opportunity with good prospects for jobs and revenues in both the near and long term—coming from start-ups to mature firms, from sectors that are high-growth emerging sectors or established profitable sectors.

In the Power Technology Industry, such diversity is easier to support because of the synergies across these market sectors. For instance, the broad sectors outlined above rely on some foundational sciences and core skills for innovation, including advanced materials sciences, power engineering/power electronics, information/computer sciences, communication sciences and others. On the product side, many of the same components can be aggregated into a number of solutions meeting needs

across different niches. From a marketing perspective, since a customer can have a variety of energy technology needs, complementary Power Technology companies can leverage many of the same paths to market (e.g. system integrators, distributors, key relationships to international markets).

A technology-driven definition also reinforces one of the challenges of the Power Technology Industry—the tendency to focus on the technology challenge as the driver of innovation rather than the underlying market need. For companies and the industry to grow, companies must strive to be market-driven. They need to identify market challenges and needs, and then collaborate and innovate to close the gaps.

For these reasons, the framework underlying this vision for the Power Technology Industry in British Columbia builds on two key principles:

- We should work from a ***broad and inclusive Power Technology definition***, rather than one that is narrow and exclusive, to ensure that we don't overlook existing emerging technology opportunities but instead create an industry portfolio with healthy diversity in technology risk.
- We should ***focus on specific market needs*** to define opportunities for regional strategies, rather than picking a specific Power Technology or set of technologies to make exclusive bets on.

We've used both of these principles to outline the industry definition and opportunity targets that follow.

## **THE POWER TECHNOLOGY INDUSTRY AND ITS GOODS AND SERVICES**

Regions are turning to power technology to improve the way electricity is generated, transported, and used. Supply side technologies move beyond the traditional oil and gas energy sources to focus on advances in alternative power production and fuel options to increase efficiencies and reduce emissions. Enhanced grid and delivery technologies make our energy systems smarter, cost effective and more reliable and enable these innovative supply choices. End-use technologies make our buildings, transportation, and equipment more efficient and provide tools to manage our energy use.

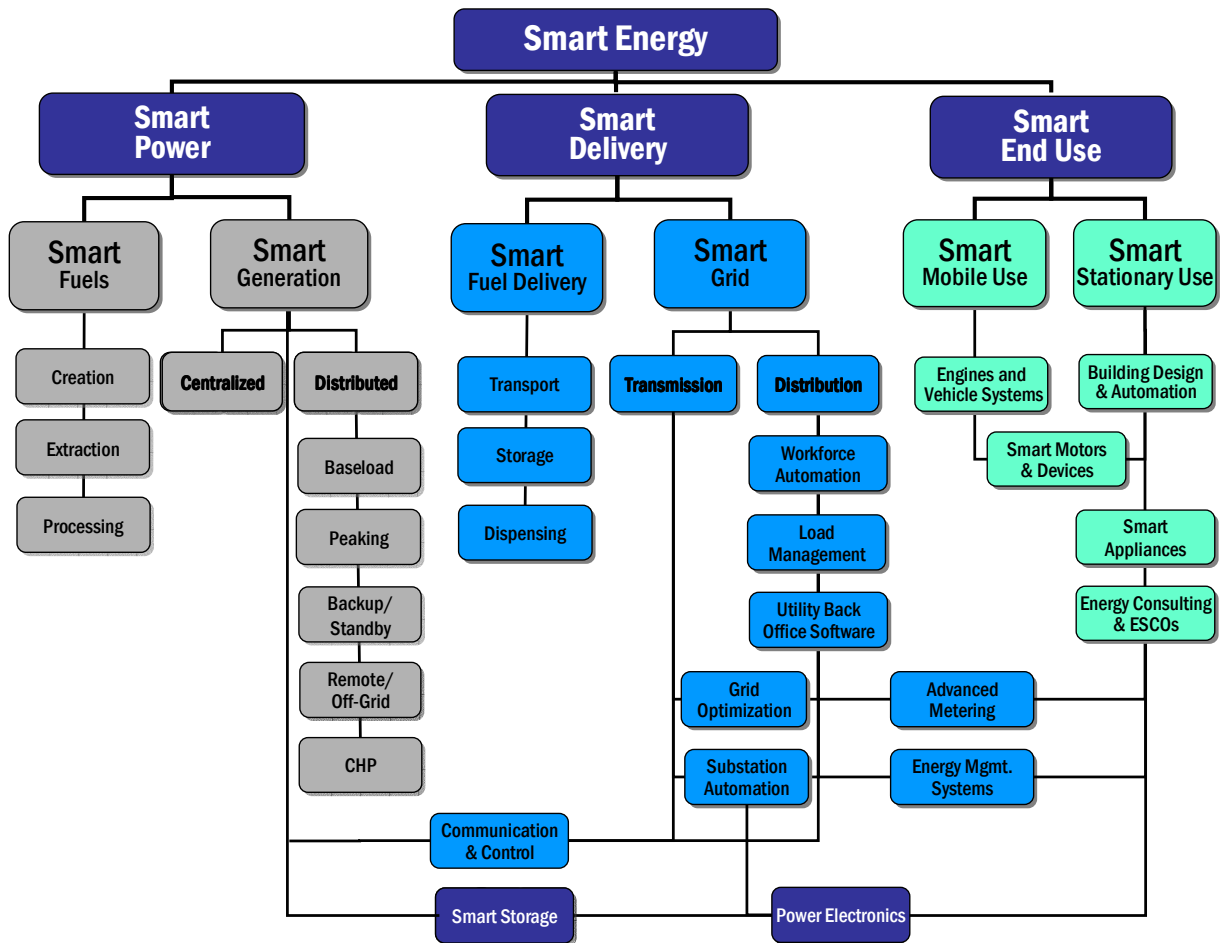


Figure 3: Smart Energy and its subsectors, from Center for Smart Energy..

The diagram above from the Center for Smart Energy outlines a number of key power technologies:

### SMART POWER

- **Smart Fuels** includes new fuel approaches for both transport and power needs (e.g. hydrogen, biofuels, geothermal, etc.), cleaner approaches to traditional sources (e.g. clean coal, low-sulfur gasoline) as well as technologies to extract and process these in cleaner, more efficient ways to make them generation or use-ready.
- **Smart Generation** includes alternative generation approaches, both large-scale centralized alternatives (e.g. wind, geothermal, ocean, tidal) and distributed generation systems located next to the point of use (e.g. fuel cells, solar, biomass, combined heat and power) that can be used for primary, back-up, stand-by, portable or programmable needs. It also includes storage mechanisms (e.g.

flywheels, batteries) that can be placed at numerous places from generation to use to make a system more robust.

#### **SMART DELIVERY**

- **Smart Fueling Infrastructures** includes the technologies used to transport and deliver fuels or convert them to more useful forms at the point of use in a secure, reliable and cost effective way.
- **Smart Power Grid** includes the technologies used to optimize operations to transmit and deliver electricity from generation to the point of use (e.g. Transmission & Distribution automation, communication and control systems), and technologies used to make distributed generation more effective (e.g. balance of system, energy routers, micro-grid devices)

#### **SMART END-USE**

- **Smart Stationary Use** Includes the technologies designed to make buildings require less energy (e.g. green building design, lighting efficiencies, material efficiencies), technologies to support better management of consumption and to make equipment and processes more efficient and power better suited to the use (e.g. energy information systems, measurement devices, variable speed drives, power factor controls).
- **Smart Mobile Use** Includes the technologies used to help make transportation solutions smarter, more environmentally friendly and reduce dependence on fossil fuel sources (e.g. fuel cells, hybrid motors, electric and natural gas vehicles).

These categories are not completely discrete; there are points of overlap. But they illustrate the broad impact that Power Technology has and the huge market this Industry represents.

### **WORLD DEMAND FOR POWER TECHNOLOGIES IS RISING**

British Columbia enjoys a fairly unique position, largely as a result of early and prudent investments in clean, renewable energy. Most British Columbians benefit from a robust, reliable power system where electricity is available and relatively inexpensive. We also currently enjoy the third lowest greenhouse gas emissions per capita in Canada, with very little change in CH<sub>4</sub> and N<sub>2</sub>O emissions in B. C. between 1990 and 2002<sup>7</sup>. There are ample sources of gasoline for our cars, and Canada is a net exporter of oil and gas without the dependence on foreign oil that other countries currently face.

So it might be harder for people living in our region to understand the growing world attention to the Power Technology Industry. For other regions not so lucky, though, they can probably relate to several key issues driving the need for more sustainable energy solutions worldwide:

### **ENVIRONMENTAL IMPACTS AND SUSTAINABILITY CONCERNS**

Concerns over climate change and other challenges in the globe's energy footprint are leading to collaborative efforts such as the Kyoto Protocol and the World Business Council for Sustainable Development (170 companies from 35 countries). Similar to demand and supply issues, these reactions ultimately drive increased investment both in alternative supplies as well as innovation that drives efficiencies up and consumption down. Governments are looking at alternative energy, power systems advances, and energy efficiency as ways to reduce future emissions and demand on the world's fossil fuel supplies.

### **DEMAND IS OUTPACING CAPACITY**

**For Fuels.** The issue over limited fossil fuels is one that everyone has had some exposure to. While there are always disagreements over when we will finally deplete supplies, there is little debating that for all practical purposes there are challenges around the supply of traditional fossil fuels. And the problem will only get more severe as large nations such as China and India modernize their economies and vastly increase the demand on fossil fuels.

**For Power.** The wholesale market for electric power is based on the fundamentals of supply and demand, and in the near term there is always a flux between the two depending mostly on weather conditions, fuel and plant availability, and wholesale market speculation. Longer term, though, the demand for electricity worldwide is predicted to nearly double in the next 20 years<sup>8</sup>. Locally, BC Hydro predicts that demand will increase nearly 35% over the next 20 years. Similar to British Columbia, other regions currently relying on large-scale hydro or other low cost, clean legacy systems for power are facing the challenges of meeting this growth by adding higher cost, less environmentally friendly sources into otherwise pristine portfolios. On one hand, future power needs will create opportunities for smart generation options with some utilities. While for other utilities, debt loads, concerns over price risk, and other issues will create incentives to invest in smart grid solutions and end-use management to reduce the need for new sources.

**For Transmission.** Experts are expressing concern over whether or not the transmission system over the next decade will meet the reliability standards

the economy requires. According to the Electric Power Research Institute (EPRI), the capital expenditures of the North American electric power industry during the 1990s were only 12% of revenues—less than half the historical average and representing an annual investment deficit at \$20B per year. That deferred investment is now coming due. Either the U.S. and Canada will pay to update the infrastructure, or they will experience continued degradation in power quality, reliability and cost. Power outages already cost the two countries more than \$100B per year, according to EPRI’s calculations (and this figure doesn’t take into account the excessive costs associated with the large scale blackout that plunged the eastern Provinces and States into darkness for days).

**ENERGY SECURITY ISSUES**

Energy security concerns both at home and abroad are driving governments around the world to look at alternative energy, conservation, and grid security as strategies to better secure their energy resources and reduce dependence on foreign oil supplies—in the case of those countries who are net oil importers.

**GROWING NEED FOR HIGH-QUALITY POWER**

Demands for electricity are increasing, and not just any power will do.

**TABLE 3 — THE COST OF POWER OUTAGES**

Industry	Hourly Cost
Cellular Communications	\$41,000
Telephone Ticket Sales	\$72,000
Airline Reservations	\$90,000
Semiconductor Manufacturing	\$2,000,000
Credit Card Operations	\$2,580,000
Brokerage Operations	\$6,480,000

Source: American Power Conversion

High-quality, high-reliability power is becoming an economic necessity in our connected, digital economy. (See Table 3.) It operates from the top to the bottom of the market, from the UPS needs of individual computer users to the power needs of small cell phone towers to the massive requirements of a major brokerage, creating opportunities for

distributed generation, power quality technologies, and end-use management solutions.

**COST COMPETITIVENESS OF ENERGY INTENSIVE INDUSTRIES**

Other traditional industries (e.g. pulp and paper, food processing, agriculture, etc.) have increased their focus on energy as a manageable cost and are investing in innovations to drive down their energy expenses and

increase their competitiveness. Governments have worked to support these industries with enhanced power systems and electricity that is more reliable, secure and less costly over time.

**QUALITY OF LIFE ISSUES TIED TO ENERGY AVAILABILITY**

Clean power to a region brings health and enables other benefits (e.g. universal internet access) to improve the quality of life in those communities. Governments are leveraging infrastructure investments in power resources and advanced grid technologies to bring power and digital communication capacity to communities.

Enlightened countries optimize technologies to reduce economic and environmental costs, while increasing reliability and availability. Advanced economies such as Germany, Japan, Denmark, Spain, U.K. and the United States are leading the way with incentives for conservation, efficiency, and renewable resources.

The impacts of all of these drivers has been a steady increase in the innovation and sales of goods and services in renewable and distributed generation (**TABLE 4**), advanced grid equipment, energy efficiency and transportation technologies.

**TABLE 4 – A GROWING POWER MARKET**

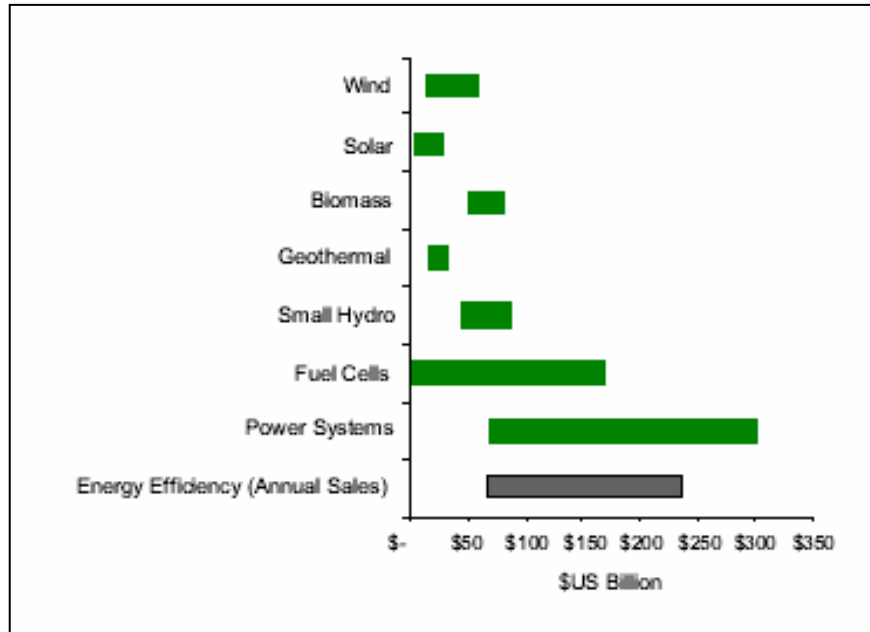
Market	Size Reports & Projections
Global Distributed Generation and Co-Gen Capacity	<ul style="list-style-type: none"> <li>▪ 53 GW in 2003<sup>9</sup></li> <li>▪ 78 GW in 2008<sup>10</sup></li> <li>▪ 300 GW by 2011<sup>11</sup></li> <li>▪ US \$30B opportunity by 2008<sup>12</sup></li> </ul>
Renewable and Hybrid Power Systems	<ul style="list-style-type: none"> <li>▪ US\$169.9 million in 2002</li> <li>▪ US\$895.2 million in 2010</li> <li>▪ Compound annual growth of 22% through 2010, and then higher to 2020<sup>13</sup></li> </ul>

Some studies have shown the growth of installed capacity and annual sales in various alternative energy, power systems, and energy efficiency are likely to grow significantly over the next fifteen years. Figure 4 below illustrates the worldwide value of installed clean energy capacity as estimated from a variety of international sources.

**Figure 4:**  
*Value of Installed Clean Energy Capacity*

*This diagram illustrates the growth of Global use by Technology, from 2000 to 2020. In the case of the clean supply technologies and power systems, it is a measure of installed capacity. In the case of energy efficiency it illustrates installed sales.*

*Source: Climate Solutions, compiled from IEA, ADL, ONL, EREN, EU Atlas and EIA*



## THE POWER TECHNOLOGY ECONOMIC DEVELOPMENT OPPORTUNITY

We know that a strong energy infrastructure can bring positive impacts to a region. Lower costs and higher reliability of power have a positive impact on the other industries in an area. A region known for a better environment and healthier living enables companies to attract talent. For regions that also provide Power Technology products, services and expertise, this sector represents a strong economic development opportunity. Power Technology provides a strong “triple win” in sustainability— economic, environmental, and social. (See Table 5.)

**TABLE 5 –TRIPLE BOTTOM LINE IMPACTS OF POWER TECHNOLOGY SOLUTIONS**

Economic	Environmental	Social
<p>New markets, revenues and jobs</p> <p>Lower costs and higher reliability of energy for other industries</p> <p>Ability to attract talent to a region that is clean and thriving</p>	<p>Reduced waste and emissions from both better supply and reduced demand</p> <p>Preservation of fossil fuel reserves</p> <p>Elimination and in some cases remediation of toxic substances</p>	<p>Reduced impacts on health, positive impacts on local communities, quality of life</p> <p>Benefits to disadvantaged groups—e.g. reduce digital divide</p> <p>Security and resilience from less dependence on fossil fuels and an energy system less vulnerable to attack</p>
<p>Source: Center for Smart Energy</p>		



**Revenues from Power Technology Companies.** Beyond the broad impacts on other industries, one of the biggest wins for British Columbia is the direct revenue and jobs from those employed in the power technology and energy sectors. Power Technology is a huge and growing market with numerous potential benefits to British Columbia. In the province, Power Technology comprises more than 60 companies employing more than 3,000 people and generating an estimated CAN\$700 million per year—the cluster is already bigger than the local telecommunications and biotech industries combined. Going forward, the opportunity is enormous. In a report released in 2000, experts projected that the global market for clean energy products and services would exceed \$3.5T from 2000 to 2020. The majority of the market will be in energy efficiency products and services. Power systems and clean energy production technologies are projected to exceed \$500B over this time period<sup>14</sup>. If our collaborative efforts accelerate this sector, we will bring in millions (eventually billions) in new revenues, much of it from serving world markets.

**Jobs from Power Technology Companies.** Power technology can also create high-paying jobs for scientists, researchers, engineers, professors, lab technicians and other knowledge workers. It also holds the potential for family-wage jobs, including technicians, trainers, operators, and programmers along with field sales, installation, repair and support.

No published estimate of revenues and jobs covers the breadth of the Power Technology Industry and such modeling of direct and indirect jobs is beyond the scope of this initial work. However, previous estimates generated on just a few of the emerging technology subsectors represented in British Columbia (e.g. clean production, fuel cells, ocean energy, and smart grid) put industry potential for direct employment at tens of thousands in this region alone over the next decades. (See Table 6.)

As a cluster opportunity, Power Technology offers the chance to build a group of companies that are highly diverse yet very synergistic. Power Technology companies draw from many core sciences that also enable other industries: advanced materials, power electronics, embedded systems, telecommunication, and many more. Developing products in this sector involve support industries (e.g. plastics, sheet metal, circuit electronics, traditional fabrication and manufacturing, etc.) increasing the positive impact these companies can have on the economic diversity of a region. These direct and broader benefits have been calculated by some as a factor of 5 jobs per million dollars in revenue<sup>15</sup>, making this a rich sector opportunity indeed. Even greater, local company Homeworks estimates that in the energy efficiency subsector, every \$1M leads to 36 jobs.

Regardless of the actual figure, many of those jobs could accrue to Canada and to British Columbia. However, if the region does not act quickly, some other region will take its place.

**TABLE 6 –PROJECTED ECONOMIC IMPACTS OF VARIOUS POWER TECHNOLOGIES**

Technology	Economic Development Projections
Low Impact, Renewable Electricity Sources	The Cleanair Renewable Energy Coalition and the Pembina Institute have estimated that low impact, renewable electricity sources provide an opportunity for the creation of between 12,700 and 26,900 jobs for Canadians by 2015. They predict that by 2020, over half of those positions will be focused on operations and management of installed facilities. This assumes a growth in capacity in low-impact renewable electricity to 35,600 MW through investments and incentives. <sup>16</sup>
Fuel Cells	Broadly, the global market for fuel cells is estimated to reach 19-35B by 2013 <sup>17</sup> . A significant market adoption in selected applications is expected to occur by 2010 with a widespread adoption of most applications by 2020 <sup>18</sup> . According to a survey by the U.S. Fuel Cell Council, fuel cell jobs in the U.S. reached 3,273 in 2002. Fuel Cells Canada attributes more than 1,200 jobs to fuel cells in British Columbia alone and 2,685 across Canada. It projects that number at 10,000 by 2010 and 30,000 by 2020.
Ocean Energy	OREG estimates that by 2025 the ocean energy sector will generate at least 25,000 MW, employ at least 10,000 people around the globe and generate worldwide sales of at least \$2 billion.
Distribution Grid Infrastructure	Cap Gemini estimates that the impending transformation of the distribution side of the grid (medium voltage, medium distance) will bring with it 30,000 to 50,000 new jobs in North America.

As more communities look for smart energy choices, they must buy those technologies from somewhere. British Columbia is poised at the edge of opportunity. We can (and should) become the providers of leading-edge power technologies to the world—the key a strategy of *Targeted Innovation* focused on solving the right market problems.

**BRITISH COLUMBIA’S OPPORTUNITY TO BUILD A COMPETITIVE ADVANTAGE IN POWER TECHNOLOGY**

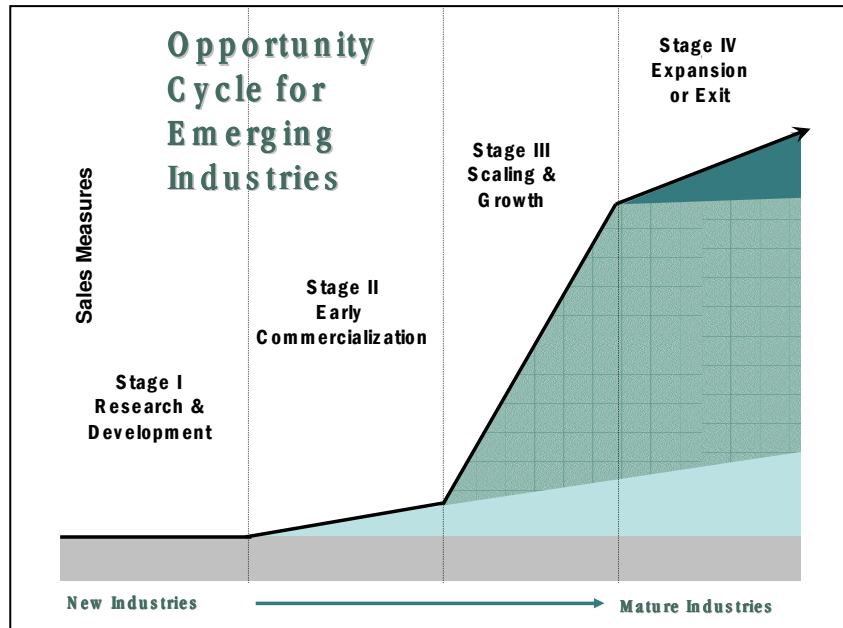
Michael Porter, the leading authority on cluster theory, described clusters as "critical masses in one location with unusual competitive success in specific fields." It stands to reason that as companies and clusters grow (see Figure 5), their underlying needs change. Building a cluster in a region means first understanding what companies and industries need as they move through this cycle.

Figure 5:  
Opportunity Cycle for  
Emerging Industries

This diagram shows how as sectors (and companies) grow, they move through various stages and have different needs.

Mature Industries have a portfolio of companies and efforts at all four points of the opportunity cycle. Cluster strategies must address the needs of each stage to support companies and industries as they grow.

Source: Center for Smart Energy



- **Research and Development.** Innovators discover new needs, make advances in foundational sciences, and develop innovations with commercial viability. They need funding support for those efforts, customers to develop with, and mechanisms for extracting and commercializing those innovations.
- **Early Commercialization.** Companies establish their first sets of customers to prove the value of the product to the market. Companies need testing resources to validate functionalities, demonstrations and pilots to prove efficacy and access to initial markets to build a foundation for growth into world markets. At this stage industries' need entrepreneurs to start-up companies and sources of risk capital—typically angels, VCs and government agencies—who are willing to fund this targeted development and early growth.
- **Market Growth.** Companies grow their revenues and expand sales and operations to move products from initial customers to market-wide acceptance. They need access to customers, distribution channels and key marketing partners to reach larger world markets. They need capabilities and capacity—specific managerial talents, manufacturing capabilities, facilities, etc. They need access to larger financing sources including debt, mezzanine private equity, or public markets.
- **Expansion and Exit.** Companies build from success in initial product and service areas by either expanding into new innovations and new markets or exiting out of the business to other players. Larger companies at this stage begin to transition from generating their own innovations to serving as channels for the innovations produced by

smaller companies, research programs and others. They need a supportive tax climate, strong regional branding and access to public capital markets.

For regions to build an effective cluster strategy, they need to align their local strengths with a set of specific needs along this opportunity cycle. In our own case, we have a number of strengths to build on, but also weaknesses that need to be recognized. (See Table 7.)

**TABLE 7 – REGIONAL STRENGTHS AND WEAKNESSES ACROSS THE OPPORTUNITY CYCLE**

Stage	Research and Development	Early Commercialization	Market Growth	Expansion and Exit
<b>Strong</b>	<ul style="list-style-type: none"> <li>▪ Strong power electronics, fuel cell, grid research capabilities</li> <li>▪ Some natural resources that can be leveraged into technology strengths</li> <li>▪ Other related industries for innovation—software, etc.</li> </ul>	<ul style="list-style-type: none"> <li>▪ V.C. industry to support early stage companies</li> <li>▪ Several world-class showcase opportunities underway or planned</li> <li>▪ Fuel cell manufacturing facilities</li> <li>▪ Some natural resources for electricity production</li> </ul>	<ul style="list-style-type: none"> <li>▪ Management talent to grow firms in this industry, and the ability to attract others to the region</li> <li>▪ Strong international market partnerships</li> <li>▪ Key companies with healthy operating profits</li> </ul>	<ul style="list-style-type: none"> <li>▪ Existing pioneers that serve as potential exit markets for local innovators</li> </ul>
<b>Weak</b>	<ul style="list-style-type: none"> <li>▪ Need more research targeted into additional technology areas where BC has relative advantages</li> <li>▪ Need more testing facilities to prove the engineering functionality of a product</li> </ul>	<ul style="list-style-type: none"> <li>▪ Need more pilots designed to prove the business value, followed by purchases</li> <li>▪ Need a government and utility framework that takes some innovation risk</li> <li>▪ Need local governments to avoid automatically putting local companies at a disadvantage in procurement</li> <li>▪ Many companies still operating at a loss</li> </ul>	<ul style="list-style-type: none"> <li>▪ Need immediate access to exports—companies can't survive for more than short time on small local markets</li> <li>▪ Need better support to access other Canadian, California and international growth opportunities</li> <li>▪ Need more sources of later-stage financing</li> </ul>	<ul style="list-style-type: none"> <li>▪ Need a region that better celebrates its success stories</li> <li>▪ Need more sources of later stage financing</li> </ul>

To build a strategy for growing this Power Technology cluster that is appropriate for British Columbia we have to face the reality that as a region, we do not represent a large volume of sales opportunity. We also don't have a reputation for low-cost manufacturing for large volume sales. So while California, China, and other areas can attract a cluster with the promise of access to massive local markets or low-cost labor, companies with those needs will not automatically be drawn to British Columbia.

But we can effectively compete in world markets to build a cluster here, if we leverage the strengths we do have to build a world reputation as a centre of innovation in smart power technologies. British Columbia can become a place where companies can innovate more effectively and get their products to world markets faster with a higher probability of success. This involves research and development, system integration, sales and marketing, and specialty manufacturing and assembly—all of which the Province is in a position to compete for. Because of their complexity and their high value-to-weight ratio, some Power Technology solutions could be manufactured in this region for export, although it is more likely that much of that manufacturing will go overseas. Even in the case where manufacturing and final assembly is likely to occur near major markets, research and development and pilot manufacturing could easily remain in the Province.

Based on this strategy to build the region as a centre of *Targeted Innovation*, we can grow the sector by leveraging our current assets to:

- **Target the right problems.** Build a Power Technology sector that is focused on targeted innovation that identifies solutions for significant market needs with growth opportunities that British Columbia’s companies can fill.
- **Get innovations to market quickly.** Find ways to shorten the time to market for products and services with policies and practices that encourage innovation and experimentation in the region.
- **Outreach to the world.** Strengthen and leverage our regional brand and connections to other large export markets (e.g. China) to provide market access for locally proven products.
- **Continue to innovate.** Support centres of innovation around these targeted market problems and selected underlying technologies where we can build a regional competitive advantage.

Properly executed, this strategy leads to retaining and growing existing companies, encouraging new start-up activity, and attracting additional companies large and small from outside of the region to relocate some or all of their operations in British Columbia.

## **BRITISH COLUMBIA STRENGTHS SUPPORT A TARGETED INNOVATION-BASED CLUSTER STRATEGY**

Fortunately, this strategy of *Targeted Innovation* suits British Columbia. The region has many advantages that it already leverages to play a leading role on the global stage and can build on this foundation to strengthen and grow the cluster. We’ve listed strengths across the opportunity cycle in Table

7, and here we highlight some of those that represent a strong foundation across a variety of sectors in the Power Technology Industry.

#### Sidebar 5 – Ballard Power Systems Lays the Foundation for Regional Fuel Cell Strengths



Ballard Power Systems is a recognized leader in proton exchange membrane fuel cells and anchors the Vancouver fuel cell cluster. Ballard is commercializing fuel cell stacks, fuel cell engines and electric drives along with fuel cell stacks for portable and stationary uses. It has also developed power electronics to convert power generated by photovoltaics, fuel cells, and microturbines.

Ballard is also a Tier 1 supplier of friction materials to the automotive industry for automatic transmissions as well as a supplier of carbon fiber paper gas diffusion layers (GDL) to the fuel cell industry. Ballard's proprietary technology

enables vehicular (automobile and bus) electrical equipment, portable power and stationary product manufacturers to develop more environmentally friendly power generation and mobility products. Ballard's presence in the region has also attracted significant investment here through angels, venture firms such as Ventures West, Crysallix and Yaletown Venture Partners, and the NRC that established a fuel cell institute at UBC to support the cluster. Most recently the fuel cell group collaborated to build a vision for a Fuel Cell and Hydrogen Strategy and have continued to build support for those technologies.

Ballard continues to play a key role in the community through technology creation, wealth generation and the addition of talent to management pool. Ballard now has facilities in Burnaby, BC, Dearborn, Michigan and Lowell, Massachusetts and in Germany (Nabern).

#### PIONEERING COMPANIES IN SELECT TECHNOLOGY AREAS

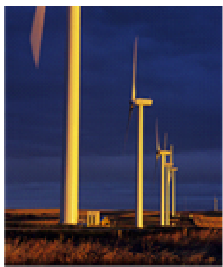
Successful clusters almost always have at least one successful pioneer. The Vancouver cluster developed from the early activities of Ballard Power Systems in fuel cells. (See Sidebar 5.) Founded in 1982, the company has approximately 570 employees in the province and 980 worldwide. It anchors a group of the world's most significant fuel cell companies and component manufacturers. Ballard's proton exchange membrane (PEM) fuel cell is a leading solution adopted by global auto and energy companies. Other regional fuel cell integrators and component supply companies have followed Ballard's lead, developing innovations across the spectrum of stationary and mobile market segments.

Former employees from Ballard Power Systems have moved on to found new corporations. One notable example is Xantrex, one of the region's economic development success stories. With annual revenues of more than CAN\$170M and over 300 local employees, Xantrex has helped put British Columbia on the world map for distributed energy systems. (See Sidebar 6.) Xantrex, in turn, has been the source for new start-up activity as former executives and members from the company take on key roles in new local companies. Other pioneering companies include Power Measurement (Sidebar 24), Westport (Sidebar 21) and many others. (See Selected Company Profiles in Appendix B.) As a result of these early pioneers, the

local Power Technology Industry enjoys a pool of skilled labor, skilled management and informed capital.

### Sidebar 6 – Xantrex leads the Way in Market Growth

Xantrex Technology Inc. is a world leading developer, manufacturer and marketer of advanced power electronics products focused on the high growth distributed, mobile and programmable power markets. Xantrex's products convert and control electricity from any source to provide cost effective, reliable, high-quality electricity as part of an integrated system.



Wind farm in Megra, Alberta uses Xantrex converters

Xantrex has over 500 employees, mostly located in Burnaby. It has 2004 revenues of US\$143.1 million (90% from outside Canada), up from \$10 million in 1998, a compound annual growth rate of over 60%. It is profitable and publicly-traded on the Toronto Stock Exchange. Advanced technologies permit Xantrex to offer products that are tailored to the needs of its customers and are smaller, lighter, smarter, more efficient and more reliable

than traditional power conversion equipment. Xantrex has over 20 years of experience in the field of advanced power electronics, and in its chosen markets it is a market leader in terms of sales, range of products, brand name and technology. It has a strong intellectual property portfolio, including more than 100 granted or pending patents.



San Francisco's Moscone Convention Center solar power system uses Xantrex converters

Xantrex's diverse customer base includes leading original equipment manufacturers, distributors, systems integrators, large retail chains and specialty retailers

across the world. Xantrex is headquartered in Burnaby BC and has facilities in Arlington, WA; Livermore, CA; Elkhart, IN; Barcelona, Spain; Reading, UK; and Beijing, China.

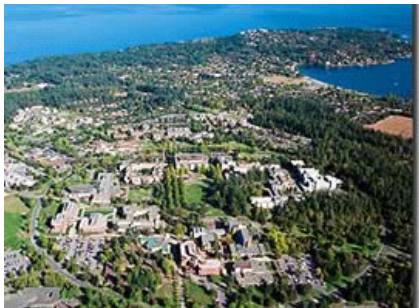
### STRONG RESEARCH CAPABILITIES

For British Columbia to succeed in Smart, Sustainable Power Technology, it has to continue to innovate around relevant local and world problems. Breakthrough ideas often come from the labs, and British Columbia is blessed with several important facilities. Almost as important as the research capabilities are the mechanisms to extract the innovations, and British Columbia is strong here as well. We've listed the most notable academic research and commercialization examples in alphabetical order below.

**The British Columbia Institute of Technology** near Vancouver, BC delivers certificates, diplomas, and degrees in technologies and trades. It also conducts applied research. Although most of its past energy efforts have centered on solar photovoltaic, it has begun to offer classes and research for fuel cells. Its Venture Development Centre provides advice and guidance in product commercialization and business development.

**The University of Victoria** provides research and development in a wide range of Power Technology. Positioned as one of the most energy efficient post secondary institutions in the province, the UVic is home to the Institute for Integrated Energy Systems which focuses on advanced energy systems

and works on leading research in alternative energy and fuel cell technology. (See Sidebar 7.) UVic also invests in green power certificates through BC Hydro, which directly fund the research and development of renewable energy resources in British Columbia. It hosts graduate and undergraduate programs in fuel cell modeling and fuel cell diagnostics. Students and staff are also doing core research to analyze local ocean resources available for energy. In addition, UVic's Innovation and Development Corporation helps researchers develop the commercial potential of their ideas. In 2001, for instance, it assisted 18 UVic spin-off companies and filed patents for 45 new inventions based on UVic research.

Sidebar 7 – Institute for Integrated Energy Systems	
 <p>The Institute for Integrated Energy Systems at the University of Victoria researches new technologies for sustainable energy. IESVic is widely known for its work in fuel cells; IESVic also researches energy systems and energy policy. The former includes work with industrial partners to provide access to specialized knowledge and</p>	<p>equipment as well as work on how to integrate alternative energy into the power grid. The latter includes work with government partners to support policy and decision making.</p> <p>The Integrated Renewable Energy Experiment (IRENE) is IESVic's solution for addressing the intermittent nature of renewable energy sources. The project will use excess electricity generated from renewable energy sources to produce hydrogen as a form of energy storage, for use in hydrogen fuel cell systems.</p> <p>Research capabilities include product design and manufacturing; materials testing; engineering mechanics; market analysis; and socio-economic studies. The Institute also promotes energy systems education at all levels, formally and informally, to convince the world of the critical need for new and sustainable energy systems.</p>

**The National Research Council Institute for Fuel Cell Innovation (NRC-IFCI)** in Vancouver, BC, is home to the NRC Fuel Cell Program. In collaboration with industry, universities, and other government agencies, the program provides research and innovation support in areas such as fuels research, system integration, manufacturing, and component development. NRC has also funded hydrogen-safe labs and testing facilities. Infrastructure includes demonstration facilities for new technology and incubation space for startups.

**Simon Fraser University** has three campuses in the Vancouver, BC area. The university offers graduate and undergraduate programs to approximately 25,000 students. Simon Fraser has world class policy expertise on sustainability and continues to innovate in the education and research of sustainability. It also conducts research on the polymer science and

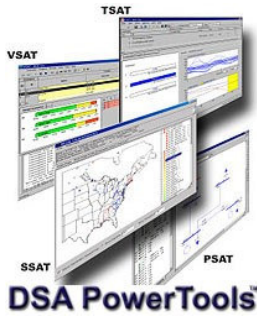


electrochemistry of proton exchange membrane fuel cells, as well as other key power technology areas.

**The University of British Columbia** conducts more than 4,000 research projects and attracts upwards of \$200M in research funding annually from government, industry, and non-profit foundations. UBC has numerous teaching and research initiatives around sustainable development and green design, renewable energy supplies, and international energy issues, and sustainable energy systems including the Clean Energy Research Centre and the Sustainable Development Research Initiative. The Department of Electrical and Computer Engineering offers undergraduate and graduate programs in power, control and electromagnetics, including programs and research into power electronics. UBC hosts the NRC Institute for Fuel Cell Innovation (see above) and conducts numerous other research programs relevant to fuel cells. For instance, the Chemical and Biological Engineering department is actively developing fuel cells as a cleaner, more efficient energy source.

**Powertech Labs Inc.** is a world-renowned technology centre located in Surrey, BC. A wholly owned subsidiary of BC Hydro, Powertech provides an extensive range of leading-edge consulting, testing and R&D services to electric power, auto and gas industries, and others. Powertech has a wide array of technical expertise in various specialized aspects of electrical, civil, mechanical, chemical, metallurgical and materials engineering disciplines. It has several specialized well equipped laboratories: high voltage, high power, high current, mechanical, materials, coatings, chemistry and civil engineering laboratory. Considered a leader in high-pressure gas storage and fueling technology, Powertech has deployed the first station on the Hydrogen Highway – the first 10,000 psi gaseous hydrogen fueling station in the world – partnering on this and other related projects with Shell, ChevronTexaco, BP, BOC, Fuel Cells Canada, Toyota, Nissan, Ford, Daimler Chrysler and Hyundai. Powertech provides a variety of services related to alternative energy technologies and is collaborating with industry in the development of a local ocean energy capability. With a worldwide recognition for its expertise in power system stability and control, Powertech also provides analytical tools and consulting services for the design and secure operation of interconnected electric power systems. (See Sidebar 8.)

## Sidebar 8 – BC Powertech Labs Secures Complex Power Systems



Power system security has become a critical concern following the numerous power system blackouts that have occurred around the world in recent years.

Powertech Labs of Surrey, BC has established itself as a leader in the development and commercialization of leading-edge security assessment software tools for the design and operation of electric power systems. With over 50 licensed users world-wide, Powertech's DSA

PowerTools™ provide the capability for comprehensive analyses of the performance of complex power systems necessary to optimize system design during planning and to assess system security during system operation. The DSA PowerTools™ have been installed "on-line" in power system control rooms to provide operators with near-real-time information on system security. Several major power system operators in the USA, Ireland, New Zealand, and China are using the software in this manner. Powertech operates one of the best equipped and most advanced high-voltage testing facilities in North America.

Building a successful cluster depends in part on drawing from labs and research centres. BC is blessed with several important facilities like Powertech Labs that develop commercializable technologies.

**Vizon SciTec** is an integrated contract science and technology development company that provides analysis, technical solutions and scientific support to vital BC industries including forestry, mining and fisheries. Originally founded in 1944, Vizon began as a publicly funded contract research institution called BC Research and was privatized in 1993 and renamed in 2004. With a staff of approximately 65 scientists, technicians, and business professionals on the 185,000-square-foot facility near UBC, it provides complete scientific, technological, and logistical support services for clients and partner companies. The laboratories incubate over 20 companies involved in biotechnology, green energy, chemical industrial processes, and pharmaceuticals. Numerous companies, including Azure Dynamics and Radiant Technologies have been spun off into successful and viable ventures.

Beyond these research programs, corporate R&D is a significant asset regionally. Canadian fuel cell companies alone spent on average over \$100,000 per employee in R&D in 2003, approximately \$290M overall.<sup>19</sup> Many new companies across the Power Technology industry have been working on break-out technologies that represent new opportunities in their respective sectors, including Day4 Solar with its innovative solar technology (Sidebar 13), and Delta-Q with its advances in vehicle charging and others. (See more company profiles in Appendix G: Profile of Selected Companies.)

### **NATURAL RESOURCES AND GEOGRAPHIC ADVANTAGES**

Our region has a number of natural resources that can be leveraged for supply and delivery innovations. British Columbia's heritage includes

hydropower, long distances between metropolitan areas and shipping power back and forth to California. As a result, it has a large network of transmission lines and deep expertise in grid issues — transmission modeling, design, planning, and installation.

We have strong natural resources in ocean energy, tidal current, run-of-river, etc. (Sidebar 27.) We also have wind resources in British Columbia and across Canada that could be harnessed. We also have a large supply of wood and timber that can be converted to pellets or other forms and used for generation and fuels. We also have a large deposit of low-sulfur coal and beds of highly fractured coal that could be used for coal-bed methane.

We are also well suited to reach some of the large-growth international markets. We have good proximity (for North America) to high growth Asian markets like China and India. There is considerable potential for cross-border partnerships and exports. The Hydrogen Highway (see Sidebar 22) is an opportunity to link forces with the entire western coast of North America and create a network of partners to serve this emerging market.

Washington and Oregon contain some of North America's most important smart grid research centres and testbed efforts. British Columbia has already cooperated on region-wide initiatives in smart energy that have the potential to grow to large-scale pilots and, eventually, to very large U.S. and international markets for British Columbian products.

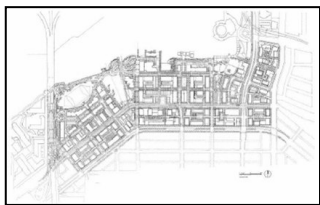
## **REGIONAL DEMONSTRATION PROJECTS AND EXPOSURE IN THE 2010 SUSTAINABLE OLYMPICS**

Plans for regional implementations of innovative power technologies abound. Examples include the proposed Hydrogen Highway, the UniverCity at Simon Frasier University, and smart building technologies at Whistler. At this stage, demonstration projects are best when they prove not only the engineering feasibility but also demonstrate the business value of a new innovation—especially when customers are willing to provide the data to others who might be interested in the innovation.

The 2010 Sustainable Olympics is being billed as the first “sustainable” Olympics, and represents an opportunity for British Columbia to promote itself world-wide as a leader in sustainability and related power technologies on the supply and demand side. A number of high-profile demonstrations are planned, including SE False Creek Sustainability Precinct (Sidebar 18), the Britannia Project (Sidebar 16), Whistler Village, and Olympic Housing (Sidebar 9). If this opportunity is used strategically, additional companies could be attracted to the region as part of those efforts. In addition to the 2010 Sustainable Olympics, the World Urban

Forum, Globe and other related sustainability events are both evidence of and an asset to the region's reputation as a leader in this thinking.

### Sidebar 9 – How the BC Sustainable Olympics Could Revolutionize Sustainable Housing



The 3,000 athletes who stay in the Olympic Village during BC's 2010 Winter Sustainable Olympics may be part of more than just sports history. They may be seeing the future of

sustainable housing—and of BC's global leadership in that field.

Now in the planning stages, the Olympic Village will be placed in a real-world housing development that will convert to normal use when the Games end. That housing development will include dozens of "cutting edge" innovations:

- \* Geothermal heat and 100% sustainable green power
- \* 25-30% reduction in energy use and zero greenhouse gas
- \* Hydrocarbon eating bacteria to reclaim the formerly toxic site
- \* Rooftop gardens watered with captured rainwater
- \* Onsite treatment ponds for household grey water

"Through the adoption of the SEFC ODP, Vancouver City Council has made a conscious decision to bring sustainable development into the mainstream development sector, embracing triple bottom line accounting to ensure the inclusion of social, economic and environmental sustainability in a way that has yet to be seen in North America," said Thomas Osdoba, Manager of the Sustainability Group, City of Vancouver.

Experience has shown that model projects can have a large impact—both on the adoption rate of new technologies, and on the "brand image" of a region. "In 2010, we want to be standing on the world's stage with a Canadian product with Canadian expertise, Canadian talent, Canadian technology," said Jeff Olson of VIA Architects, the project's urban design consulting firm.

A noble vision for the Village—and for BC's entire power technology cluster.

### PROGRESSIVE UTILITY AND GOVERNMENT LEADERSHIP

Enhancing sustainability through innovation requires enlightened approaches across the region. This is true especially for the regional utilities, as they make decisions that affect the province's overall approach toward energy optimization. Luckily, utility leadership has made a commitment to sustainable management of current and future business and has set twenty year environmental targets that will create opportunities for Power Technology. BC Hydro has both the necessary experience and the necessary "mind-set" — an interest in and openness to advancing technology and has collaborated in the targeted development of several regional companies. (See Sidebar 10.) With a policy framework that supports innovation, our local utilities can be a major asset in the targeted development, testing and early commercialization areas.

## Sidebar 10 – BC Hydro’s Forward-Thinking Demand-Side Management Efforts



As it has in the past, BC Hydro’s Power Smart

Program will implement innovative new technologies that enhance the utility’s ability to deliver energy savings. Power Smart will explore the benefits of time-of-use rates, revised energy codes for buildings, advanced metering and micro grids, along with dozens of other leading-edge opportunities to enhance customers’ demand side management opportunities.

Currently, for example, Power Smart is working with the City of Prince George is to test light-sensing controls in 170 streetlights as part of the first remote streetlight management system in Canada. The project will allow the city to reduce its energy use and costs by approximately 40 percent by reducing overlighting during off-peak hours when there is little vehicle and pedestrian traffic.

Complementing Power Smart’s drive toward energy efficiency is a visible increase in customer demand for smart energy solutions. Developments such as Victoria’s Docksider Green – a \$300M, 12-acre sustainable residential development that will incorporate an on-site green energy source — and the Centre for Interactive Research on Sustainability are creating and requesting sustainable DSM solutions. In addition, programs such as COOL Vancouver, the City of Vancouver’s commitment to greenhouse gas reductions, are driving innovation and building demand for energy efficiency programs. .

Power Smart will continue to partner with government, business, industry and communities to maximize its future ability to deliver energy savings. All of these programs and initiatives represent future demonstration and market opportunities for Power Technologies.

Governments at all levels have taken steps that have positive implications for the Power Technology cluster. The provincial government is investing to increase the number of electrical, electronics and software engineers. Provincial and local governments are working on sustainability initiatives, greening of fleets and buildings, and other related efforts. Nationally, Canada has made a number of commitments to advance select technologies. One example is the Canadian Transportation Fuel Cell Alliance, a \$23M initiative to demonstrate and evaluate fueling options for fuel cell vehicles. Another is Fuel Cells Canada (FCC), a national nonprofit association established to advance Canada’s fuel cell industry. Canada has also put in place production tax credits and other incentives to grow wind resources in the country.

### **POWER TECHNOLOGY FUNDING SOURCES**

British Columbia has two key energy V.C.’s in Ventures West and Chrysalix. They are joined by Growthworks, Cyprus Capital, Yellowpoint Capital Partners, Yaletown Ventures, and others who have pursued investments in the Power Technology sector. Other financial resources supportive of the sector include Royal Bank, HSBC, VanCity, Business Development Bank of Canada and Bank of Montreal. There are also funds targeted on sustainability challenges that Power Technology Companies can access, including Sustainable Development Technology Canada (SDTC), and Technology Partnerships Canada (TPC) and various Natural Resources Canada Programs.

The key to this *Targeted Innovation* strategy is the leadership and vision to leverage our existing assets and make future investments in line with the right market needs, and demand coordination throughout the region to outreach to world markets.

## **FIVE OPPORTUNITIES WITH WORLDWIDE MARKETS**

For this vision and strategy to work, British Columbia Power Technology companies need to continue to be market driven and target their efforts at challenges that are meaningful to British Columbia and also represent world-wide market opportunities where British Columbia could have a competitive advantage. From the existing research and discussions with industry experts, five areas emerged that are both key for the Province and also represent some of the biggest opportunities world-wide:

- Remote Power Solutions
- Sustainable Urban Practices
- Smart Transport
- Smart Grid
- Large Scale Clean/Green Power Production

### **REMOTE POWER SOLUTIONS**

Integrated power systems that combine renewables, storage solutions and efficiency measures to meet the power needs (electricity, heating and cooling) of remote communities and applications. British Columbia has 60 remote communities not integrated into the system; there are 300 across Canada. Where they do have power, it is generally at an energy cost up to 10 times higher than the rest of Canada, and produces about 200,000 tonnes of GHG emissions every year.

Worldwide, the growth in demand for remote power systems for village power and off-grid solutions is huge. China, India, South America are leading the way in electrifying their villages, and are looking for forward-thinking, integrated solutions that leverage the best of their own natural resources.

British Columbia has Power Technology companies that provide off-grid distributed systems, inverters and other balance of system components to countries all around the world. We have advanced development underway in areas such as ocean wave, tidal current, and biomass that could be used to serve larger community-based generation projects in remote communities. We also have original research into hydrogen production from renewables that could be used to firm up renewable off-grid solutions.

See more details about Remote Power opportunities, assets and strategies in Appendix A.

### **SUSTAINABLE URBAN PRACTICES**

Planning approaches and building design that optimize energy sources and use in dense urban settings, grid-tied distributed generation systems, demand-side management and tools to manage energy consumption of industrial/commercial processes.

Growth in green buildings and other related concepts in Sustainable Urban practices has been explosive across the United States, Europe and elsewhere. British Columbia can use these approaches to effectively manage the impact of its own urban growth.

British Columbia has some of the world's leading experts in sustainable community planning, green building design and development, multiple providers of grid-tied distributed systems, and progressive utility leadership that has made a strong commitment to meeting a third of load growth through demand side management innovation. There are a number of strong academic and professional programs in sustainable urban practices, as well as a number of proposed showcases including the Centre for Interactive Research on Sustainability.

See more details about Sustainable Urban Practices opportunities, assets and strategies to move forward in Appendix B.

### **SMART URBAN TRANSPORT**

A portfolio of solutions that solve high-energy urban transport challenges—public transport, ports, and urban hauling—and build the Hydrogen Highway and infrastructure for fuels of the future.

Transportation is one of the world's leading sources for emissions, and is a major focus of climate change discussions and proposed policies. Fuel cells, hybrids, natural gas engines and other advances are seeing worldwide attention, and several countries have joined British Columbia with large investments into those technologies as potential solutions for transportation systems of the future.

British Columbia has the world's leading firms in public transport solutions providing engines that leverage new approaches to fuels. We are taking the lead in the fueling infrastructure of the future with world-class research

and high profile Hydrogen Highway showcase opportunities with the upcoming Sustainable Olympics.

See more details about Smart Urban Transport opportunities, assets and strategies in Appendix C.

### **SMART GRID SOLUTIONS**

A set of hardware, software, and power electronics to update and automate the world's power grids, to integrate renewables and distributed generation and to enable advanced approaches to demand side management.

Decades of underinvestment in the grid has created a capacity and operations crisis for many regions, but new technologies hold the promise of being able to get more efficiencies, better control, and more reliable operations out of assets. Grid investments are expected to climb and newly industrialize economies will likely leapfrog over traditional technologies right to new, smarter innovations.

British Columbia has leading researchers in grid optimization, and as part of the Pacific Northwest is already a recognized centre of excellence for leading grid technology companies and innovation.

See more details about Smart Grid opportunities, assets and strategies in Appendix D.

### **LARGE SCALE CLEAN, GREEN POWER PRODUCTION EXPORT**

A robust energy market of alternative power production (e.g. wind, biomass, ocean energy, etc.) from independent power producers and other sources that meet our region's needs to convert to cleaner, greener resources and provide surplus to sell into the western power market.

Driven by consumer interest and government mandates, the market demand for clean and green resources will rise. In the near-term, that translates into strong potential for electricity sales from IPP projects in our region that leverage large scale renewables. As the market grows and more centralized renewable sources are sited, there will be increased demand for the technologies that support the design, build and operation of that production.

British Columbia has natural resources that could be leveraged into robust production in ocean wave and tidal current, geothermal, wind and other large centralized renewables. In some cases, regional companies' innovations could lead to a strong export market in technologies and



project development for other countries who want to install their own local large scale production to tie/sell to the utility market (e.g. new solar technologies and ocean wave and tidal current).

See more details about Large-Scale Clean and Green Production opportunities, assets and strategies in Appendix E.

These areas have implications for the triple bottom line for British Columbia. They also represent opportunities where world demand is growing, where our assets can be built into a world presence, and where we can take clear steps to move forward.

# REGIONAL ACTION PLAN TO GROW THE POWER TECHNOLOGY CLUSTER

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**We have the need. We have the opportunity. We have the assets.**

**We also have competition.** Other regions will be happy to sell the world Power Technology for a modern, smart, sustainable electric system and transportation solutions. California, Connecticut, Massachusetts, Michigan, and Texas have all set aside millions to promote the creation of specific energy technology clusters in fuel cells and other alternative energy. Japan and Germany have taken the lead in solar power. Denmark, Germany and Spain dominate wind power. Even in Canada, other provinces like Ontario and Quebec are moving ahead on this emerging opportunity and adding to previous commitments to the industry. For instance, Ontario recently announced that it would launch a Centre for Excellence in Energy that would encourage research and development into leading edge and emerging energy sources and technology.

We can grow the sector through collaboration among industry, government, NGOs, First Nations and academia and leverage current assets to accomplish:

1. **LEADERSHIP—Establish leadership, targets and resources for the five key world-wide opportunities** and let the most suitable technologies rise to the right challenges.
2. **COMMERCIALIZATION—Speed early commercialization in the five opportunity areas** with support for commercialization activities, incentives for local demand, and removal of utility barriers to help British Columbia companies get innovations to market faster.
3. **GROWTH—Access world markets in the five opportunity areas** through regional branding, industry coordination, and targeted outreach that establish the image of British Columbia as a world leader in power technologies and give local companies the relationships, opportunities and capabilities they need to grow.
4. **INNOVATION—Develop streams of research in the five opportunity areas** with centres of innovation and education programs to give local companies access to the best talent and development opportunities to maintain the region's value proposition as the world market grows.

**TABLE 8 – STRATEGIES TO GROW THE POWER TECHNOLOGY SECTOR**

Targeted Market Opportunities	
Five Areas with Worldwide Markets and British Columbia Needs	<ol style="list-style-type: none"> <li>1. Remote Power Solutions</li> <li>2. Sustainable Urban Practices</li> <li>3. Smart Urban Transport</li> <li>4. Smart Grid Solutions</li> <li>5. Clean, Green Exports</li> </ol>
Strategy	Actions
1. <b>LEADERSHIP:</b> Establish Clear Targets for the Industry	<ol style="list-style-type: none"> <li>1.A. <b>Goals.</b> Promote Economic Development Goals for the Power Technology Sector</li> <li>1.B. <b>Leadership.</b> Establish Leadership and Working Teams to Coordinate Industry Collaboration</li> <li>1.C. <b>Plans.</b> Build a Full Implementation and Resource Plan that Prioritizes, Schedules and Coordinates Around the Vision</li> </ol>
2. <b>COMMERCIALIZATION:</b> Speed Innovation to Local Markets in the Five Opportunity Areas	<ol style="list-style-type: none"> <li>2.A. <b>Local Demand.</b> Grow Local Demand through Increased Government Procurement, Mandates and Incentives Across the Region, and Changes to the Local Utility Policy Framework</li> <li>2.B. <b>Commercialization Fund.</b> Establish a Fund for Targeted Commercialization through Demonstration and Pilots of Previously Tested Power Technologies to Now Prove the Business Value</li> <li>2.C. <b>Testing and Showcasing.</b> Increase the Attention and Resources that Utilities and Key Industries have Available to Test the Engineering Capability of Specific Technologies.</li> </ol>
3. <b>GROWTH:</b> Access World Markets in the Five Opportunity Areas	<ol style="list-style-type: none"> <li>3.A. <b>Industry Partnerships.</b> Industry Should Work Together to Tailor Solutions and Leverage Marketing Channels to the Five Opportunity Areas</li> <li>3.B. <b>Branding the Region.</b> Brand the Region as a Leader in the Five Areas of Opportunity</li> <li>3.C. <b>Outreach to Markets and Capital.</b> Outreach to World Markets with Coordinated Efforts Across the Region</li> </ol>
4. <b>INNOVATION:</b> Develop Streams of Research in The Five Opportunity Areas	<ol style="list-style-type: none"> <li>4.A. <b>Targeted Research.</b> Support Centres of Innovation in Key Markets and Technology Areas and Coordinate with Corporate R&amp;D Efforts to Target These Opportunities</li> <li>4.B. <b>Human Capital.</b> Connect Existing Efforts in Basic Sciences to Power Technology Applications</li> </ol>

These strategies represent the best way to move the industry forward, and are framed and ordered to reflect what is most critical to the industry’s success. An Individual company’s strategy may differ somewhat; they may put more emphasis on issues later or earlier in the cycle based on their company or particular subsector. This set of initiatives is not meant to disparage those particular company strategies or needs, but rather these initiatives are put forth as the best way to leverage British Columbia’s relative strengths to move the industry as a whole forward. This strategy emphasizes leadership and commercialization first, recognizing that there is a lot of innovation in the industry, but there are fewer examples of companies that have made it through the cycle enough to experience strong

operating profits (e.g. Xantrex, Power Measurement). The strategy underscores the importance of the early commercialization stage in the cycle and companies' needs during that stage.

We'll now describe each of these strategies and initiatives, with the assumption that these initial ideas would eventually be fleshed out in more detail in an implementation plan.

## **1. LEADERSHIP**

### **STRATEGY:**

#### **ESTABLISH LEADERSHIP, CLEAR TARGETS AND RESOURCES FOR THE INDUSTRY**

This document creates a place to start the discussion around a vision for the Power Technology Industry, but strong leadership, coordination, strategy and an investment plan are important to making sure that these efforts add up to the economic development goals outlined in the last point.

#### **1.A. PROMOTE ECONOMIC DEVELOPMENT GOALS FOR THE POWER TECHNOLOGY SECTOR**

The Premier needs to reinforce the link between the Power Technology cluster and the value in economic development. Specific goals and metrics strengthen the ability of a region to take the first steps and begin moving toward a vision. The Premier and his government should work with the industry to establish and communicate objectives for the sector around economic growth, job creation, competitiveness and environmental protection.

#### **1.B. ESTABLISH LEADERSHIP AND WORKING TEAMS TO TAKE THE VISION FOR EACH OF THE FIVE OPPORTUNITY AREAS FORWARD**

The Premier should establish a Vision Team to carry forward the discussions and design of future initiatives and efforts across these recommendation areas. This Vision Team would be made up of key leaders across the region, and would be responsible setting out vision, and working with the Premier to coordinate efforts between industry and government to ensure that this recommendation for leadership is met.

The Vision Team would be supported by several interrelated working groups that focus on 1) how to move forward the five market opportunity areas, and 2) how to strengthen the assets in early commercialization, growth, and innovation necessary to support the five opportunity areas. These working groups would include many overlapping members, and would need to work in a tightly linked way. The working group approach allows the industry to flesh out the *Targeted Innovation* strategy and identify and

work on coordinated initiatives that move the Power Technology cluster forward. (See **Error! Reference source not found.**)

### **1.C. ESTABLISH LEADERSHIP AND WORKING TEAMS TO TAKE THE VISION FOR EACH OF THE FIVE OPPORTUNITY AREAS FORWARD**

The Premier and the Power Technology Industry should collaborate to set out clear goals, strategies and initiatives to move the sector forward, including specific economic development goals and strategies for each of the five target areas, along with leadership and project coordination to implement the vision.

**1.C.1. Priorities and Initiatives.** In this paper, we've outlined some ideas about what each of the five opportunity areas needs to be successful (summarized in Table 1 on page 15). In the rest of this recommendation section, we outline additional ideas that should be implemented across each of the areas to build a successful cluster. These preliminary thoughts should be taken as a starting point for more discussions to add the next level of design and detail. The strategies should be prioritized into key initiatives based on which efforts will yield the best near and long-term economic development benefits. The initiatives should be built into a project plan and a set of tools that can be used to help communicate and coordinate.

**1.C.2. Resource Plan and Specific Funds.** The Premier should work with his government and the Power Technology Industry to identify resource commitments from different organizations across the region to the vision and economic development goals. The Premier and the Vision Team should establish the investment plan necessary to build out the strategy. The actual mechanism for investing these resources could take the form of a direct contribution to any specific funds established. On the other hand, it could also involve an organization aligning an existing program or perhaps creating a new activity to accomplish part of the vision laid out in this document. Either way, resources should be targeted at specific areas that will create the highest return on investment (as measured in jobs and revenues per dollar spent).

A complete investment plan should be done as part of the overall strategy development, but we can already identify a number of areas where resources are necessary for success. Some of these resources have already been/are now under consideration, and we encourage the Premier to:

- Establish a **Commercialization Fund** (see Recommendation 2.B.)  
A separate fund should be set up to support commercialization

activities to provide bridge financing for innovative pilots to support early commercialization of technologies that have already been tested and found to be commercially viable but need early paths to market.

- Establish a **fund to support Market Development efforts** to build larger export markets for local products. Examples include 1) feasibility studies or relevant market research, 2) summits for key decision-makers to increase adoption, 3) policy research and recommendations, and 4) outreach activities and branding.

As critical as each of those are, we are also recommending that the investment strategy identify significant resources for two other important initiatives. The Premier should:

- **BC Hydro's Research and Development Fund** (see Recommendation 2.C.) BCUC should work with the Ministry of Energy and Mines and BC Hydro to ensure that a significant program is in place that facilitates value added innovation, Research and Development in support of the testing of targeted developments in alignment with this vision, including new power supplies, smart grid, and demand-side management technologies.
- **Expand Funds to Purchase Green Power** The Premier should explore the merits of a public use charge, either in the form of a modest line charge or an expansion of the green certificates/green tag program that would allow contribution of additional funds earmarked toward projects around efficiency and renewables.
- Provide **Resources for Centres of Innovation** (see Recommendation 4.1) Several current or proposed centres of innovation have the potential to advance the region in the four key areas.
- Continue **Commitments to Advancing Showcase Opportunities**, including funds for the 2010 Sustainable Olympics and others.

## 2. COMMERCIALIZATION

### STRATEGY: **SPEED INNOVATION TO LOCAL MARKETS IN THE FIVE OPPORTUNITIES**

British Columbia should enhance its existing strengths to become a place where new technologies in these five opportunity areas get to market faster, better armed, and with a higher probability of success. This emphasis on speed to market translates into a number of initiatives:

- **Grow Local Demand** through Challenges, Incentives and Mandates on Procurement and Adoption

- **Establish a Commercialization Fund** to Support Demonstration and Pilots for Market-Ready Solutions
- **Increase Resources and Programs for Testing** Unproven, Prototype Technologies

These initiatives should help support companies and technologies emerging from the R&D stage into and through the first stage of early commercialization. (See Figure 5 for Reference).

## **2.A. GROW LOCAL DEMAND**

Local Demand is a critical part of the strategy to be able to grow companies here, and can be accomplished by opening up markets in three important ways:

- 2.A.1. Challenge Local Governments to Optimize Energy Use
- 2.A.2. Challenge Utility Leaders and Stakeholders to be More Forward-Thinking in Supply Choices, Grid Technologies, and Demand-Side Management
- 2.A.3. Create Incentives and Policies for Others in the Region to Support and Adopt Innovations in the Five Areas

**2.A.1. Challenge Local and Provincial Governments to Optimize Energy and Procure Local Power Technologies.** Government procurement represents a major area to encourage innovation around Sustainable Urban Practices, Smart Urban Transport, and Clean, Green Power Production. The Premier should challenge all government ministries and Crown corporations to reduce their energy footprint. This should include specific targets and timeframes to reduce their energy use, for instance:

- 20% of reduction in energy by government/public buildings
- 100% of new capital construction of government buildings to be silver/gold/platinum LEEDs standard with at least 10% platinum to stimulate innovation
- 30% of government fleets to be green by 2010
- 20% of energy purchases by the government should be Green Power Certificates with some portion dedicated to near-commercial supply options (e.g. biomass, ocean energy, wave and tidal)

To turn this use into opportunity for the regional Power Technology sector, local and regional governments should look towards purchasing these goods and services from local providers when their solutions meet the requirements for government needs. Local governments should also be encouraged to evaluate the economic development value of buying from

local providers (or consortia that include local providers) as part of their overall purchase decision.

**2.A.3. Require Changes in Utility Policy Framework to Remove Barriers to Power Technology.** The Premier should issue a challenge for BC Hydro, BC Transmission Company (BCTC), British Columbia Utilities Commission (BCUC), Ministry of Energy and the Power Technology Industry to create an environment that encourages innovation and forward-thinking across the utility system and leads to measurable economic development from the Power Technology sector. BC Hydro’s leadership has set out twenty-year goals for the utility; the efforts around the Energy Policy and climate change have also laid out relevant targets for the region. Now this challenge group needs to work together to aggressively translate the Energy Policy and BC Hydro’s twenty-year goals into specific initiatives across the utility industry and changes in mandates that will move the sector forward. This group needs to review the utility regulations governing power technologies, renewables, distributed generation, and other related topics and identify barriers to meeting these goals. (See Table 9.) It must look at appropriate amendments to the relevant statutes (e.g. the BC Hydro Act and the BCUC Act) to remove barriers and further technology adoption.

<b>TABLE 9 – KEY OUTCOMES FOR THE UTILITY CHALLENGE TEAM</b>
Find mechanisms to ensure that new power production investments made by BC Hydro to meet additional domestic demand comes from only clean or green production sources.
Determine appropriate level of BC Hydro revenue to allocate to short-, medium- and long-term innovation and establish metrics to identify the value to ratepayers
Establish mechanism for funding pre-commercial and near commercial technology demonstrations
Clarify the acceptable rate impacts of renewables and efficiency, and the importance of low bills vs. low rates where demand-side management measures are concerned
Develop accurate marginal costs and the appropriate decision-making tools to pursue cost-effective efficiency and renewables
Accelerate pilots of innovative pricing options and incentives (critical peak, time-of-use, etc.) in a manner that preserves customer benefits of low-costs heritage assets
Develop approaches to allow utilities to recover lost revenues resulting from efficiency and distributed energy programs (e.g. rate base CHP)
Identify planning and funding mechanisms to allow BC Hydro and BCTC contract for 1) renewable power sources and 2) construction of transmission in advance of need
Evaluate creation or expansion of line charges, other public use charges, or Green Power Certificate Program as a solution to stimulate the construction of green generation
Ensure transmission adequacy to provide BC generators access to electricity markets



**2.A.2. Create Mandates and Incentives for Innovation Practices Across the Region.** Beyond the use of these solutions in government settings, a more systematic evaluation of barriers and incentives should identify specific policies that will both increase the use of sustainable, smart solutions and also support local industry wherever appropriate. Sample policies and programs are listed in Table 10. These should be further evaluated as part of the implementation plan.

<b>TABLE 10 – EXAMPLE POLICIES TO ENCOURAGE LOCAL USE</b>	
Remote Power Solutions	<ul style="list-style-type: none"> <li>▪ Support federal production tax credit and other incentives (rebates, low-cost financing) that are focused on remote clean distributed generation</li> <li>▪ Leverage the Federal Green Municipal Funds program and others to direct more funds at remote power solutions in the Province</li> <li>▪ Establish policies that balance least-cost and least-emission approaches to support cleaner alternative Power Technology approaches instead of current systems in place</li> <li>▪ With First Nations, continue to establish policies that address service objectives, cost allocation, delivery mechanisms, ownership and funding arrangements to create “best practices” in placing remote power solutions in aboriginal communities</li> <li>▪ Build a local content preference into existing programs that are already directing capital at remote power (e.g. Western Diversification’s Community Based Program, SDTC, EcoTrust)</li> </ul>
Sustainable Urban Practices	<ul style="list-style-type: none"> <li>▪ Strengthen standards for the 2010 Sustainable Olympics for sustainable Urban Practices</li> <li>▪ Support federal production tax credit and other incentives (rebates, low-cost financing) that are focused on grid tied clean distributed generation</li> <li>▪ Strengthen building codes for the province and BC that include efficiency requirements</li> <li>▪ Encourage National Resources Canada to develop an energy performance rating system for commercial and high-rise residential buildings</li> </ul>
Smart Urban Transport	<ul style="list-style-type: none"> <li>▪ Establish efficiency and emissions policies for all public transport vehicles that encourage replacement on an aggressive time frame—e.g. establish and achieve a national goal to have at least at least 5% of the vehicles on the road fit a “green” profile by 2010, and 10% BY 2015, including both passenger cars and heavy-duty trucks and buses.</li> <li>▪ Establish local emissions caps and trading credits for vehicle purchasers, particularly large diesel fleets, as has been done in California. Financial incentive support for the credits can be achieved through initiatives like vehicle registration fees and cross-industry emission credits (such as with power generation).</li> </ul>
Smart Grid Solutions	<ul style="list-style-type: none"> <li>▪ Employ PST exemptions strategically and in coordination with Demand Side Management programs.</li> </ul>
Large Scale Clean & Green Power	<ul style="list-style-type: none"> <li>▪ All new power production investments made by BC Hydro to meet additional domestic demand is to come from only clean or green production sources</li> </ul>

**TABLE 10 – EXAMPLE POLICIES TO ENCOURAGE LOCAL USE**

Production	<ul style="list-style-type: none"><li>■ Promote federal production tax credits and other tax incentives (e.g. tax shifting options) for alternative renewable energy projects across Canada, including alternative energy sources not currently included in the credits (e.g. ocean and biomass)</li><li>■ BC Hydro to source a defined percentage of new green power at the best market price available</li><li>■ BC Hydro to source a defined percentage of new clean/green power that represents near-commercial resources</li><li>■ BC Hydro and BCTC to contract for capacity ahead of need for some period of time</li></ul>
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## **2.B. ESTABLISH A COMMERCIALIZATION FUND**

Beyond better leveraging of existing resources, the Province should establish a substantial fund that leverages provincial and federal money to provide targeted support to encourage innovation in Power Technology. This fund would focus on products and services that have proven their basic technical functioning, but need to prove that they actually can solve the customer’s problem and create business value. The fund would focus on pilot projects and other activities that support the early commercialization phase in these five market opportunities.

The fund would be designed to generate measurable return in jobs and revenue from the Power Technology sector in the near, intermediate and long term. The fund would target demonstration projects that satisfy the following requirements:

- Address an identified BC need with a solution that has significant demonstrable world markets
- Build a case for the competitive advantage of commercializing such a system from British Columbia, and the potential jobs and revenues that such activity represents
- Represent a system solution, not just one product or service, and includes integration of commercial and near-commercial products
- Prove the business value (not merely the engineering functionality) of this particular solution to the marketplace
- Identify specific strategies (that may be implemented subsequently to the demonstration) for bringing costs and price points for the solution down to acceptable market levels
- Represent a collaboration among multiple companies with a majority of those participating from local companies or companies that have made some form of local commitment

- Involve the participation of at least one company that represents broader market access if the demonstration is successful (e.g. a participant has a large base of existing customers who could adopt a solution from a successful demonstration; they represent a source of financing for subsequent projects; they represent a market channel into an international opportunity; etc.)

These projects could occur inside British Columbia or outside the region where a case could be made that such a demonstration would be further the industry in the five opportunity areas. Demonstrations would be designed with the idea of promoting pilot results and providing collateral to aid the participating companies in subsequent sales processes inside and outside the region. Beyond this support, results from the demonstrations should be used to raise the awareness of the region as a centre of innovation. Demonstrations associated with high profile events like the Sustainable Olympics would be particularly attractive for this reason.

These funds should be managed by a body of leading industry representatives with government oversight. This group should create a five-year vision for the fund that is in alignment with the broader action plan to grow the sector, and that will identify the infrastructure necessary to market the program, distribute the funds, and monitor and measure performance towards the goals of the fund.

Financially, the mechanisms of distribution and collection will return a reasonable percentage interest over the life of the fund. This group should explore a variety of mechanisms for the financial arrangements with the companies participating, including cost-sharing, interest-free ten year loans, and royalty repayments based on percentage of revenue or specific revenue triggers.

Initial targets for the fund will be determined by the Vision Team based on the strategy that is built from the working groups. Resources from the Province will be combined with matching funds and more solicited from Federal sources. Over time the fund should find additional resources—or coordinate matching funds in particular projects—from a combination of other sources inside and outside the region (e.g. Western Diversification, Technology Partnerships Canada, Early Action Measures, SDTC, Canadian International Development Agency, World Bank, US Aid, etc.) who have mandates to solve world problems in the five areas and are interested in seeing solutions.

## **2.C. INCREASE ACCESS AND RESOURCES AVAILABLE FOR TESTING THE ENGINEERING MERIT OF NEW TECHNOLOGIES**

In the early stages, having customers who are willing (or given incentives) to take on some development and technology risk is fundamental to success. Startups often take years to penetrate the market and establish their credentials. To the extent British Columbia can make it easier for its companies to test their products and services, we will provide companies located here an advantage. While the resources described in 2.B. are focused on testing the market value of commercial-ready products and services, there also needs to be access and resources to test the engineering capability of yet to be proven technologies.

**Utilities and Others Need Resources to Test Innovation.** The challenge laid out to the utilities and their stakeholder should, in theory, lead to more access to early commercialization opportunities where Power Technology companies can target development to specific customer needs, certify quality and establish the engineering capabilities of a solution. But just as critical is making certain the testing organizations have not only the mandate but also the resources to support that innovation and risk-taking.

The BC Hydro Research and Development fund is one example of a program that can be tailored to meet this need. This fund could aid the utility in testing of innovations developed by others. Other resources that support targeted development and field testing like SDTC, TPC and others should be thought of as resources to be leveraged to support the vision.

Testing these innovations isn't just good for the growth of the Power Technology industry, it also makes good business sense for the utility. In the Smart Grid sector, for instance, while the existing transmission systems in BC and around the world are facing congestion in the near and far future, some smart technologies that have the potential of relieving congestion issues are shelf ready but not necessarily tested. It is prudent to have enough time to test new technology and overcome possible limitations well before the need to make sure that transmission systems are reinforced in the most cost effective and technologically sound manner. The regulators typically have very limited appetite for testing projects without virtual assurance of success and therefore the opportunity to initiate such projects under the cost based structure is limited. The developers of the technology are usually eager to find test sites and partnership opportunities.

**British Columbia Could Become Known For Testing and Certification.**

There are a number of ways to pursue this that are consistent to building local industry. A partnership model with technology providers inside and outside the region led by BCTC, BC Hydro and Powertech Labs can leverage these resources to solve key issues for British Columbia and establish the Province as a leader in the development of modern technology. Going further, British Columbia could look at opportunities across the five areas to create opportunities not only to showcase, but to create a test bed that is recognized even outside the region as a leader in testing and certification of particular products. Several areas inside Smart Grid and Sustainable Urban Practices are ripe for this approach and should be explored in more depth by the Vision Team.

**3. GROWTH**

**STRATEGY:**

**ACCESS WORLD MARKETS IN THE FIVE OPPORTUNITIES**

All over the world, Silicon Valley stands for innovative software and Washington State for aerospace excellence. British Columbia must create a similar image around Power Technology and reach out to world markets:

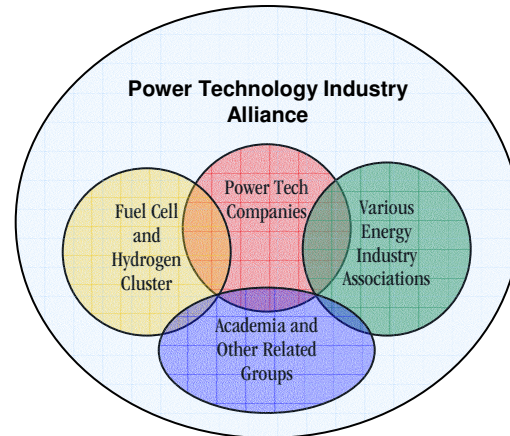
**3.A. INDUSTRY COLLABORATION AND PARTNERSHIPS THAT BUILD SOLUTIONS AND LEVERAGE MARKET CONNECTIONS TO GET TO WORLD MARKETS**

Economic clusters occur because of the powerful effects of proximity and networking. To provide integrated solutions to the world, our local industry needs to seek out opportunities to collaborate. The Power Technology Industry Alliance (Sidebar 11) is designed to move the industry forward. The Alliance should convene industry, governments, NGOs and others to find common ground where companies could jointly pursue opportunities into these five areas. Effective partnering should be one of the regional strengths that we leverage immediately, and the industry needs to step up to the challenge and create that environment of collaboration.

## Sidebar 11 – British Columbia’s Power Technology Industry Alliance

The Power Technology Industry Alliance in British Columbia has a plan to build from the strengths of the existing fuel cell and hydrogen cluster, various industry associations (e.g. wind, solar, ocean energy) and the depth of power technology companies and expertise in the region.

A subset of British Columbia Technology Industry Association (BCTIA), the Alliance’s vision is to grow the industry through collaboration. Members will coordinate across broad sectors to overcome industry challenges and reach key market opportunities. The Alliance builds from efforts like the Fuel Cell and Hydrogen Strategy, OREG report, that outline visions for moving their technologies the industry forward. The Alliance aims to integrate the needs and opportunities from all groups and companies in the Power Technology Industry to move the whole industry forward.



### 3.B. BRAND THE REGION AS A LEADER IN THE FIVE AREAS OF OPPORTUNITY

The Premier should work with the Industry Association to craft a regional message and leverage the Sustainable Olympics and related events to provide ongoing media coverage to the Power Technology cluster.

Building a clear message statement around smart, sustainable power technologies (or whatever variant deemed best after analysis) would allow the region to build on its growing reputation in sustainability. It will be important that the message also includes message components targeted at the five key areas to ensure that others begin to see the Province as a source of innovation for these key market challenges.

Of course, many regions are making commitments to sustainability and power technologies in their various forms, but with the upcoming Sustainable Olympics British Columbia has a unique opportunity to leapfrog others and take the world stage. The Vancouver 2010 proposal goes beyond just minimizing potential impacts; it plans to showcase high standards and leading technologies such as clean transportation, energy efficient buildings, waste management and conservation strategies. By following through on existing commitments to the Sustainable Olympics and mandating new construction energy optimization, “smart” (digitally controlled) buildings, LEEDS conservation and efficiency standards and practices in industry and commercial applications for all construction related to the 2010 Sustainable Olympics, the region can draw the attention of industry and industry associations as well as ongoing media coverage to its Power Technology cluster. (See example around Olympic Housing in Sidebar 9.)

### **3.C. COLLABORATE ON OUTREACH TO KEY WORLD MARKETS**

Beyond these opportunities to develop solutions together, the region should work in a coordinated way to build connections to China, India and other areas of opportunity in the world and communicate the brand and the substance through via events, outreach, education and publicity. The goal of this outreach is twofold, both to bring local companies together with business opportunities, and to raise awareness of British Columbia as a place to locate a Power Technology company. Again, outreach should target opportunities in the five areas outlined, not just outreach for individual technologies. Some tactics include:

- The Industry Alliance and government should identify specific outreach opportunities in the five areas in key world markets. In addition, where appropriate Power Technology also should be included in trade missions and other formal outreach activities from the Province to reinforce the branding strategy.
- The Industry Alliance should look for ways to support shared cost marketing to relevant industry conferences throughout North America and abroad where appropriate.
- Cross-region and cross-border relationships to outreach to world market opportunities should be encouraged and even facilitated if necessary. The industry should also link with other Pacific Northwest and U.S.-based efforts to help raise awareness of the entire Northwest region as a world centre of excellence.
- NGOs that are already in a position to support branding and outreach efforts (such as the International Centre for Sustainable Cities) should be provided resources to leverage their “trusted agent” role into introductions for local collaborations into new international markets.
- Those individuals actively involved in economic development efforts should all be informed of our regional strengths in Power Technology so that they might also communicate them to companies considering siting here.
- Site selection journals and other market tools should be leveraged to promote the Sustainable Olympics, the Power Technology industry, etc.

## **4. INNOVATION**

### **STRATEGY:**

### **DEVELOP STREAMS OF RESEARCH IN THE FIVE OPPORTUNITY AREAS**

For BC to strengthen its position in the world as the market demand for power technologies in these five opportunity areas grow, we need to develop

ongoing sources of innovation. This includes efforts to establish centres of excellence that generate research and innovations around the five opportunity areas, and strengthen core sciences and create applied courses that expose future graduates to power technology opportunities.

#### **4A. SUPPORT CENTRES OF INNOVATION IN KEY MARKET AND TECHNOLOGY AREAS**

The Premier should support co-operation between the Ministry of Advanced Education, the University Council of Presidents and key individuals in British Columbia's universities to ensure that British Columbia develops ongoing sources of Research and Development targeted at these five issues—programs that collaborate and coordinate with Industry R&D efforts.

There are already a number of programs in place, under development or being proposed. (For simplicity in this passage we'll refer to them all as Centres, whether or not they are actually using that terminology themselves.) The first step would be an inventory to determine which programs are currently or have the potential to meet the needs of these five areas. The inventory should identify appropriate enhancements to existing programs or new potential programs.

For the Centres of Innovation to really become an asset to the Province, three conditions should be designed into this recommendation:

First, the emphasis of a particular center should be on either 1) solutions or process that integrate systems and components to better meet the needs within one of the five opportunity areas, or 2) enhancements of core technologies to increase our regional competitive advantage in that technology, assuming that the technology is meeting one of the five market opportunities.

Second, we should only consider an organization a true Centre of Innovation if we can confirm its intent to generate extractable Intellectual Property. If the Centre merely represents another showcase or demonstration opportunity it is still valuable, certainly. But it shouldn't be considered a Centre of Innovation unless its research and development leads to more commercializable products and services.

Third, the nature of the relationship between these Centres and corporate R&D efforts is important. The Centre research should be done in collaboration and partnership with industry wherever possible to facilitate the commercialization of those technologies in a way that grows the cluster.



So going forward, for any program either established or proposed to be considered a true *Centre of Innovation* for the industry, the program should

- identify how it intends to work with the local industry cluster to develop a technology agenda and research strategy and collaborate on R&D that move our region closer to competitive advantage in solutions to meet the five market opportunities,
- describe the mechanisms to make those innovations available to industry
- establish clear, measurable goals around generating intellectual property and contributing to economic development

Where these elements can be demonstrated, the Centre efforts should be supported with federal investments in basic research and collaborative research support (and potentially resources) from companies, universities, labs and institutions.

#### **4B. CONNECT EXISTING EFFORTS IN BASIC SCIENCES TO POWER TECHNOLOGY APPLICATIONS**

To continue supporting the Industry's need for new innovation as it grows, we need to build connections to secondary education system to generate human capital. We can develop an ongoing source of knowledgeable engineers and managers for Power Technology businesses by leveraging the Province's existing investments into the engineering sciences. The Ministry of Advanced Education has already implemented efforts to build the volume and quality of engineers produced by our universities. We should continue to strengthen the foundation sciences that are important to this industry (advanced materials, power electronics, embedded hardware/software systems, etc.) and create applied courses to help engineers and others understand the market applications of their skill sets into the power technology industry. In this way, we will have a better chance of keeping some of that talent in the region to fuel the growth of the Power Technology sector.

To complete this circle, the success of economic development goals and leadership outlined in the Leadership Recommendation will be key to ensuring that investing in innovators ultimately leads to strengths here in British Columbia. Growth jobs in existing Power Technology companies, a supportive entrepreneurial culture for new start-ups, new research positions in university and laboratory programs will all be important to leveraging this *Targeted Innovation* strategy into long-term competitive advantage for the region and its companies.

There are opportunities to provide support to existing training programs in the industry as well. Increased funding to BCTC's Transmission Academy, mentioned earlier, would expedite the program for the benefit of all utilities in British Columbia. It would also reinforce the image outside the region of British Columbia as a centre of activity in Smart Grid innovation and provide an opportunity to train North America's transmission engineers and expose them to leading technologies (ideally many of those coming from local providers).

## **TARGETED INNOVATION STRATEGY LEADS TO ECONOMIC DEVELOPMENT BENEFITS THROUGH START-UP, GROWTH, AND ATTRACTION OF COMPANIES**

Properly implemented, this strategy leads to company growth in a number of ways—by retaining and growing existing companies, encouraging new start-up activity, and attracting additional companies large and small from outside the region.

As more communities around the world look for smart energy choices, they must buy those products and services from somewhere. British Columbia is poised at the edge of opportunity. We can (and should) be the providers of leading-edge Power Technology to the world.

## **NEXT STEPS**

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To implement this vision, we recommend the following immediate steps:

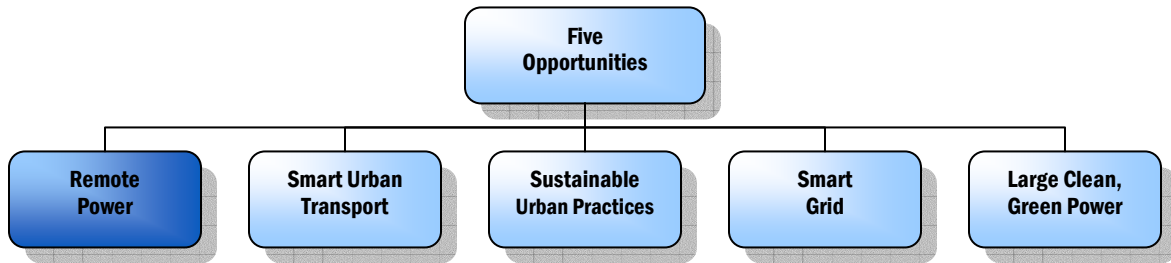
- **Establish a Short-term Task Force** to shape the overall strategy and plan
- **Build the Implementation and Resource Plan** in a document that outlines priorities, action steps, roles and responsibilities, budget requirements and sources, and schedule
- **Establish the Ongoing Vision Team, Working Groups and Coordination** to implement the overall strategies and its subcomponents.
- **Hold a Launch Event** to announce the commitment to the strategy and major initiatives

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start-up activity, and attracting additional companies large and small from outside of the region.

As more communities around the world look for smart energy choices, they must buy those products and services from somewhere. British Columbia is poised at the edge of opportunity. We can (and should) be the providers of leading-edge Power Technology to the world.

# APPENDIX A: MARKET OPPORTUNITY IN REMOTE POWER SOLUTIONS



Remote power (a.k.a. remote energy, portable power, off-grid systems) generally refers to power needs for isolated applications or entire communities that are not currently integrated with the existing region-wide power grid.

- **Single remote applications** — refers to off-grid power needs for individual applications where the supply (which may include storage) is typically linked directly to the use through an inverter or direct load coupler.
- **Village power**— refers to providing power to entire remote non-integrated communities (communities not connected to the existing integrated electricity system or natural gas network) where the solution might be a number of one-to-one solutions or a portfolio of supply serving the community through an islanded local distribution system.

Our focus for this discussion is primarily on electric power, but it is conceivable that as technologies evolve one could broaden this same thinking to apply to holistic systems that also meet additional remote energy needs (e.g. non-electric based fuels and energy solutions for heating, cooling and transport).

## MANY REMOTE SINGLE APPLICATIONS ARE ECONOMICALLY COMPETITIVE

While residential needs are the fastest growing market for single off-grid power solutions, distributed off-grid generation can be cost-effective for use where small amounts of power are needed. (See Table 11.)

**TABLE 11 – REMOTE SINGLE OFF-GRID APPLICATIONS**

Market Segment	Sample Applications
Residential	Remote cabins, landscaping lights, refrigeration, rural telephones
Agriculture	Farm lighting, water pumping for livestock watering, irrigation and controls, pond aeration, fence chargers, gate openers, automatic animal feeders, battery charging
Utilities	Remote data acquisition for operations in the oil and gas industries, cathodic protection systems for pipelines
Telecommunications	Repeaters and fiber-optic amplifiers, mobile phone systems, cellular phone systems, radio communications, emergency communications
Transportation	Traffic signals, message boards/billboards, highway call boxes, highway rest stops, navigational signals, railroad crossings, bus stop shelters, marinas, parking lots, automatic traffic recorders, road ice detection systems,
Government	Remote occupied stations (e.g. ranger stations, fire lookouts), water level gauge stations, meteorological information, park irrigation, campground water supplies, community parks, community warning sirens, disaster relief, cathodic protection systems for bridges/buildings/wharves, satellite power and other space applications
Mobile	Power on recreational/commercial vehicles and boats, power equipment on maintenance vehicles
Source: Center for Smart Energy, 2003	

Single off-grid applications have experienced numerous surges in shipments over the last several years, partly in response to various incentives and programs encouraging adoption, in parallel with the maturing of some of the more common technologies including solar PV.

Increasingly, these sales will come from renewable distributed generation or hybrid power systems. Hybrid power systems combine various forms of renewable energy source and a gen-set, or in some cases renewable- only sources and sufficient battery systems. These solutions can offset some of the intermittency challenges faced by relying purely on renewable power sources such as wind and solar power. They can even involve more complete systems that combine LED lighting and other efficiency measures to increase the effectiveness of the off-grid application, as with local provider Carmanah. (See Sidebar 12.)

## Sidebar 12 – Carmanah Excels in Off-Grid Lighting



Carmanah, based in Victoria, BC, is a world leader in the design, manufacture and supply of patented, proprietary solar-powered LED lighting solutions. They are illustrative of the growth of a new sector in self-contained lighting systems as an off-grid power solution.

In the winter of 2004, Truckee Tahoe Airport

of California installed 560 of Carmanah's taxiway lights with an up-front savings of US\$850,000 in capital costs and now saves more than US\$16,000 annually in energy, simply by not connecting to the grid. The Federal Aviation Administration

(FAA) in the United States has purchased 90 units of the Company's solar-powered LED taxiway edge lights for field trial testing to determine if Carmanah's technology is a cost-effective solution at general aviation airports.

Carmanah is the largest supplier of solar LED lighting systems currently in use by the city of London England. In addition, more than 40 transportation authorities throughout Europe have already installed Carmanah's technology, as well as over 75 transit authorities in North America, including recent installations of over 300 units in Los Angeles and 150 units in Toronto.

To date, they have an installed base of more than 100,000 lights; they employ more than 100 people and are growing at double digits. In 2003 they were ranked the 90<sup>th</sup> largest high-tech firm in BC. In 2004, Carmanah received the BCTIA "Best Application of Technology" Award and the GLOBE Award, Canada's national environmental award for Industry Export Performance.

The markets outlined in Table 11 represent strong market segments, but perhaps the biggest near- to intermediate-term opportunity lies in Village Power, a phenomenal world growth market.

## WORLD NEEDS FOR REMOTE VILLAGE POWER ARE GROWING

Remote power solutions are a key issue for many developing nations and near-industrial countries. Across the globe, over one-and-one-half billion people in the world are without electricity, and this figure is set to increase significantly over the next 10 to 20 years as the world's population rises. Governments in developing countries are looking for methods to electrify these people in a quick, cheap and reliable ways. Extending the electricity grid to many of these remote villages and communities is often not feasible; so as a consequence, global distributed generation capacity and revenues are projected to increase drastically. (See Table 4.)

China, India, Latin America, South Asia, and Africa all offer major opportunities for village electrification markets as their economies lack the resources and funding to implement internal development schemes for off-grid regions. Energy production is set to become the fastest growing market segment in developing countries such as India, where the government has committed to electrification of all rural villages by 2007 and all 78 million rural households by 2012 with conventional and renewable resources.<sup>20</sup>

Solutions can include not only off-grid one-to-one power sources, but larger local generation systems that can serve the needs of whole communities in an island or micro-grid environment. In a limited number of cases, a line extension from the existing grid can make sense, but more often renewable distributed energy systems are the answer. Local generation and distribution systems based all or in part on renewable sources can provide the most technically and economically feasible options to address primary environmental, social and economic goals in these non-integrated areas of the world.

## REMOTE COMMUNITIES IN BRITISH COLUMBIA NEED BETTER POWER CHOICES

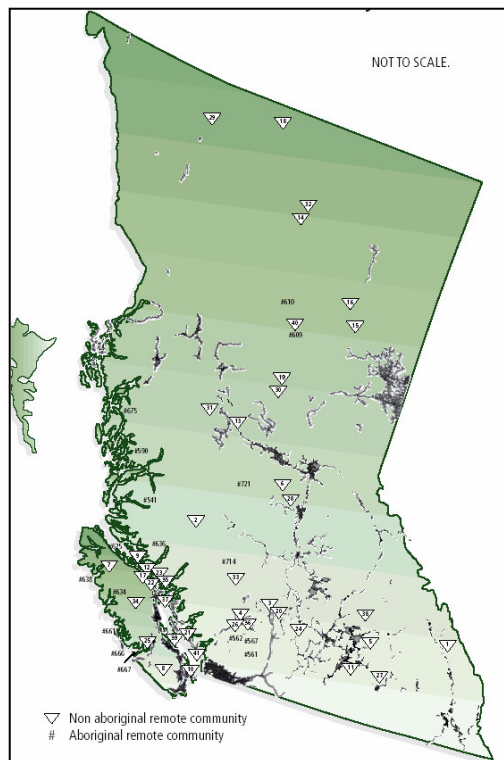
According to research from BC Hydro, across the Province there are about 60 remote communities (defined as permanent or long-term settlements of five or more years and at least ten permanent residences) with approximately 4,800 residents—including about 2,500 First Nations individuals—with limited or no electricity<sup>21</sup>. (See Figure 6.) Other research shows that across Canada, these communities exceed 300, most of which are aboriginal and in the north, with a total population of about 200,000 people<sup>22</sup>.

**Figure 6:**  
*British Columbia's Remote Communities*

*This map illustrates the number and distribution of the remote communities in BC currently not connected to the grid, many of which are First Nations.*

*These communities represent one of the more immediate needs for remote power in the Province. Solutions applied there could also benefit other remote applications in agriculture and elsewhere.*

Source: BC Hydro



For those communities who are getting some access to electricity, it is often diesel-based generation. (In the case of British Columbia, it is diesel-based generators, with some small hydroelectric power provided by independent power producers for which BC Hydro provides back-up diesel generation). This approach depends on imported oil and leads to energy costs up to 10 times higher than in the rest of Canada.<sup>23</sup> Diesel-generating capacity in

these remote communities approaches 400 MW and produces about 200,000 tonnes of GHG emissions every year<sup>24</sup>.

**Remote power enhancements bring many benefits.** The need to shift to more economically attractive and environmentally viable energy solutions in these communities represents the most immediate need and opportunity for remote energy in British Columbia. And there are a number of good reasons to solve this problem. For the communities themselves, adequate, reliable electricity supply can pave the way for other important enhancements (e.g. internet access—for which electricity is a prerequisite). For the Province as a whole, the resulting reduction in GHG (Greenhouse Gas) emissions from fossil fuels and increase in renewable energy supplies aid in the social and economic growth of all of British Columbia’s aboriginal and non-aboriginal communities.

## **BRITISH COLUMBIA HAS REMOTE POWER ASSETS BUT NEEDS INDUSTRY COLLABORATION**

No region of the world has yet cornered the market on remote power solutions for off grid and village power. British Columbia is in a good position to leverage several assets.

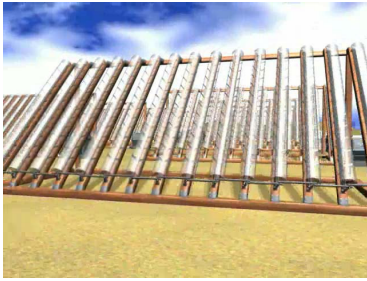
**Willing Funders and Customers.** British Columbia has made a commitment to solving the power issues of remote communities. BC Hydro has identified this need as one of its key goals. Western Diversification and others are taking steps to encourage and channel resources to remote communities to fund community-based power projects. As for single off-grid applications, numerous examples of local use abound. For instance, BC Hydro is field testing 1Kw Ballard Power System fuel cells as replacements for batteries, which currently provide emergency power at more than 600 sites.

**Companies to Serve Need.** British Columbia has a number of Power Technology components that could be harnessed to provide integrated remote power solutions. For single, off-grid residential applications, Soltek, Xantrex (Sidebar 6), Ballard (Sidebar 5) and others provide distributed generation components and integrated solutions to the remote power segment. In Carmanah (Sidebar 12), the region has a major innovator in self-contained lighting systems. Still others provide batteries and other technologies to help make the solution viable in an off-grid environment.

**Innovative Research.** British Columbia is also home to several innovations that could have a large impact on the remote power market and renewable energy generation in general. Day4 Energy Inc. is innovating large-scale solar systems that will drive the costs of solar energy generation down to be price-competitive with other market options for many applications in a wide variety of locations (See Sidebar 13).



## Sidebar 13 – Day4 Energy Poised on Solar Breakthrough



the Order of Canada) together with Professor Leonid Rubin (a well-known Russian scientist), Day4 Energy's PV technology is expected to significantly reduce the cost of PV power systems, making solar energy generation cost-effective in a wide range of locations and applications where previously it was considered unsuitable or too expensive. The technology achieves cost competitiveness by enabling conventional mass-produced PV cells to operate efficiently in solar concentrators thus reducing the

Day4 Energy is a Burnaby-based company that has developed a new kind of Photovoltaic (PV) technology. Formed by John MacDonald, (one of the founders of MacDonald Dettwiler and a recipient of

amount of cell material required per watt of power generated. This breakthrough reduces system cost substantially and can be expected to permit solar energy to enter the mainstream of electrical generation in many parts of the world in the near future.

Day4 Energy is privately held. Its shareholder group is international, but BC residents constitute the majority. The Company is currently discussing the deployment of prototype systems based on their new PV technology for field-testing with utilities such as BC Hydro and Arizona Public Services as well as with commercial users. A manufacturing facility is being planned for the Greater Vancouver area with operation commencing in the first quarter of 2006. Day4 employees include scientists from Russia and Germany as well as Canadian employees attracted to BC to work on this technology and develop a renewable energy business.

Others are working on solving the intermittence challenge of renewables that can make them cost prohibitive for the larger power needs of remote communities. Many renewable systems require additional storage or other resources to create continuous capacity. University of Victoria (Sidebar 7) has been conducting advanced research for single off-grid solutions in the form of the Integrated Renewable Energy Experiment (I.R.E.N.E.). IRENE addresses the intermittent nature of renewable energy sources by using the excess electricity they generate to produce hydrogen to store in hydrogen fuel cell systems. The research also integrates Ballard Power Systems 1kW NEXA™ fuel cell and Stuart Energy's 5kW, prototype hydrogen generator. University of Victoria is also a partner with BC Hydro, GE and others in Hydrogen Assisted Renewable Power (H.A.R.P.), a project to bring the concept of hydrogen generation as a storage mechanism to meet the power needs of entire remote communities. (See Sidebar 14.)

### **NEED FOR CLEAR TARGETS AND INDUSTRY COLLABORATION TO MOVE THE OPPORTUNITY FORWARD**

This market opportunity represents a significant world need and British Columbia has local customers willing to innovate, sources of funding, companies with technologies, and research and innovations to overcome barriers. To grow the local industry, these efforts need to be coordinated with specific goals to build a world-class set of products and service offerings in remote power.

## Sidebar 14 – Collaborating on Hydrogen Assisted Renewable Power (HARP) for Remote Solutions

A partnership between BC Hydro, GE, Stuart Energy, Natural Resources Canada, the National Research Council and the Institute for Integrated Energy Systems at the University of Victoria is focused on developing sustainable power solutions for remote communities.

Renewable energy resources such as wind, solar and micro hydro are intermittent, inhibiting them from being a sole source of reliable power. Currently, diesel power generation is used to firm up renewable energy, but entails high operating costs and environmental impacts.

The partnership is focused on a project to overcome these challenges of intermittence, Hydrogen Assisted Renewable Power (HARP), uses hydrogen as an energy storage medium for firming up intermittent renewable energy resources. A HARP

system utilises excess renewable energy during low demand periods (eg. night-time) to produce hydrogen from the electrolysis of water. The hydrogen is stored as a compressed gas to be reverted back to electricity when the renewable resource is flagging and/or when the demand for electricity exceeds the installed capacity of the renewable resource. The project will demonstrate GE's pre-commercial low cost electrolyser and hydrogen fuelled internal combustion engine.

The team has completed Phase 1 of the project, a conceptual feasibility study, and is initiating Phase 2, a detailed engineering design of a HARP system. Phase 3 is a pilot study in a remote community serviced by BC Hydro and Phase 4 is subsequent remote community installations in the US and across Canada.

Specifically in the village power segment, the industry needs to sit down together and start mapping out ways to collaborate on integrated solutions for British Columbia and the world.

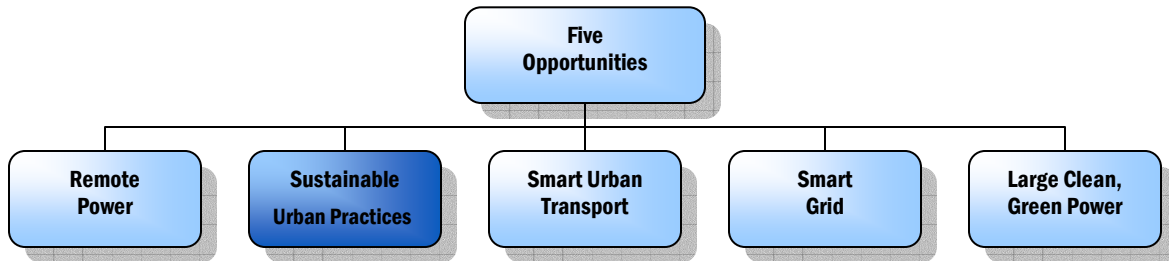
- **Identify Resources and Targets for British Columbia Remote Power Innovation.** The Federal Government, First Nations, BC Hydro and others need to determine what resources are available to meet this need and sort through any other significant issues. Then they can identify a number of remote communities where innovations could be tested over the next several years.
- **Create a Program to Channel Innovation to Meet the Needs of Those Communities, Within the Timeframe and the Level of Investment Available.** Either through RFPs or other mechanisms, companies can be encouraged to participate to test and demonstrate innovations in the communities chosen. Emphasis could be put proposal criteria that 1) encourages consortia with technology and market partnerships among firms, 2) demonstrates local commitments in a variety of forms, 3) identifies a clear path to a world market if the innovation proves successful, and any other criteria that will help leverage the local investment into worldwide market opportunities.
- **Outreach to Targets Outside the Region.** Industry and Government should work together to collaborate on outreach to other international markets that are looking at the same problem to make them aware of the Province's strengths.

Taking these steps should ensure that our opportunity to commercialize targeted innovations should be leveraged as aggressively as possible (while

also as strategically as possible) so that a thriving local industry is left behind to serve world markets long after British Columbia's needs for remote power are met.

## APPENDIX B: MARKET OPPORTUNITY IN SUSTAINABLE URBAN PRACTICES

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Energy optimization in high density areas represents a core challenge for industrialized regions. The primary issue is peak load—where the amount of energy users consume during peak hours drives a bulk of utilities’ energy costs and needs for power production. Sustainable urban practices can provide solutions tailored to multiple needs. For the energy users, it is about getting the right kind of power (availability, quality, cost) when and where they need it. For the utility, it is about load shifting from peak to non-peak, overall load reduction, or mechanisms to better capture the true cost and value of the energy from the user. For communities, it is about reducing the externalities from energy consumption. Here we are defining the Sustainable Urban Practices opportunity to include several subsectors:

- **Sustainable Development Community Planning** where decision-making includes material and energy input from renewable or recyclable sources, smart buildings, and other advanced environmental principles.
- **Green Building Design and Retrofit** that utilize alternative energy sources, energy efficient materials, and advanced energy management systems to minimize and optimize energy use to the benefit of the occupants and the broader community.
- **Grid-connected Distributed Energy Systems** that leverage clean, green distributed technologies for primary, stand-by and back-up use.
- **Industrial and Commercial Energy Management Technologies and Practices** that optimize the energy use associated with ongoing operations—lighting, motors, equipment, plants, chillers and boilers, etc.
- **Demand Side Management of Energy Use** where utilities leverage programs, efficiency products and advanced metering and control

“An average British Columbian consumes 15,000 Kwh per year—three times higher than the average German, two and a half higher than the average Briton and more than the average American.”

Bob Elton, President and CEO, BC Hydro

October 22, 2004

technologies to encourage conservation and shift in use away from high-peak times of the day.

## **WORLD DEMAND FOR SUSTAINABLE URBAN PRACTICES IS RISING**

On the world scale, the urban population is expected to grow rapidly. The United Nations predicts that by 2030, 60% of the 8.1 billion global population (4.9 billion) will reside in urban areas<sup>25</sup>. The urban population is expected to double in 38 years<sup>26</sup>. This growth will drive considerable investment into urban infrastructure, creating large market opportunities across all of these sectors.

**Sustainable Urban Planning** is being used in advanced societies to preserve the environment and enhance the quality of life. Principles include effective urban design and land use that promotes high density, mixed-used neighborhood, energy efficient buildings and effective demand side management to reduce use of electricity and energy for transport.

**Green Buildings** began in the institutional and public sector, where the motivation is to reduce resource consumption and greenhouse gas emissions from buildings. Now private sector developers and building owners are beginning to find competitive market advantage in new green buildings and green retrofits. Advanced materials, design and building automation reduce long-term building operations and maintenance costs for building owners; increase marketability and building value for developers; result in faster lease rates and better tenant retention; and benefit occupant well-being and productivity through better indoor environmental quality.

Some industry pundits have projected that green building market penetration will grow exponentially over the next five years as standards unify around systems like LEED, driving building codes and increasing providers with LEED certifications. Nine states in the U.S. have signed executive orders and or legislated some level of LEED certification for buildings (including California and NY, as well as Washington and Oregon). Financial instruments that value green buildings (e.g. green mortgage backed securities) are also helping to legitimize the trend. Green Building Councils (GBCs) currently exist in Canada, US, Mexico, Brazil, Spain, India, Japan, Australia and membership of the GBCs in North America is increasing exponentially, (e.g., in the US from ~500 in 1999 to ~3600 in 2003). The Canadian GBC's membership is growing at ~10% a month<sup>27</sup>. The explosive growth that local green architects are experiencing supports these trends. (See Sidebar 15.)

## Sidebar 15 – Busby, Perkins & Will Leads the Way in Sustainable Architecture



As green building design grows in popularity, the reputation of local firms also continues to climb. Busby, Perkins & Will

provides architectural consulting services to the commercial, institutional and residential building sectors. The company is the result of an August 2004 merger between Peter Busby and Associates of Vancouver and Chicago's Perkins & Will (which was declared Firm of the Year by the American Institute of Architects in 1999). Based in Vancouver, Busby, Perkins & Will also has offices in Calgary, Seattle and now Chicago.

World market experts in sustainable development, they have won more than 60 national and international awards, including six Governor General's Awards. They have been involved in numerous local sustainable projects and are involved in design for the 2010 Sustainable Olympics. The firm is working in BC and across Canada, as well as North America, Europe, Middle East and Asia. Busby drives growth in the green building and sustainable community industry in BC and represents a major influence on shaping policies and practices in the region.

"Five years ago, we were doing \$ 25M of green building construction value, mostly in BC" said Peter Busby. "Now we are working all over North America and doing over a billion dollars worth of green building construction." This rise in projects has also led to growth in the high value jobs in the firm. Over the last three years, the company has nearly doubled, growing from 35 people locally to 66 people (not including the growth from the recent merger). Busby's success over the last several years represents the enormous uptake of interest in sustainable design in all sectors of the market.

**Grid-tied Distributed Generation Systems** in urban settings are growing. In some cases distributed generation is put into the grid and serves as another source of power for the system. Some distributed systems provide electricity when the primary power source fails (backup power) or when power from the grid is most expensive (peak power), often using renewables (e.g. solar) or other quieter, low-emission alternatives to diesel generation (e.g. fuel cells). The first successes for new technology innovations in backup power are usually in the so-called "premium power" niche — those sites that must have high-quality power 24 hours per day, 365 days per year. Examples include substations, telecommunications sites, cellular towers, financial services centres, computing centres, pipeline-monitoring stations, etc. As hybrid buildings evolve (ones with both DC and AC loads) industry experts predict that grid-tied distributed generation systems will also need to evolve and innovate, creating opportunities for both incumbents and new entrants. (See example of regional showcase for these technologies in Sidebar 16.)

**Industrial Practices** look at ways to extract more energy efficiency and savings from equipment and processes. Technologies focus on better control of energy cost through variable speed drives and other mechanical efficiency enhancers, command and control systems, and other mechanisms. As high-energy industries like food processing, pulp and paper and others see energy as a controllable cost, more firms are investing in

tools that help them manage energy consumption and increase efficiencies in their operations.

### Sidebar 16 – The Britannia Projects Charts New Territory for the Mining Industry



The Britannia Project will transform the mining legacy at the Britannia Beach site, on the Sea-to-Sky corridor, into a compelling, world-class innovation and interpretive destination that demonstrates history, regeneration and sustainability on a global stage. Through a series of exciting, entertaining and educational venues, the project will demonstrate BC

leadership and innovation in emerging global, environmental, energy and resource sector markets. It will tell the story of resource sustainability using the site's mining history, current remediation programs, and environmental technology as the underlying themes.

It also represents a unique opportunity to showcase advanced power technology solutions. Britannia's Innovation and Sustainability Centre will be built to LEED Platinum design standards. Solar, micro-hydro and other technologies demonstrate innovative distributed generation approaches to power sources. Advanced metering, energy information systems, and other technologies can show forward-thinking approaches to managing demand.

Currently in Phase Three of a five-phase development, the project will open in 2009, in time for the 2010 Olympic winter games.

**Demand-side Management/Demand Response** is growing rapidly as utilities evolve from traditional conservation programs to efforts to create “Nega-watts” through 1) incentives to users reduce use or 2) passive technologies and networked energy management systems that do it automatically or allow the utility to directly manage load to the same level of control (or more) that they currently have when dispatching supply resources. These programs are rising in popularity across Europe and North America as utilities and Governments take steps to curb the rising energy demand. Even the largest potential energy user, China, has put an emphasis on designing and implementing efficiency measures to bring the demand for electricity down as the country continues to modernize.

## BRITISH COLUMBIA FACES URBAN GROWTH

British Columbia's interests in sustainable urban practices stem from our need to preserve our current environment. In BC in 2001, about 50% of the 4.1 million people in BC live in 21 municipalities across the Greater Vancouver Regional District (GVRD)<sup>28</sup>. In GVRD, nearly a third of greenhouse gas emissions come from buildings<sup>29</sup>. By 2021, the GVRD will be home to 2.7 million people, a 35% increase from 2001<sup>30</sup>. Growth in population and economic activity will drive up demand for other resources, such as land and energy. Opportunities to reduce greenhouse gas emissions through more efficient communities, buildings, and energy use practices

will become more important as the community feels the impacts of this growth.

## **BC HAS SOME ASSETS BUT NEEDS BETTER COORDINATION AND INVESTMENT TO BE A WORLD PLAYER**

We have a considerable amount in the asset column in Sustainable Urban Practices.

**Willing Customers.** The provincial and local governments and Crown Corporations have already made some commitments to Sustainable Urban Practices. BC is already a recognized leader in sustainable urban design and buildings. It has received international recognition for the livability and sustainability of its cities. Moreover, it recently won a world competition for the best 20-year sustainability plan for the Lower Mainland that was a collaborative effort among Sheltair, GVRD, and others. Governments have made investments in LEED buildings. In July 2004 the City of Vancouver became the first North American municipality to adopt LEED™ Gold, the leading edge energy and environmental performance system as its standard for all new city buildings. Canada's first refurbished LEED™ (gold) building is the Vancouver Island Technology Park and the first new LEED™ (gold) building is the White Rock Operations Building, also in the Province. A provincial government initiative, Green Buildings BC, enables British Columbia's education and health care agencies to dramatically increase the performance of their new and existing buildings through the New Buildings and Retrofit Programs respectively. Improving energy efficiency in new and existing buildings and managing greenhouse gas emissions are also key actions in "Energy for our Future," British Columbia's plan for environmentally responsible energy generation and management.

BC Hydro is implementing a suite of demand side management (DSM) programs called "Power Smart" that are expected to save 3,600 GWh of electricity per year by 2011. This represents a third or more of the utility's load growth through 2011. This is in addition to BC Hydro's historic DSM programs that are saving 2,500 GWh per year today. (See Sidebar 10.)

**Local Providers and Expertise.** British Columbia is also home to leading firms in sustainable building and engineering, and accounts for around one-third of the members of the Canada Green Building Council, established in 2002 to mainstream green building in Canada. The province has more LEED™ accredited professionals than any other in Canada. In grid-tied distribution systems, local providers Soltek, Xantrex and others



provide components and systems for a variety of back-up, stand-by, and programmable power needs. Homeworks helps to translate demand side management and energy efficiency programs to those who have to adopt them for the programs to be successful. Power Measurement provides energy management information that helps firms manage their energy and operations more effectively. Legend Power provides a conservation voltage device that provides power quality, aiding both the industrial/commercial business and the utility. Other examples of companies working on particular building, equipment or process technologies, still others that have engineering and other services business that fit in this category. We also have good examples locally of “trusted agents” in this area. Often NGOs, these are firms that are relied on by other countries for education and awareness of best practices, and represent a very natural partner for local firms. (See Sidebar 17 for one example.)

### Sidebar 17 – International Centre for Sustainable Cities Opens the Door to China



The International Centre for Sustainable Cities (ICSC) is a non-government organization (NGO) that uses their expertise in sustainable design to bring BC and Canadian technology firms to the world. In cities and towns around the globe, ICSC focuses on demonstration projects in community infrastructure, builds networks to share learning and holds events to promote the message of urban sustainability.

In BC's sister city of Jinan, China, ICSC led an effort to bring a demonstration of leading edge energy efficiency technologies to the Shandong University of Architecture and Engineering.

ICSC worked with the University officials and taught the Chinese about efficiency and building techniques. In partnership with a consortium of firms that included several power technology companies from British Columbia and Canada, they leveraged design principals and advanced technologies to build a new student dorm that showcases best practices in building design. Four months into operation, University officials are describing the savings as 75% of what they are seeing in other traditional dorms on campus. “The students of architecture and engineering at Shandong are seeing first hand what impact innovation can have on building comfort and efficiency,” says Nola Kate Seymour from ICSC. “The companies that are involved in this outreach end up with key relationships, partnering opportunities and new business.”

ICSC's numerous efforts in China and elsewhere are good examples of how NGOs can serve as trusted agents and enhance the branding of the province worldwide with their outreach. Through their expertise on topics where BC companies have strengths, they can bring the education around sustainability to the world in a way that opens opportunities for other British Columbia power technology products and services to follow.

**World-class Showcase Opportunities.** The World Urban Forum, Globe Conference, and the 2010 Sustainable Olympics represent some of the greatest opportunities to build a world stage for the Province's innovations in Sustainable Urban Practices. The region is already thinking ahead and leveraging these opportunities with the design of several showcase and demonstration projects, including Sustainable Olympic Housing (Sidebar

9), SE False Creek Sustainability District (Sidebar 18), the Britannia project (Sidebar 16) and many others. In addition to these existing efforts, the University of British Columbia is currently developing the Centre for Interactive Research on Sustainability. When complete, the Centre will represent a revolutionary showcase for power technologies (Sidebar 19). GVRD, Powertech, and OREG are also collaborating to propose the Renewable Energy Centre to demonstrate leading energy innovations in an urban setting.

**Need A Plan for Leveraging Catalyst Events Into a Sustainable Urban Practices Industry.** To take the Sustainable Urban Practices opportunity forward, the region has to deliberately focus on building a more robust local industry that can supply these goods and services to the world.

**Fully Leverage Showcase Opportunities.** The upcoming showcase opportunities are key to branding the region as a leader in smart, sustainable technologies. For the Government, It will be important to ensure that funding is available to follow through on Olympic opportunities, and that this funding is being used strategically to grow industry here through local content and local commitments through partnerships, etc. The emphasis should be on getting projects in the ground that represent true breakout technologies with participation of local firms that can be featured on that international stage. Government procurement around green buildings and other measures should be used to encourage adoption over the next several years leading up to the event.

## Sidebar 18 – Southeast False Creek - A Successful Sustainable Urban Neighborhood Model



Known as an industrial site since the late 1800's, the Southeast False Creek (SEFC) area is being transformed to a sustainable urban neighborhood. The 1999 Southeast False Creek Policy Framework envisioned the 80 acres (36 hectares) area near downtown Vancouver as a mixed use, mixed income community that will promote a highest possible level of social and economic health while at the same time maintain the local and global ecosystem's health through efficient use of energy.

The recently approved Official Development Plan ensures the provision of nearly 26 acres of waterfront park, the Athletes' Village for the 2010 Olympic Winter games and two million square feet of diverse mix of residential housing, retail and public use buildings. Public amenities will be at walking distance to reduce auto dependence. The planning department also explores the use of innovative water management systems and renewable energy supplies, as well as higher standards for private sector

buildings to reduce energy use and waste and create a healthier environment for occupants.

A Green Building Strategy was approved that adopts LEED Silver as a minimum design standard for all development. For all new civic buildings over 500 square metres, LEED gold is required. These buildings need to show at least a 30-per-cent improvement in energy consumption from the city's current energy bylaw. The Athletes' Village will be developed to LEED Gold Standards.

Next on the staff agenda is the development of a green building strategy that will ultimately apply to all building types in Vancouver. An initiative is underway to explore the creation of a 550 acre sustainability precinct around the False Creek Basin, including an area-wide neighbourhood energy system built on environmentally friendly energy sources and distribution systems. This combination of initiatives will keep Vancouver in the forefront of sustainable urban development.

**Emphasis on Export Opportunity and Outreach.** Successfully penetrating export markets outside of North America a requirement for providers in this space, as in the near- to mid-term, other countries will represent more demand for these practices than Canada. With higher electricity prices and higher emission standards, Japan and Europe will have more demand for distributed generation and related technologies. China and India are major opportunity areas for sustainable community planning, green buildings and other efficiency measures. We also need to encourage the Power Technology companies, NGOs and others operating in Sustainable Urban Practices to seek out more opportunities to cooperate and collaborate around local joint projects and export markets. Any branding and outreach campaign should leverage the expertise and relationships of the strong local NGO community as trusted agents that can help pave the way for whole groups of firms in new areas. Government should also be a part of and support this collaboration where outreach is concerned.

**Invest in Future Innovation and Local Culture.** For success over the longer-term as these markets take off, it will be important to make investments in research and development to ensure long term sources of innovation in the goods and services. Ongoing showcases and education at a primary and secondary level will also generate an even stronger regional awareness and more local demand over time. The Center for Interactive Research on Sustainability (Sidebar 19) is a good example of such a program.

## Sidebar 19 – Centre for Interactive Research on Sustainability



the core of a cluster of related industries.

The CIRS building at the Great Northern Way Campus will be a research and demonstration facility for a wide variety of environmentally advanced building technologies and techniques. The adaptable design of the CIRS building will allow on-going testing of a wide range of technologies and systems, undertaken in conjunction with industry partners.

The insights gained will become incorporated into guidelines and policies for planning and development of the Great Northern Way Campus and Vancouver's Sustainability Precinct. Beyond that, the involvement of regulatory agencies, testing agencies and

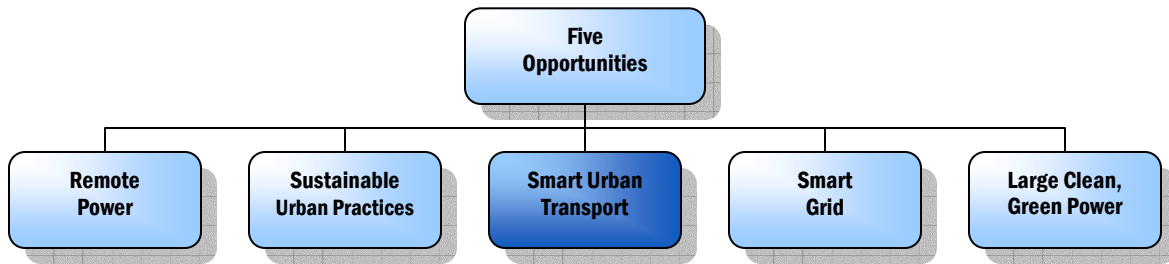
The Centre for Interactive Research on Sustainability will be a regional and international hub for sustainability research, resulting in innovative, marketable solutions to sustainability problems at the local, national and global levels. It can be

private sector partners will ensure that the insights gained inform actual building practice and technology development in Canada and around the world. This is critical at a time when considerable technical advance in building environmental systems and technologies is occurring without comprehensive, long-term monitoring and validation. In addition, the building's role as a demonstration centre will increase the exposure of the technologies to potential consumers and the visibility of BC to the global technology community.

These new forms of partnership will allow innovative sustainability strategies and technologies to be implemented on the ground in BC. This will serve as a springboard to the trillion-dollar export market in urban infrastructure. CIRS will therefore itself be the hub of a new innovation cluster in BC, focusing on urban sustainability strategies, with potentially huge economic benefits.

## APPENDIX C: MARKET OPPORTUNITY IN SMART URBAN TRANSPORT

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Transportation is fundamental to industrialized economies by enabling efficient movement of goods, services and people. While transportation has become an integral part of the society, it also has its negative environmental and social implications. As a primary consumer of fossil fuels-based energy, transportation is the largest source of GHG and smog causing emissions. The growing traffic congestion has been linked to stress and other related health problems. Given the projected growth in urban areas going forward, Smart Urban Transport is key to continued economic growth across a majority of the world’s communities.

Smart Urban Transport as we have defined it here focuses on a couple of key market needs:

### **CREATING ALTERNATIVES TO AND EFFICIENCIES IN VEHICLE POWER SYSTEMS**

(Motors, Drives, Engines, On-Board Power, etc.)

- **Smart Public Transportation** or “people movers” including public buses, light rail, and other forms of in-city mass transport
- **Short-Haul and In-City Long-Haul Transportation** of goods with trucks and large vehicles, railways, rail spurs, and other transport
- **Smart Personal Transport** including passenger cars, motorbikes, electric bikes, and other modes of people transport

### **CREATING THE TRANSPORT POWER INFRASTRUCTURE OF THE FUTURE**

- **Advance Fueling Infrastructure** for fuels of the future (e.g. hydrogen, bio-fuels)
- **Access Point Stationary Power Solutions** related to idling and on-board power needs during transport into and out of ports, airports and other key junctions

Technologies around vehicle transport power systems problems include fuel cells, electric and natural gas cars, and hybrid vehicles. On the fueling infrastructure side, fuels being advanced include hydrogen (either electrolyzed from water, from renewables, or reformed from fossil fuels locally or externally), as well as biodiesel and other fuels, and even grid-connected stationary systems for charging and auxiliary use. The fueling infrastructure includes everything from on-board processors to large hydrogen pipelines running in parallel to the current fuel delivery systems.

The more the technology represents a departure from the traditional oil and gas based combustion engine, the more these two broad categories—vehicle power systems and fueling infrastructure—really depend on advances in the other to create widespread market adoption. Therefore, we can expect them to evolve together, albeit in fits and starts (similar to the way hardware components and software applications have pushed and pulled at each other to shape innovation in the computer industry).

## **WORLD'S INVESTMENT IN SMART URBAN TRANSPORT ARE RISING, EVEN IF OPERATING REVENUES FOR SPECIFIC TECHNOLOGIES ARE NOT**

The markets for vehicle power systems and advanced fuels infrastructure are predicted to grow, with some projections show significant market adoption in selected applications is expected to occur by 2010 with a widespread adoption of most applications by 2020<sup>31</sup>. There are large, real markets for these technologies all around the world. Expanding economies in India, China, and other Asian regions are large drivers for adoption.

*"The Hydrogen Highway will take us from the fossil-fuel economy we live in now to the new hydrogen economy. Canada's going to show the world that hydrogen fuel-cell transportation is more than a great idea - it's practical, efficient and within reach. Hydrogen technology is part of our commitment to responding to climate change and creating new economic opportunities."*

**The Right Honourable  
Paul Martin, Prime  
Minister of Canada at  
Globe 2004**

### **Alternatives to and Efficiencies in Current Vehicle Power Systems.**

Many of the world's most significant users of vehicles today (e.g. California) and the greatest potential users tomorrow (e.g. China and India) are setting goals of reaching 10% to 20% penetration of alternative fuels within the next 10 years. To meet its aggressive targets, the California Energy Commission announced that vehicle fuel efficiency would have to double, and at least 20% of fuels used on-road should be non-petroleum. Other regulatory changes, including the Zero Emission Vehicle mandate and GHG regulations are also driving technology changes.

Some of the first opportunity areas are public transit, and as urban planners move toward development approaches that emphasize the use of transit and reduced reliance on automobiles, support of sustainable public transport will increase. Short haul or in-city portion of long haul is another key place where new systems are finding good use in trucks and rail lines (Sidebar 20). For most communities, passenger cars continue to be the

major source of transport problems and therefore represent another key opportunity. Most major auto manufacturers have either limited production or demonstration models of electric, fuel cell or hybrid cars. Unfortunately, experts are divided as to when alternative technologies (ex. hybrid, fuel cell, advanced diesel) will displace existing ICE's in significant numbers and at what adoption curve they will penetrate the market. However, they do agree it will happen and will likely be driven by external factors (ex. government regulations and environmental challenges). While it is true that passenger cars are a challenging market to enter for various reasons, there are various other markets along the way (ex. forklifts) that will help accelerate these alternative technologies into the market.

### **FUELING INFRASTRUCTURE KEY TO SUCCESS FOR TRANSPORT ADVANCES**

During the initial introduction of fuel cell technology into automotive markets, in the late 90s, analysts largely ignored the issue of fuel. Some assumed it would be reformed from fossil fuels while others thought that methanol would be the fuel of choice. Still others assumed that hydrogen would soon be available from renewable methods. Today fuelling infrastructure, the costs to obtain hydrogen and hydrogen storage loom as real barriers (but also possible opportunities) to the rapid emergence of the hydrogen economy.

While hydrogen generated from renewables is still a niche production methodology, there are a number of other transition approaches that are being considered and developed. Bio fuels are an option—synthetic methane or synthetic diesel fuel made from feedstocks like waste wood, or fuels such as ethanol. Natural gas is growing in popularity as a potential transition fuel to a hydrogen economy. Already at 1% of the transportation industry and widely available, natural gas is currently cheaper than oil and good for internal combustion engines. Electric-based or hybrid transport systems that rely on a grid-tied recharging system are continuing to get attention as well.

In the meantime, though, the quest for a renewables based fueling station will continue. In California, the Governor's hydrogen highway initiative taken strong steps toward developing a hydrogen fuelling infrastructure and is targeting up to 200 stations by 2010 that will fuel compressed-hydrogen based tanks on fuel cell demonstration vehicles. In April of 2004 Praxair began work on the first fueling station for public use in the United States at Los Angeles International Airport (LAX). This prototype commercial automobile fueling station will showcase the generation, compression, storage and dispensing of compressed-hydrogen fuel. Praxair

is funding construction, along with grants from the local government, U.S. Department of Energy, and British Petroleum.

## Sidebar 20 – Railpower Revolutionizes the Railroad Shunter



The familiar rumble of the train engine running through urban areas may someday be history if a local innovator is successful. RailPower Technologies Corp. is the world leader in hybrid yard locomotive technologies, bringing managed energy solutions for rail operators. The Green Goat Series switcher (shunter) locomotives are noted for the innovative way they reduce operational and fuel costs,

While also bringing about major reductions in emissions and noise.

The company recently received its first multi-year order for 35 of its 2,000 hp Green Goat hybrid switcher locomotives to be delivered over the next four years. Another 43 firm or conditional orders are in hand.

Developed in British Columbia, Canada, the hybrid switcher technology is now being sold in North America and introduced into Europe where it is also suitable for diesel hydraulic conversions. RailPower also sees potential for the technology being applied in transit and larger switcher variants.

Headquartered in North Vancouver, British Columbia, Canada, RailPower has its principal engineering management facility in Erie, Pennsylvania. The company's common shares are traded on the Toronto Stock Exchange under the Symbol "P".

There is a second opportunity in the infrastructure that is often overlooked. Some of the best near-term opportunities are at the access points, where numerous near-market and market-ready solutions could be brought to bear—most notably for ships and waiting trucks idling diesel engines in ports. The Delta terminal at the Port of Vancouver currently sees 1,800 truck trips per day in and out of the terminal. This figure is projected to nearly double by 2012 with substantial increase in diesel fuel consumption and commensurate strains on local air quality. The Delta expansion plans need to enable the introduction of cleaner-burning fuels and associated technologies to public and private fleets operating in and around the site. Potential technologies here include an on-site LNG vehicle fuel loading facility, stationary fuel cells for onboard power, grid connected ships and vehicles to avoid emissions from idling, and a number of other distributed generation options also designed for that purpose.

**World Competition is Increasing.** With significant market opportunities and its environmental benefits, Smart Urban Transport and its underlying technologies have seen a rise in investment by government and industries in various jurisdictions. The United States has committed US\$2.7 billion to a 5-year program in fuel cell vehicles and hydrogen infrastructure technologies<sup>32</sup>. China has invested nearly US\$200 million into fuel cell research and its university start-up, Shanghai FCV Powertrain, is expected



to sell 250,000 fuel-cell cars by 2020<sup>33</sup>. The Japan's Railways Technical Research Institutes has invested in research and development that will see a hydrogen fuel-cell train operate by 2010<sup>34</sup>. So countries and companies are investing in developing the technologies, but little in the way of actual revenue is being generated by specific innovations at this point.

## **BRITISH COLUMBIA HAS SMART URBAN TRANSPORT AND HYDROGEN HIGHWAY ASSETS**

**Willing Government Customers and a Commitment to Technology.** In British Columbia, transportation accounts for 39% of the province's GHG emissions<sup>35</sup>, it is the province's largest and fastest growing source of GHG emissions<sup>36</sup>. The Kyoto Protocol, which came into effect in February, commits Canada to cut its greenhouse gas emissions in the period 2008 to 2012 by about 20 to 30 per cent from what they otherwise would have been. This is likely one of the reasons why local and provincial governments have voluntarily looked at "greening" their fleets and creating showcase opportunities for smart urban transport innovation. As for fueling infrastructure, BC Hydro, GVRD and others have been willing partners to invest in showcase opportunities for advanced fueling solutions; BC Hydro has identifying additional grid-connected opportunities to provide power at key access points to reduce emissions in ports. Regional efforts have led to the creation of a BC Hydrogen and Fuel Cell Strategy<sup>37</sup>, part of which applies to transport opportunities.

**Leading Companies and Innovation in Smart Urban Transport.** British Columbia is already a globally recognized leader in hydrogen and fuel cell technologies, and has demonstrated their effectiveness in urban transport. Ballard Power System's Proton Exchange Membrane Fuel Cells (PEMFC) technology for mobile application has been widely adopted around the globe. Other companies in dealing with the power systems issue for a variety of vehicles, including Cellex, PEM, Railpower (Sidebar 20), Westport (Sidebar 21), and many others. BC is also a leader in fueling infrastructure efforts, with Questair (Sidebar 23), General Hydrogen and others working on innovations that will make hydrogen more available. BC Hydro's Powertech Labs has world-renowned expertise in hydrogen research and is home to the world's first 10,000 psi fueling station.

## Sidebar 21 – Westport Innovations Takes BC Technology to the World



Westport Innovations develops technologies that allow diesel engines to operate on alternative fuels such as natural gas, propane and hydrogen. Their initial technology came out of work done at UBC, and they've continued to pursue research and development to become one of the world leaders in natural gas fired engines. Their technology.

is widely identified as an example of how the industry can make a transition away from traditional engines while fuel cells continue to move toward better commercial viability

Westport offers high-performance, low-emission alternate-fuel engines through its joint venture Cummins Westport (both headquartered in Vancouver). Westport has been recognized as the world leader in gaseous fuel engine technology and has partnerships with several alternative fuel providers (Clean Energy Fuels, Iqara, Ruhrgas, Japan Gas Association). The company is truly global, and has technology alliances with BMW, Ford, Isuzu and MAN; The company does R&D in multiple centres (US, Europe, Asia and Vancouver) and all manufacturing is outsourced. Its facilities in Vancouver total more than 78,000 square feet of laboratory and office space.

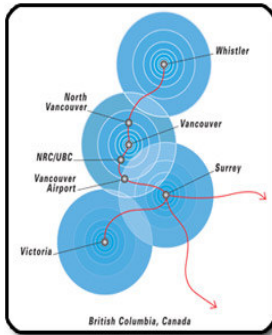
On January 17, 2005, Westport announced signing an MOU with Guangxi Yuchai Machinery Co. Ltd. (Yuchai) to work together on exploring business opportunities to develop, market and sell gaseous fuelled vehicle in the People's Republic of China using Westport's portfolio of direct injection technologies.

BC is also the home for the National Research Council's Institute for Fuel Cell Innovation, a world-class hydrogen and fuel cell research facility and Canada's primary government fuel cell research institution, providing an important focal point for the development of these technologies in Canada.

**Access to World Markets.** The world-class partnerships that companies like Ballard Power Systems, Westport (Sidebar 21) and others have put together are world-class, and in many cases represent key access to international markets that could be leveraged across the smart transport industry.

**World-Class Showcase Opportunities.** As with the Sustainable Urban Practices, the upcoming Sustainable Olympics and World Natural Gas Vehicle Congress represent an opportunity to feature British Columbia's efforts in the Hydrogen Highway. (See Sidebar 22.) Other showcase opportunities are being explored, including a Hydrogen West strategy that outlines several key local demonstrations either underway or proposed.

## Sidebar 22 –BC Gains World-Wide Exposure with the Hydrogen Highway™



The Hydrogen Highway will be a showcase of smart transportation at the 2010 Olympic and Paralympic Winter Games in Vancouver and Whistler by allowing fuel cell powered vehicles to travel between the Vancouver Airport and Whistler.

The BC Hydrogen Highway is a concerted effort of industry and government to accelerate the commercialization of hydrogen and fuel-cell technologies by demonstrating and deploying a hydrogen fuelling infrastructure along a corridor between Vancouver and Whistler, with an extension to Victoria.

With seven fuelling nodes, the project will demonstrate the operational, economic, environmental and social feasibility of a hydrogen fuelling infrastructure. It will also show a wide range of transportation, stationary, portable and micro-power applications that can utilize the hydrogen fuelling infrastructure.

The showcase will send an important message to the world that BC has the critical mass of expertise, knowledge and experience in the area. It will also stimulate the demand for the technology by allowing the media and general public to feel, touch and see the benefits of a hydrogen economy and open doors for international partnership to create a hydrogen infrastructure. This project is part of a long-range plan to transition Canada to a hydrogen economy and a sustainable future.

## NEED TO CONTINUE COMMITMENT AND EXPAND DEFINITION TO DRIVE OPERATING PROFITS

There are significant efforts in other regions of the world such as Michigan, Illinois, California and Japan to build their own hydrogen and fuel cell clusters. These jurisdictions have offered substantial incentives to leading BC firms in an attempt to relocate their facilities to these jurisdictions. In spite of these efforts, BC has been able to retain and grow this cluster and is still considered a global leader. The challenge is to continue making investment and understand that it requires both investments in technology development, but even more efforts in linking innovations to local markets.

**Local Targeted Development, Testing and Demonstrations.** There needs to be more early deployment opportunities close to the engineering teams so that they will learn quicker and speed the development processes. Specifically, the government should encourage both public sector and private sector fleets to deploy prototype and early commercial vehicles to encourage feedback, collection of field data, and to provide visibility. Encourage collaboration among local innovators to deliver complete solutions with stronger overall economic benefits. Strong players should build from the cohesion among the fuel cell and hydrogen industry to leverage other partner jurisdictions and other technologies also focused on smart transport.

## Sidebar 23 – QuestAir Gas Purification Contributes to Hydrogen Infrastructure



Fuel cells need hydrogen to operate, and a local company is contributing to the infrastructure needed to produce hydrogen for

stationary and automotive fuel cells. QuestAir is a developer and supplier of proprietary gas purification systems for use in a range of industrial and power technology markets, including improving the quality of hydrogen produced for industrial fuel cell applications.

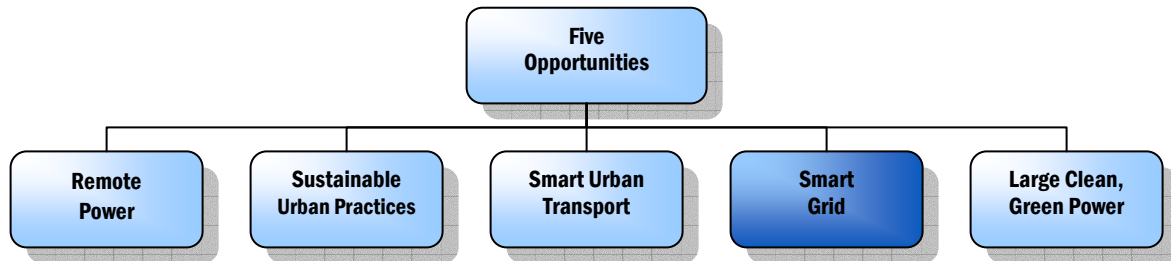
QuestAir's compact hydrogen purification technology removes carbon dioxide and other impurities. QuestAir's HyQuestor(r) and H-3200 hydrogen purifiers have been installed in seven hydrogen fueling demonstrations in the US, Japan and Canada. The company's compact gas purification products are also used by customers in the industrial gas, oil refining and chemical processing industries for applications including hydrogen generation from natural gas and hydrogen recovery in refineries. QuestAir also markets a range of systems for recovering pipeline- and LNG-grade methane from renewable 'biogas' sources, including landfill gas and anaerobic digester gas.

QuestAir employs approximately 80 engineers, scientists, technicians, and support staff with principal facilities in Burnaby, BC..

**Build Broader Economic Development Strategy Into Commercialization Plans.** For larger investments of time and energy like the Hydrogen Highway, there should be a clear strategy for how this will broaden and support the Smart Urban Transport sector. How will the region become a player in the fueling infrastructure of the future? Are there parallel industries that could be brought into this broader vision now, so that they are developing some of the specialized skills and assets along the way? Ultimately by integrating the fuel cell cluster into the broader picture of Smart Urban Transport and having a vision for building the parts of that industry British Columbia can compete for, the Government can see a diverse portfolio of winners that will yield benefits to the region and meet job and revenue growth needs in the near, intermediate and longer term.

## APPENDIX D: MARKET OPPORTUNITY IN SMART GRID SOLUTIONS

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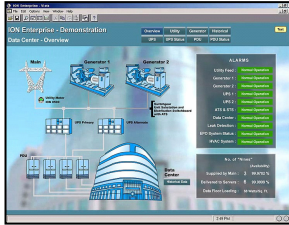


Beyond the source of power, the delivery systems themselves represent a growth market as the utility industry seeks ways to make current transmission and distribution grid assets more efficient, reliable, and lower cost to serve load with centralized power sources. Digital technologies are revolutionizing the power grid, turning it into a smart, self-healing superhighway for electricity. Like other utilities around the world, BC Hydro and BCTC are continually updating and automating their transmission (high voltages across longer distances) and distribution grids (medium to low voltages down to the point of use).

Today's electric power grid is largely made up of electromechanical gear designed in the 1950s, before the era of the microprocessor. The grid of the future will take full advantage of digital technology and advanced materials, which will make the grid more reliable, more efficient and more cost-effective. Several subsegments represent opportunity:

- digital protection devices and intelligent controllers that create a “self-healing” infrastructure
- Advanced materials and electronics that wring more capacity from existing systems and reduce operating instability
- Grid optimizing tools that bridge the gap between simulation and operations
- Networked energy platforms to integrate multiple supply resources and hybrid end use systems either at a grid, campus, or single use level

## Sidebar 24 – Power Measurement Celebrates 20<sup>th</sup> Year



employees and roughly \$50M in sales.

Now celebrating its 20<sup>th</sup> year, Saanichton, BC-based Power Measurement is a global provider of advanced meters and enterprise energy management systems with approximately 250

For utilities, Power Measurement supplies advanced meters and supporting software. The company's products can collect data from customers, but also from generating stations, substations and grid inter-ties.

For industrial and commercial users, Power Measurement promises to identify energy-intensive activities, pinpoint power problems and supervise facilities through a command-and-control center (see sample screen at left).

**World demand for Smart Grid technology is rising.** The electric power industry — one of the world's largest — is in the early days of a radical transformation. Over the next two decades, the planet's power grid will be upgraded and remade. Those regions that establish themselves as centres of excellence will gain thousands of new jobs and tens of millions in new revenue. British Columbia has all the ingredients — including an early start — to become a world leader.

For instance, studies in the United States have shown that electricity demand has increased 25% since 1990, yet construction of transmission facilities has decreased 30% and annual transmission investment has declined steadily for the past 25 years<sup>38</sup>. According to the Electric Power Research Institute (EPRI), the capital expenditures of the North American electric power industry during the 1990s were only 12% of revenues—less than half the historical average and representing an annual investment deficit at \$20B per year. That deferred investment is now coming due. Either the U.S. and Canada will pay to update the infrastructure, or they will experience continued degradation in power quality, reliability and cost. Power outages already cost the two countries more than \$100B per year, according to EPRI's calculations (and this figure doesn't take into account the excessive costs associated with the large scale blackout that plunged the eastern Provinces and States into darkness for days.) Other research reveals that the majority of existing transmission lines are over 20 years old, and while utilities already have plans for more than \$12B worth of upgrades to the transmission system over the next decade in North America alone, in reality that figure should be closer to \$56B<sup>39</sup>.

According to the Freedonia Group, the market for grid equipment amounts to US\$17B in the U.S. and US\$70B worldwide. Many related sectors are substantial as well.

**How the Smart Grid aids other sustainability initiatives.** The smart grid is vital to British Columbia's other sustainability initiatives. Automating the transmission and distribution systems that deliver power strengthens the ability to optimize sources with uses, integrate non-traditional assets, and leverage infrastructure in more reliable and cost-effective ways. Advanced grid technology can make it easier to bring clean power some areas (and deliver advanced functions such as broadband access at the same time). Likewise, it holds a key to the smart growth of urban areas around British Columbia to enable the demand-side management practices outlined earlier.

The smart grid is also essential if British Columbia hopes to leverage alternative power sources. Renewable energy is often stymied by the difficulty of getting the power from where it is generated (windy regions, for instance) to where it is needed (urban areas). It is likewise held back by its intermittent nature (the wind doesn't blow at constant times and speeds, for instance). The smart grid helps with both problems by providing controls and optimizing functions that can handle the additional complexity.

The grid may even play a valuable role in smart urban transport in the region. Many experts believe that hybrid and fuel cell cars should eventually be hooked to the grid, either to recharge them at night (when there may be an "energy surplus") or to use their built-in power plants to prop up the system during times of peak demand. Either scenario would require a level of grid sophistication and control far beyond the current system.

The level of education and training necessary to produce high calibre of electric utility engineers and technicians has been steadily deteriorating thanks to the focus of the educational institutions on other modern time technology education and business. Utilities all over North America and BC have been struggling to find the calibre needed to operate plan, design and operate the complex electrical grids of modern times.

## **BRITISH COLUMBIA HAS ASSETS, BUT NEEDS COMMITMENT TO MOVE THE INDUSTRY PAST DEMOS**

**Knowledgeable, Willing Local Customers.** British Columbia's heritage includes hydropower, long distances between metropolitan areas and shipping power back and forth to California. As a result, it has a large network of transmission lines and deep expertise in grid issues — transmission modeling, design, planning, and installation. British Columbia Transmission Corporation and BC Hydro have both the necessary experience and the necessary "mind-set" — an interest in and openness to



advancing technology. BC Transmission Corporation has also shown a commitment to enhancing and upgrading its internal know-how about advanced grid solutions. To mitigate this issue, BC Transmission Corporation established recently an internal program "The BC Transmission Academy" to fill the skill gap. The current program of the academy has over 20 courses and 50 faculty members identified.

#### Sidebar 25 – BC Transmission Corporation Trains the Adopters of the Future



There is a phenomenon in the utility industry called the "greying of the force" that refers to the perceived threat to utilities all over who are dealing with a large amount of their engineering and line staff retiring or nearing retirement. In parallel, the boom in the computer and telecommunication industries attracted the attention of the educational institutions and many institutions either dropped all together or virtually eliminated the power programs. The level of knowledge of the graduates on the subjects related to the electric power industry has been steadily deteriorating. The issue is serious enough that a local utility has stepped up to fill the gap.

BCTC has initiated the "BC Transmission Academy" to build competency for dealing with traditional and new technologies. A group of experts from BCTC developed a plan to fulfill the gaps by providing high quality structured training to all levels of the technical ranks of the corporation. The faculty of the Academy comes from BCTC, the local institutions, manufacturers, and experts in other utilities. The program will start April 1st and will progress slowly or rapidly depending on available resources.

Over time, the program could be used to educate the industry more broadly. If combined with hand-on demonstrations of regional Smart Grid technologies, it could also serve as strong market resource for local companies.

**Leading companies and research.** British Columbia and the Pacific Northwest are recognized world leaders in smart grid and are home to some of the leading companies in this sector. A study done by the Center for Smart Energy showed that companies in these categories across Oregon, Washington and British Columbia represented a collective \$1.5B in annual revenues and growing. British Columbia, and the Pacific Northwest more broadly, boasts of several category-leading and emerging vendors, including Xantrex, Power Measurement, Tantalus and Nxtphase here in British Columbia; Itron, Areva and SEL in Washington, and SAIC in Portland. British Columbia also has Powertech labs, with some of the world's best expertise in grid management.

### NEED UTILITY ADOPTION AND A LINK WITH BROADER INITIATIVES

The biggest challenge in this area remains the barriers to utility adoption. We need to identify and remove the barriers in the utility policy framework that keep local utilities from adopting innovations. Utilities need to have the mandate to innovate, test innovations and move beyond pilots to actual deployment—where those innovations enhance the overall energy system.



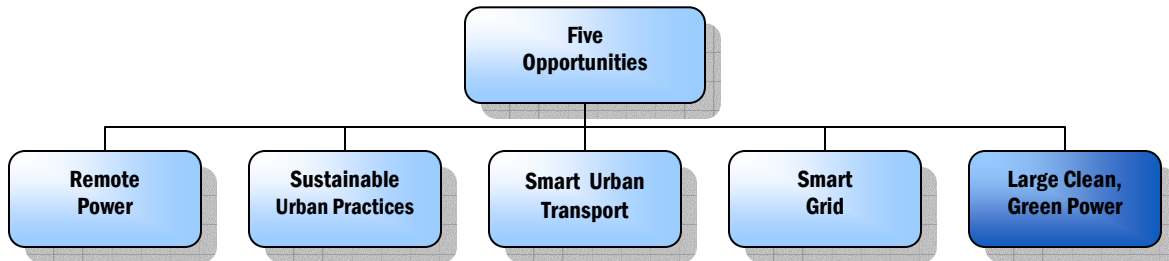
**Build Unique Assets Here to Test the World Technologies.** There is a strong need for a testing and certification process that integrates various Smart Grid components into systems to show how they work together. We should also explore the idea of creating a long-term testbed to attract more grid technology development to British Columbia.

**Partnerships and Collaboration Outside the Region.** We also need to look for ways to connect local grid innovations into larger North American and international grid initiatives to provide the kind of exposure and outreach necessary to grow opportunity. Some of the best grid opportunities are dealing with grid congestion back east, or advanced grid command and control demands in those regions who are innovating in demand response/demand side management, we need to encourage cross-border collaboration to provide more access for local companies. The industry should also link with other Pacific Northwest and U.S.-based efforts to help raise awareness of the entire Northwest region as a world centre of excellence. For example, credible efforts are underway to build next-generation systems and protocols for the grid of the future. BC Hydro and British Columbia's smart grid companies should be well-represented in these efforts, which also represent an opportunity to interact with key systems integrators and other important groups across all five of these strategies.

One of the opportunities that starts to make the transmission investment make more sense is the next market opportunity—the chance to send electricity into the Western Power Market.

## APPENDIX E: MARKET OPPORTUNITY IN LARGE SCALE CLEAN/ GREEN POWER PRODUCTION

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British Columbia is in a position to become a net exporter of clean and green electricity. This opportunity can best be described as three market subsegments:

- **Western Power Market Electricity Exports** from BC Hydro and Independent Power Producers in the region who are building large scale clean or green supply-side resources that generate into the grid (rather than smaller scale distributed generation) and leverage local technologies or resource advantages.
- **Independent Power Production of Large-Scale Clean or Green Supplies** where the physical production is cited outside of the region, but is owned and/or operated by local power producers
- **Export of Production Technologies to Utility and IPP Industry** where we sell goods, services and expertise to the broader power production industry

**Clean Energy** has been defined by the Province in *Energy for our Future: A Plan for BC* as “alternative energy technologies that result in a net environmental improvement relative to existing energy production. Examples may include small/micro hydro, wind, solar, photovoltaic, geothermal, tidal current, wave and biomass energy, as well as cogeneration of heat and power, energy from landfill gas and municipal solid waste, fuel cells, and efficiency improvements at existing facilities. This broad definition will allow for the development of a diverse range of cost-effective and environmentally responsible resources across the province.”<sup>40</sup> **Green Energy** can be defined as low impact renewable energy which must meet general environmental related criteria as well as criteria specific to the generation resource. Clean tends to be a broader category and can include more traditional technologies that are emission-friendly, whereas green tends to refer to only the subset of technologies that are also from renewable sources.

Both are important. When we build a thriving market opportunity for green and clean power production here, we provide a financial foundation for independent power producers, developers, and alternative production technology providers. These companies can also sell their products, service and expertise to other parts of the world.

## **MARKET DEMAND FOR CLEAN AND GREEN POWER WILL CONTINUE TO GROW**

**Western market region will value green, clean electricity exported from British Columbia.** The market for green and renewable electricity across western North America is expected to grow, driven by government mandate and consumer interest:

- **Government mandates**—Renewable Portfolio Standards and other policies regulate the minimum amount of green and/or clean power that a utility has to have in its portfolio.
- **Consumer interest**—demand for green and clean power options is rising, and as a general rule green power programs launched in several states have often sold to capacity (or have even been oversubscribed) within a short period of time from launch.

There are a number of mechanisms that will increase the demand for and premium available for clean and green power purchase, some voluntary and some mandatory:

- **Green certificates**—represent a way to collect and aggregate funds for the purchase of or investment in green power and decouple the financial resource from the physical delivery of green electrons to the buyer
- **Public use charges**—states like Oregon have chosen to collect a public use charge (a percentage of revenues from Utility fees) and pool those funds outside of the utilities to be reinvested into renewables and efficiency projects in the state.
- **Emissions markets**—markets for GHG, NOx, and Sox across North America are localized, with some states primarily in the North East having emission reduction and trading programs in place. These programs will gradually find their way to other parts of North America and will provide funds for more clean and green resources.

For the sell of electricity, the market that is relevant for local Independent Power Producers (IPPs) is the western power market. Transmission lines

connect this market, which includes Western Canada with the Pacific Northwest, down through California, and select parts of contiguous states. So the relevant question for large scale clean and green power production in British Columbia is whether there is currently a premium for clean and green power, and whether demand for clean and green going forward is likely to outpace supply.

**Green Generates a Premium.** Although it varies, it seems clear that there are both wholesale and retail premiums for clean and green power. A survey of program prices shows the premium being paid for green electrons range from less than 1 cent/kWh to 11.6 cents/kWh, with most premiums being between 2 and 5 cents/kWh. These figures, however, are not really good indicators of premiums paid on the wholesale market because, depending on the program, the distribution entity or service provider has to recover a range of administrative and marketing costs in the retail price. On the wholesale side, for instance, BC Hydro's recent green energy call paid (C) \$8 per MWh premium to green producers for both their energy and the emissions credits.

To ensure a premium, though, there needs to be high demand and not an overabundance of supply. On the wholesale side, demand for green and clean power in the eastern US markets are driven by either the requirement to meet state RPSs, or by emission caps (NOx, SOx, etc.). Should such drivers be put in place across western jurisdictions we could see similar premiums for green over traditional electrons, i.e. roughly 10 times more than in voluntary markets. Unless the drivers are put in place, there will be much less uptake in the near to mid-term and therefore the premium will be lower.

When it comes to demand at the retail market level, preliminary figures from the U.S. Department of Energy show that consumer interest in green programs is growing. They registered a 23 % increase in the customers participating in green pricing programs from 2002 to 2003 (711,550 to 877,126 customers), and anecdotal evidence says that is still rising. As well, there were 308 industry participants offering green options in 2003, up 45% from 2002.

**Supply and Demand Trends Favor a Production Opportunity in the Western Power Market.** The overall supply of clean and green power is harder to predict. Using information from Western Electricity Coordinating Council's (WECC) 10 year Coordinated Plan renewable capacity in California and the Northwest Power Pool Area (NWPP; includes BC, Alberta, Washington,

Oregon, Idaho, and parts of Montana, Wyoming, Utah, and Nevada) as of January 1, 2004 was 4,593 MWs, about 3.3% of total installed capacity. The WECC Coordinated Plan, which is based on announced plans of member companies, says that after adjusting for retirements and ratings, roughly 1.7% of capacity additions made between 2004 and 2013 will be renewable technologies. Other forecasts have been more bullish on the percentage of installed capacity that will be renewable. What future capacity additions might look like is very difficult to say. For example, there are currently over 50 proposals to build new LNG import facilities around North America; but many will never break ground. Certainly the recent trend is towards more renewables than in the past, but while we are in a more carbon-conscious business environment, but the timing and extent of increased renewable generation is largely tied to public policy. For example, the installation of wind turbines in the US dropped in 2004 from 2003, primarily because Congress was tardy in renewing the 1.8 cent per kWh production tax credit.

**World opportunities for Independent Power Production and supply technologies abound.** But the overall trend around supply and demand is favorable. Regions are coming to the realization that clean and green production is key going forward. A recent report from the West Coast Governors global warming initiative concludes that the economic benefits for the western region of these low-carbon strategies are real, and features renewables prominently.

Beyond the western power market, the general opening of the international power sector to private investment has created major new opportunities for electric power system and component manufacturers, as well as designers, engineers and constructors. Green and Clean resources will continue to grow as a percentage of the overall electric-generating capacity, as these supplies will be especially vital to developing nations such as China and India, where energy demand is rising at 10% a year, but where the environmental impact of power production is of great concern<sup>41</sup>.

If British Columbia is able to become an exporter of clean and green power, then we are likely to get a premium now for electrons into the western power market, and see our overall revenues grow as demand climbs. Then when other regions increase their investment in their own clean and green production technologies where we aren't able to ship electrons from our region, our local technology firms, IPPs and others can benefit through additional sales and expansion outside of the region.

## BRITISH COLUMBIA HAS THE ASSETS TO PROVIDE CLEAN AND GREEN POWER SOLUTIONS TO THE WORLD

**Motivated Market Partners.** BC Hydro is currently a net importer of power. (See Table 12) From a long-term resource planning perspective, BC Hydro's goal is to make the province self-sufficient in generating capacity and electricity production with no net incremental environmental impacts. Under this scenario, BC Hydro would be planning and acquiring domestic resources that have the capability to meet the domestic customers' electricity requirements in each and every year. Given the slow load growth expected by BC Hydro, this doesn't represent a huge market opportunity, but could be used strategically to help test some of the more innovative solutions where British Columbia has a competitive advantage.

**TABLE 12 – BC HYDRO 2004  
POWER SOURCES**

Source	%
Hydro	52%
Imports	34%
IPPS or other long-term contracts	13%
Thermal	1%

### Sidebar 26 – Wood Pellets Represent Large Domestic and Export Resource



The pellet market has seen dramatic growth over a relatively short period of time. In North America the trade in bagged pellet fuels growing from 200 tonnes in 1984 to over 750,000 tonnes in 2001 representing about a 14% growth in the market per

year.<sup>42[1]</sup> The Pellet industry, while associated with waste wood, also includes pellets made from agriculture waste and fuel crops such as Switch grass.

Four companies represent the industry in BC. Pinnacle Pellet in Quesnel, Premium Pellet in Vanderhoof, Princeton Co-Generation in Princeton, and Pellet Flame in Prince George.

These companies are creating jobs and opportunity where very little existed before. For example, Premium Pellet recently

invested \$7M into a new plant in Vanderhoof. The Pellet Flame plant, which is set for a multimillion dollar expansion, currently produces 120,000 tonnes of pellets/year and is operating 24 hours a day, seven days a week. And finally Pinnacle Pellet recently opened a new plant in Williams Lake. Much of the production from these plants is loaded onto boats and shipped to Europe.

These companies are taking advantage of the growth of biomass as a renewable energy source in heat and electricity generation. Pellets play a key role in achieving these targets, as they are cheaper and less cumbersome to transport than other forms of biomass, while the high degree of standardization allows for extremely low-emission combustion, even in very small appliances.

**Resources and Technologies for Clean and Green Production.** The region has a number of areas where it has the natural resources, technology and local technology providers to produce exportable clean and green electricity. One of our biggest resources is the hydro system itself. We have the ability to support renewable production by using smart grid technology

and approaches that allow us to produce alternative generation, using the hydro system as a large back-up generator and the dams and pondage as storage.

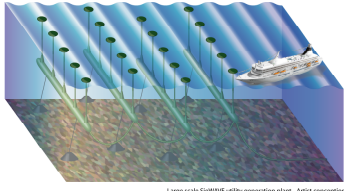
In terms of resources to generate the large-scale alternative energy, these include potential in areas (organized alphabetically) such as

- Biomass—forests hit hard by infestation represent a huge resource only modestly tapped at this point for large scale production and export (Sidebar 26).
- Coal—the region has large beds of low sulfur coal, as well as sources of highly fractured coal that may have enough water content to be appropriate for Coal Bed Methane extraction.
- Ocean Wave and Tidal Current (Sidebar 27), our rugged coast is exposed to one of the highest wave Energy regimes in the North Pacific. A fjord coastline, dotted with islands, creates many passes with high energy tidal current. British Columbia has a history of leadership in ocean science and Engineering, marine operations and fabrication that can make the ocean energy sector an economic success as a major contributor to worldwide markets and a supplier to meet regional needs for sustainable power.
- Run of River—British Columbia's geography provides many opportunities for run-of-river small hydro development up to 50 MW in size, with a potential estimated at some 2450 MW (10,700 GWh/year) with capacity factors between 25% and 70%.
- Solar—while solar irradiation levels are not a source of strength for the coastal regions of BC, neither are they the weakness that many might believe. Many areas in the interior of the province experience levels of solar irradiation that are suitable for solar power generation. In many locations our levels are generally higher than most of Germany, where solar energy is used extensively. Even with our current resources we are in a position to demonstrate the efficacy of new solar innovations that use concentrators that in theory could generate power levels relevant for export.
- Wind—wind levels at different areas in the Province (see at [www.windatlas.ca](http://www.windatlas.ca)) make larger scale wind farms a viable option that should be explored for power production and export.

As well as others. Each of these should be explored in more depth and mapped against a framework that outlines their market potential,

economic development impacts, and British Columbia's relative strengths in the near and longer term.

### Sidebar 27 – BC Opportunities for Ocean Wave and Tidal Current Power



Large-scale, futuristic utility generation plant - Artist conception

Ocean Power derives from the waves, tides or the thermal energy (heat) stored in the ocean, ocean energy provides

clean energy from free renewable resources. While still in its infancy, BC's ocean energy sector has the basic resources to become a leading provider of ocean energy:

- BC has emerging research in ocean energy. The University of Victoria researchers are examining tidal flows in the Haro Strait, and the powerful tidal currents created in the narrow channels along the coast of BC.
- BC has wave and current testing facilities. Some environmental assessment companies have data acquisition and analysis capabilities for wave and tidal current monitoring.
- BC companies and institutions are on the edge of ocean technology. Six companies are developing wave and tidal current technology and projects. BC Hydro has examined the

feasibility of exploiting wave and tidal current energy in the province and has developed ocean energy resource maps. The coasts of mainland BC and Vancouver Island have many potential tidal energy sites.

While British Columbia could eventually become a world leader, it currently lags behind other areas of the world that have recently made commitments to develop and demonstrate these technologies.

To accelerate the development of the sector, OREG has developed a strategy and action plans that consists of four elements to address the sector's constraints. The strategy calls for actions to develop the sector's supply/value chain, infrastructure, financial capacity and public and policy profile. The industry champion, the BC's Ocean Renewable Energy Group (OREG) is collaborating efforts between industry, academia and government to develop 5 pre-commercial demonstrations of ocean energy capacity by 2010.

**Transmission Access to Western Market.** There are roughly 3,150 MWs of transmission capacity from British Columbia into the United States, and roughly 2,000 MWs of capacity from the US back into British Columbia. This capacity can be down-rated at times because of maintenance. There are two points of interconnection. The largest is on the west side of the province, 2,850 MWs); the east side interconnection is rated at 300 MWs<sup>43</sup>. At most times transmission capacity is adequate, permitting BC Hydro and Independent Power Producers to book access to the system to export electricity. At times, however, notably when market prices indicate the greatest need for power in the United States, existing transmission capacity limits the movement of power from BC into the US.

**Ability to Market Clean and Green Technologies.** Powerex currently serves the function of power marketing for BC Hydro, with approximately 150 customers in Western Canada and the United States (includes utilities, power pools, large industrials and other power marketers). They are currently marketing BC Hydro surplus (and purchasing imports), but would be in a position to take on a broader role of power marketing under an export framework.



### **Approaches to Deal With Local Siting and Utility/IPP Relationships.**

Through the work of groups like the Fraser Basin Council (Sidebar 28) and others, the region has the opportunity to have world class expertise on siting production in a community in a utility control center. This expertise applies as well across the other five areas, and will be a key part of providing market ready solutions to the world.

#### **Sidebar 28 – World-class Expertise in Collaboration and Partnership Creation**



Growing a Power Technology cluster in British Columbia demands a high level of collaboration among a diversity of private and public sector interests.

Excellence in fostering productive multi-interest collaboration is already well established in BC through the work of the Fraser Basin Council (FBC), a non-government organization formed in 1997 to advance sustainability in the Fraser River Basin and beyond. A made-in-BC success story, the FBC acts as a catalyst, multi-interest convener and impartial facilitator to help people and organizations work together more effectively towards common goals that support social well-being, a vibrant economy and a healthy environment.

In addition to exporting its expertise internationally, the FBC is currently leading a number of initiatives in BC that directly complement Power Technology cluster development. For example, the FBC is the BC partner for the National Fleet

Challenge, a Canada-wide initiative to enhance the energy and cost efficiency of vehicle fleets. The FBC is also working with public and private sector interests to advance biomass utilization solutions at the Fraser River debris trap, a waterborne wood debris capture facility situated near the town of Hope, BC. Working with the Business Council of BC and under the auspices of the Sustainable Region Initiative, the FBC is advancing progress towards a “sustainability-inspired” regional economy for Greater Vancouver, one that embraces the concept of clusters that deploy solutions locally that directly enhance the region’s livability while helping cluster partners position themselves for prosperity at a global scale. On the Independent Power Producer (IPP) front, the FBC is helping government, civil society and private sector interests collaborate on the selection, design and approval of green energy projects throughout BC.

The FBC may be in a position to assist with Power Technology Cluster advancement on a variety of fronts, from application of its multi-interest facilitation expertise to establishment of direct linkages to specific FBC programs that align with the five opportunity areas presented in this document.

### **NEED TO COMMIT TO EXPORT OF POWER PRODUCTION AND INVEST IN INNOVATION**

The utility system is currently mandated to serve local need and only exports opportunistically during periods of surplus. For the region to get the benefits of becoming a power exporter, the local utilities will need to be allowed to serve as a mechanism to help grow the IPP market and get that power production built and transported to where it can be used.

We need to better communicate the value of electricity exports to British Columbia. We would also have to see exports as a way to help pay for infrastructure (such as transmission lines) that would be uneconomic otherwise but are also needed to meet BC needs. Ultimately, these directions may require a shift in thinking to begin seeing our local utilities as part of

an overall economic development engine that we have to continue to evolve and improve to compete in world markets.

Beyond creating access to the Western Power Market for electricity generated in British Columbia, the region needs to invest in research that will develop British Columbia's unique assets in power production technologies. Our biggest export opportunities in renewables long-term are likely to be the technologies, goods and services that are exported by the technology providers and power producers located in British Columbia. To tap into these benefits, it will be important that we sort through our available supply-side technologies and give some development priority to those areas where we as a region could also have a relative advantage and become a world leader in innovation.

## APPENDIX F: THE POWER TECHNOLOGY SECTOR IN BRITISH COLUMBIA

Sector	Description	Market Opportunity	BC Companies	Support Organizations Focused on This Segment
Biogas Biomass BioFuels	<ul style="list-style-type: none"> <li>▪ Biofuels: ethanol made from corn or lignocellulose (wood fibres) or biodiesels, bio-oils, used primarily in mobile applications such as fuelling vehicles</li> <li>▪ Biogas may be produced via anaerobic digestion by bacteria, e.g., methane from landfills or livestock manure. biogas can be used to generate heat and/or power.</li> <li>▪ Biomass: heat and power derived from biomass includes agricultural waste, forest waste and municipal waste</li> <li>▪ Biomass applications include pellets for woodstoves, pulping liquors/hog fuels to generate heat and power in pulp mills, and woodchip boilers in institutional facilities</li> <li>▪ Biomass includes high-efficiency biomass gasification</li> </ul>	<ul style="list-style-type: none"> <li>▪ Biomass as a fuel for creating power is growing in acceptance as countries seek new sources of renewable fuels. BC actually gets 23%<sup>44</sup> of its energy from Biomass. Most of this is generated by lumber mills that burn their own waste for heat and power. BC has a very good opportunity to expand its pellet production in the north. There is a growing global market for the BC product, which is considered high quality.</li> <li>▪ Biogas will start to grow as an industry with the technology available to capture landfill off gassing and the implementation of Kyoto, which requires the capture of the methane.</li> <li>▪ Biofuels, specifically biodiesel now the fastest growing alternative fuel in Europe. In 2003, Germany, France, Austria and Italy produced over two billion litres of biodiesel, and in Germany and Austria, around 1700 service stations now sell biodiesel. In Germany, over 19,000 jobs have been generated growing the feedstock, processing the raw materials, and marketing the resulting biodiesel. <sup>45</sup>Presently the majority of production is in Ontario</li> </ul>	<p>Biomass</p> <ul style="list-style-type: none"> <li>▪ Dynamotive Energy Systems Corp.</li> <li>▪ Pellet Flame Inc.</li> <li>▪ Pinnacle Pellet Inc.</li> <li>▪ Premium Pellet Inc</li> </ul> <p>Biogas</p> <ul style="list-style-type: none"> <li>▪ Syntec Biofuel</li> </ul> <p>Biofuels</p> <ul style="list-style-type: none"> <li>▪ Ecofuels Canada</li> <li>▪ Lignol Innovations Corp</li> </ul>	<ul style="list-style-type: none"> <li>▪ BC Pellet Fuel Manufacturers Association</li> <li>▪ Canadian Renewable Fuels Association</li> <li>▪ UBC</li> <li>▪ Vizon Scitec</li> <li>▪ Biodiesel Canada</li> <li>▪ NRCan</li> <li>▪ Transport Canada</li> <li>▪ City Green</li> <li>▪ Clean Air Renewable Energy Coalition</li> </ul>
Communications and Control	<ul style="list-style-type: none"> <li>▪ Technology devoted to the design, development, and <u>application</u> of <u>communications</u> facilities</li> </ul>	<ul style="list-style-type: none"> <li>▪ As in many of BCs other power technology sub sectors the origin of these companies have been a combination of expertise from the wireless, software, and power industries.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Legend Power</li> <li>▪ Nxtphase</li> <li>▪ Power Measurement</li> </ul>	<ul style="list-style-type: none"> <li>▪ UBC</li> <li>▪ SFU</li> <li>▪ PowerTech Labs</li> </ul>

Sector	Description	Market Opportunity	BC Companies	Support Organizations Focused on This Segment
	used specifically for control purposes, such as for controlling industrial processes, electric <u>power generation</u> , distribution, and utilization, communications networks .	In this case the IP formed at organizations like PowerTech Labs forms an important base for these new technology companies	<ul style="list-style-type: none"> <li>■ Tantalus</li> <li>■ Xantrex Technology</li> </ul>	<ul style="list-style-type: none"> <li>■ BCTIA</li> <li>■ VIATEC</li> </ul>
Distributed Generation Systems	<ul style="list-style-type: none"> <li>■ Electricity generation that occurs at or near the site of ultimate consumption as opposed to most electricity which is generated at a remote site and transported by long-distance transmission lines to the consumer.</li> </ul>	<ul style="list-style-type: none"> <li>■ While the near-term DG markets are still uncertain, the long-term distributed generation market potential appears enthusiastic. Global installed DG capacity is projected to nearly triple to 200,000 megawatts by 2011, according to ABI Research. Companies such as Vestas, NEG Micon, Gaemsa, GE Wind Energy, and Sanyo have been benefiting tremendously from strong government incentives across the globe, starting with Japan, the EU, and followed by the US.<sup>46</sup></li> </ul>	<ul style="list-style-type: none"> <li>■ Ballard Power</li> <li>■ Westport</li> <li>■ Xantrex Technology</li> </ul>	
Energy Management Systems	<ul style="list-style-type: none"> <li>■ A computer-controlled system used to monitor the real-time performance of the various elements of an electric system and to control generation and transmission facilities</li> </ul>	<ul style="list-style-type: none"> <li>■ This group of companies will continue to grow in BC over the next few years as organizations who provide similar products but exclusively for Telecommunications begin to look at the renewable energy markets.</li> <li>■ There are very good opportunities for this group to work with the Fuel Cell Group and the Wireless group in powering of small wireless devices</li> </ul>	<ul style="list-style-type: none"> <li>■ Legend Power</li> <li>■ S Matrix Group</li> <li>■ Thomson Technology</li> <li>■ Xantrex Technology</li> </ul>	<ul style="list-style-type: none"> <li>■ BC TIA</li> <li>■ Canadian Manufacturers and Exporters Alliance</li> </ul>
Fuel Cells	<ul style="list-style-type: none"> <li>■ A fuel cell chemically combines hydrogen and oxygen to produce water, heat and electricity</li> </ul>	<ul style="list-style-type: none"> <li>■ BC has a reputation as a world-class cluster for fuel cells. The hydrogen highway, the Fuel Cell Institute and our deep knowledge of the sector are going to continue to draw</li> </ul>	<ul style="list-style-type: none"> <li>■ Angstrom Power Inc</li> <li>■ Ballard Power Systems</li> <li>■ Cellex Power Products Inc.</li> </ul>	<ul style="list-style-type: none"> <li>■ Powertech Labs</li> <li>■ UBC</li> <li>■ SFU</li> </ul>

Sector	Description	Market Opportunity	BC Companies	Support Organizations Focused on This Segment
	<ul style="list-style-type: none"> <li>▪ Can be powered by hydrogen, either in pure form or extracted from methanol or other fuels (including biogas).</li> <li>▪ Can be used for mobile applications, to power vehicles (personal, transit, industrial), or to provide stationary power via an electricity generation plant.</li> </ul>	<p>companies such as Ford and Mitsubishi. Near term opportunities in micro fuel cells and stationary equipment are beginning to develop and should help keep the industry vibrant. More work is needed to integrate the other Power Technologies such as power management, solar, wind with fuel cells.</p>	<ul style="list-style-type: none"> <li>▪ General Hydrogen</li> <li>▪ Greenlight Power Technologies</li> <li>▪ Heliocentris Energy Systems</li> <li>▪ Magpower Systems Inc.</li> <li>▪ Membrane Reactor Technologies Inc.</li> <li>▪ Palcan Fuel Cells limited</li> <li>▪ PowerDisc Development Corp</li> <li>▪ Questair Technologies Inc.</li> <li>▪ Xantrex Technology</li> </ul>	<ul style="list-style-type: none"> <li>▪ Uvic ISE</li> <li>▪ NRC Fuel Cell Institute</li> <li>▪ NRCan</li> <li>▪ WED</li> <li>▪ Province of BC</li> <li>▪ Transport Canada</li> <li>▪ SDTC</li> </ul>
Geothermal	<ul style="list-style-type: none"> <li>▪ geothermal energy uses steam or hot water in the earth's crust to power turbines or heat buildings or water.</li> <li>▪ Steam or hot water is passed through pipes to supply heat, or steam is used to power turbines</li> <li>▪ Earth energy uses temperatures found in the earth or water to heat or cool air and water for buildings.</li> <li>▪ Heat pumps extract heat from underground in winter and are reversed in summer to provide air conditioning by moving hot air out of the building and into the ground.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Geothermal power capacity is estimated to be 50,000 times the energy of all known petroleum reserves. In BC there are a number of small companies that will install a geothermal heating system. Only Western Geopower is planning a utility scale plant. Their plant South Meager is located approximately 170 km north of Vancouver and has capacity of 100 MW and a maximum capacity of 250MW<sup>47</sup>.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Western Geopower</li> </ul>	<ul style="list-style-type: none"> <li>▪ Independent Power Producers</li> </ul>
Green Buildings	<ul style="list-style-type: none"> <li>▪ Building components that reduce heating and cooling</li> </ul>	<ul style="list-style-type: none"> <li>▪ The market for Green building technology is estimated to be \$16 billion by 2006<sup>48</sup>. This</li> </ul>	<ul style="list-style-type: none"> <li>▪ Delta Controls</li> <li>▪ Edwards (LED Exit Lighting)</li> </ul>	<ul style="list-style-type: none"> <li>▪ APEG</li> <li>▪ GVRD</li> </ul>

Sector	Description	Market Opportunity	BC Companies	Support Organizations Focused on This Segment
	<ul style="list-style-type: none"> <li>loads</li> <li>▪ Equipment that conserves energy</li> <li>▪ Fixtures and equipment that conserve water</li> <li>▪ Products that improve light quality</li> </ul>	<ul style="list-style-type: none"> <li>includes energy efficient windows, doors, heating, and lighting.</li> <li>▪ High tech wooden windows that combine advanced materials or photo voltaics represents an opportunity for BC to marry the value added wood sector with the power technology sector. The US window and door market is estimated to be \$11 billion by 2007<sup>49</sup>.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Eneready Products Ltd. (heat recovery)</li> <li>▪ Ledalite Architectural Products (lighting)</li> <li>▪ Leviton Manufacturing of Canada (motion sensors)</li> <li>▪ Starline Windows</li> <li>▪ Tekmar Control Systems</li> </ul>	<ul style="list-style-type: none"> <li>▪ Globe Foundation</li> <li>▪ GVRD</li> </ul>
Green Building Services	<ul style="list-style-type: none"> <li>▪ LEED® emphasizes five performance areas of green building design and construction: <ul style="list-style-type: none"> <li>- sustainable site development</li> <li>- potable water efficiency</li> <li>- energy efficiency</li> <li>- green materials selection</li> <li>- indoor environmental quality.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ Green building services are in high demand as consumers and building owners begin to realize the benefits from designs that create a health livings space. This shift in thinking coincides with the pressure being placed on developers by government to design buildings that are more efficient and create fewer demands on infrastructure. The demand for this knowledge will continue to grow as water and energy become scarcer.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Busby &amp; Associates Architects</li> <li>▪ Douglas Spratt &amp; Associates</li> <li>▪ Keen Engineering Co.</li> <li>▪ Prism Engineering</li> <li>▪ Rethinking Building</li> <li>▪ Stantec Consulting</li> <li>▪ VEL Engineering</li> <li>▪ Water Matrix Inc.</li> </ul>	<ul style="list-style-type: none"> <li>▪ BCIT</li> <li>▪ UBC</li> <li>▪ APEG</li> <li>▪ GVRD</li> <li>▪ Green Building Council</li> </ul>
Ocean Wave & Tidal Current	<ul style="list-style-type: none"> <li>▪ Ocean Wave: utilizes ocean wave activity to power turbines and create electricity via a generator</li> <li>▪ Tidal Current: harnesses the natural rise and fall of coastal waters to generate electricity via tidal turbines (similar to wind turbines).</li> </ul>	<ul style="list-style-type: none"> <li>▪ Globally the industry is still its infancy with no clear technology being dominant. BC has some of the best conditions for ocean energy in the world-which is a magnetic for companies to set up here and look for demonstration projects Given the Province's core competency in ocean technology, BC Hydro mandate for clean energy, and the strength of IT knowledge available there is no reason why we can not be the leaders in the sector.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Amec,</li> <li>▪ Aqua Energy Canada Ltd.</li> <li>▪ Axys</li> <li>▪ Blue Energy Canada Inc.</li> <li>▪ Canoe Pass Tidal Energy Corporation (tidal)</li> <li>▪ Clean Current Power Systems (tidal)</li> <li>▪ Energetech Americas LLC</li> <li>▪ Sieber Energy Inc</li> <li>▪ Triton</li> </ul>	<ul style="list-style-type: none"> <li>▪ DFO Institute of Ocean Sciences</li> <li>▪ Ocean Industries BC</li> <li>▪ Power Tech</li> <li>▪ UBC Engineering</li> <li>▪ Uvic Engineering</li> </ul>
Run of River/Small/	<ul style="list-style-type: none"> <li>▪ Water is channeled through a penstock to capture the energy of the moving water by powering</li> </ul>	<ul style="list-style-type: none"> <li>▪ BC has a long history of hydropower development and it shows in the number of companies in the sector. The big engineering</li> </ul>	<ul style="list-style-type: none"> <li>▪ Asian Phoenix Resources</li> <li>▪ ASL AQFlow</li> </ul>	<ul style="list-style-type: none"> <li>▪ Power Tech Labs</li> <li>▪ BCIT</li> </ul>

Sector	Description	Market Opportunity	BC Companies	Support Organizations Focused on This Segment
Micro Hydro	<p>turbines to generate electricity in run-of-river applications, turbines are placed in mid-stream with no/minimal water impoundment.</p> <ul style="list-style-type: none"> <li>micro hydro = up to 2MW</li> <li>small hydro = 2 MW to 50 MW (typical Non Utility Generator development or low end of range to supply power grid).</li> </ul>	<p>firms dominate large-scale hydro and are not listed here. The efforts of BC Hydro to buy green energy have helped to create a vibrant independent power sector that consists largely of micro and small hydro. Micro Hydro technology from the province is being shipped around the world.</p>	<ul style="list-style-type: none"> <li>Dependable Turbines Limited</li> <li>Energy Alternatives</li> <li>Energy Systems And Design</li> <li>Homestead Hydro Systems</li> <li>Northwest Hydraulics Consultants</li> <li>Thomson And Howe Energy Systems</li> </ul>	<ul style="list-style-type: none"> <li>Independent Power Producers of BC</li> <li>Canadian Electricity Association</li> </ul>
Smart End Use	<ul style="list-style-type: none"> <li>Technology that allows the increases the efficiency of the final application</li> </ul>	<ul style="list-style-type: none"> <li>The high-brightness (HB) LED market continued to grow at more than 31% per year. For the past 10 years, the HB LED industry has applications in automotive lighting, outdoor signs, mobile phones, traffic signals and illumination, and with a market size projected to reach \$3.6 billion in 2004.<sup>50</sup></li> </ul>	<ul style="list-style-type: none"> <li>Carmanah Technologies, Inc.</li> <li>Streetlight Intelligence</li> <li>TIR Systems</li> </ul>	<ul style="list-style-type: none"> <li>UBC</li> <li>BC Hydro</li> <li>GVRD</li> <li>City of Vancouver</li> <li>BCIT</li> <li>VIATEC</li> </ul>
Solar Photovoltaic Solar Thermal	<p>Photovoltaic (PV)/Thermal</p> <ul style="list-style-type: none"> <li>Sunlight is converted to electricity using photovoltaic or solar cells, bundled into modules or panels.</li> <li>PV cells are semi-conductor devices usually made of silicon an inverter is used to convert direct current from solar and/or batteries to alternating current.</li> </ul> <p>Solar Thermal</p> <ul style="list-style-type: none"> <li>In active solar applications,</li> </ul>	<p>Photovoltaic</p> <ul style="list-style-type: none"> <li>This category is a combination of integrators and developers. There is no PV manufacturing in BC however there are a few companies doing research in the area. Given the size and growth of this sector, the electronics, materials, and power management knowledge in BC there is a potential to do more. The industry is growing at over 25%<sup>51</sup> per year. California is largest consumer in the United States.</li> </ul> <p>Thermal</p> <ul style="list-style-type: none"> <li>This is a growing area but still represents a tiny portion of the solar market. As</li> </ul>	<p>Photovoltaic</p> <ul style="list-style-type: none"> <li>Advanced Delineation Systems</li> <li>Analytic Systems Ware Ltd</li> <li>Carmanah Technologies Inc.</li> <li>Day 4 Energy Inc.</li> <li>Firebird Semiconductors</li> <li>Landmark Glass</li> <li>Soltek Solar Energy</li> <li>Sovran Energy</li> <li>S Matrix Group</li> <li>SunWind Solar Industries</li> <li>Tideland Signal Canada</li> </ul>	<ul style="list-style-type: none"> <li>BCIT</li> <li>NRC Fuel Cell Institute</li> <li>Cdn Solar Industry Association</li> <li>NRCan</li> <li>Industry Canada</li> <li>Centre for energy</li> </ul>

Sector	Description	Market Opportunity	BC Companies	Support Organizations Focused on This Segment
	<p>solar collectors are used to capture energy from the sun to provide heat, which is distributed by pumps or fans. Used to heat homes and buildings, swimming pools, domestic hot water, water for the aquaculture industry</p> <ul style="list-style-type: none"> <li>Passive solar involves building design, orientation and placement of appropriate building components (e.g., windows) to make use of sunlight for day lighting and space heating and cooling.</li> </ul>	<p>sustainable building practices grow more buildings will be built using solar thermal and passive solar technology. Taylor Munroe is considered the leader in BC and is starting to see clients like Vancouver Airport look for its services. The 2010 Games and the upcoming World Urban forum should increase the level of activity in the area.</p>	<p>Thermal</p> <ul style="list-style-type: none"> <li>Swiss Solar Technologies</li> <li>Taylor Munroe Energy Systems</li> </ul> <p>Curtain Wall</p> <ul style="list-style-type: none"> <li>Kawneer</li> </ul> <p>Power Systems</p> <ul style="list-style-type: none"> <li>Xantrex Technology</li> </ul>	
Storage	<ul style="list-style-type: none"> <li>Storage device technology or technology that manages the power in storage devices</li> </ul>	<ul style="list-style-type: none"> <li>US demand for battery and fuel cell components (discrete fabricated devices that are incorporated into the final product) is projected to rise 6.8 percent annually through 2007 to \$4.8 billion<sup>52</sup>. BC has a strong presence in the market with E-One.</li> </ul>	<ul style="list-style-type: none"> <li>Cadex Electronics Ltd</li> <li>Delta-Q Technologies</li> <li>Eagle Pitcher</li> <li>E-One Moli Energy Technology Inc</li> <li>New World Batteries</li> <li>VRB Power Systems</li> </ul>	<ul style="list-style-type: none"> <li>UBC</li> <li>Vizon Scitec</li> <li>Power Tech</li> <li>NRC Fuel Cell Institute</li> <li>BC TIA</li> </ul>
Transport	<ul style="list-style-type: none"> <li>Uses a hybrid of diesel/battery or gas/battery or battery directly to transportation</li> <li>Manufactures a technology that is used in alternative transportation</li> <li>Auxiliary power units</li> </ul>	<ul style="list-style-type: none"> <li>BC has a small but vibrant alternative transportation industry. Together with the hydrogen highway, if marketed and invested in, can become an economic star for BC.</li> </ul>	<ul style="list-style-type: none"> <li>Azure Dynamics</li> <li>Canadian Electric Vehicles</li> <li>Delta-q Technologies</li> <li>Dynasty Motorcar Corp.</li> <li>Rail Power Technologies</li> <li>Westport Innovations</li> <li>Wismer &amp; Rawlings Electric Ltd.</li> <li>Xantrex Technology</li> </ul>	<ul style="list-style-type: none"> <li>Canadian Electric Vehicle Association</li> <li>Vizon SciTec</li> <li>Fuel Cells Canada</li> <li>Power Tech</li> <li>NRC Fuel Cells Institute</li> <li>UBC, BCIT</li> </ul>



Sector	Description	Market Opportunity	BC Companies	Support Organizations Focused on This Segment
Wind	<ul style="list-style-type: none"> <li>▪ Converts kinetic energy present in the wind into mechanical energy and/or electricity (the latter via wind turbine generators)</li> <li>▪ Mechanical energy powers windmills and pumps water (also begins the process of powering turbines)</li> <li>▪ Two designs of wind turbines are vertical axis and horizontal axis</li> </ul>	<ul style="list-style-type: none"> <li>▪ The global market for wind continues to grow at over 30%<sup>53</sup> per year. Europe leads the growth with the US. The European wind strategy spells out a clear path for their R&amp;D. BC has many of the pieces that they will require to achieve their goals. Collaboration with Europe on their plan represents the best chance for BC to participate in the industry, given its late entry.</li> <li>▪ BC has no active wind farms</li> </ul>	<ul style="list-style-type: none"> <li>▪ Holburg Wind Farm (developer)</li> <li>▪ Nai Kun Wind Development (developer)</li> <li>▪ Power Pacific Poles (towers)</li> <li>▪ Sea Breeze (developer)</li> <li>▪ Westech Energy (technology)</li> <li>▪ Xantrex Technology (technology)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Canadian Wind Energy Association</li> <li>▪ Pembina Institute</li> <li>▪ Canadian Renewable Fuels Association</li> <li>▪ NRCan</li> <li>▪ Office of Energy Efficiency</li> </ul>

## APPENDIX G: PROFILE OF SELECTED COMPANIES

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This is not a complete inventory, but represents the strengths and diversity that characterizes this industry in British Columbia.

### **ANGSTROM**

Using technology discovered and developed at the University of Victoria's Institute for Integrated Energy Systems (IESVic), Angstrom is a privately held firm developing micro-fuel cells for use in portable electric and electronic devices. Chaired by Denis Connor, the founder and Chair of QuestAir, Angstrom is now deploying prototype micro-fuel cells for field testing in devices such as "Mag-light" flashlights. Angstrom is one of a small cluster of British Columbia-based micro-fuel cell companies centered around the NRC fuel-cell institute.

### **AQUAENERGY CANADA**

AquaEnergy Canada, Ltd. is a wholly owned subsidiary of AquaEnergy Group, Ltd, an offshore ocean wave energy technology and project development company. The company has formed a consortium of partners with the qualifications to demonstrate and commercialize the offshore wave energy conversion technology to produce clean, electrical power for Canadian consumers. The Consortium proposes technology development, optimization and demonstration of a wave energy conversion device – AquaBuOY. AquaEnergy technology is an offshore wave energy converter, suitable to generate electrical power by converting wave energy. In addition, further technology development would allow stored energy generation in a form of desalinated water, or hydrogen. Clusters of AquaBuOY devices form an offshore power plant, scalable from hundreds of kilowatts to hundreds of megawatts, suitable for distributed or central generation. AquaEnergy is leveraging proven technologies, local strengths in marine engineering, and partners in the emerging Ocean Energy Industry to innovate and move British Columbia ahead in this emerging opportunity.

### **AZURE DYNAMICS**

Azure is a world leader in hybrid electric vehicle systems for commercial vehicles. They retrofit chassis with high-efficiency diesel engines and hybrid electric systems. Better-known customers include Purolator, Canada Post, the U.S. Postal Service and London Taxi (UK). Their systems are based on technology developed in BC at Vizon SciTec (formerly BC Research). Azure does all product development and primary assembly in BC. Azure represents a growing cluster of alternative transportation companies in BC that are

creating a strong supply chain of high-tech machine shops, battery suppliers, and other equipment unique to the needs of their industry. Having this capability in BC, in addition to the Hydrogen Highway, will likely continue to attract other transportation-industry companies to locate here.

### **BALLARD POWER SYSTEMS**

Ballard Power Systems is the world leader in developing, manufacturing, and marketing zero-emission proton exchange membrane (PEM) fuel cells. The company is commercializing fuel cell engines for the transportation market, electric drives for both fuel cell and battery-powered electric vehicles, and power electronics and fuel cell systems for both portable and stationary power generation markets. Ballard is also a Tier 1 supplier of friction materials to the automotive industry for automatic transmissions as well as a supplier of carbon fiber paper gas diffusion layers (GDL) to the fuel cell industry. Ballard's proprietary technology enables automobile, bus electrical equipment, portable power and stationary product manufacturers to develop environmentally clean products. Ballard is the reason Vancouver has a fuel cell cluster. Their presence here has also attracted significant investment to the region through angels, venture firms such as Crysallix, Ventures West and Yaletown Venture Partners, and the NRC that established a fuel cell institute at UBC to support the cluster. Ballard continues to play a significant role in the community through technology creation, wealth generation and the addition of talent to management pool. Ballard now has manufacturing facilities in Burnaby, BC, Dearborn, Michigan and Lowell, Massachusetts and in Germany (Nabern).

### **BUSBY, PERKINS & WILL**

Busby, Perkins & Will provides architectural consulting services to the commercial, institutional and residential building sectors. World market experts in sustainable development, they have won more than 60 international awards, including an AIA Top 10 Green Building Award. They have developed numerous local examples of sustainable projects and are involved in design for the 2010 Sustainable Olympics. About half of Busby's projects have been in Vancouver; many efforts are large international projects, including a current sustainable community project in Saudi Arabia. Busby drives growth in the green building and sustainable community industry in British Columbia and represents a major influence on shaping policies and practices in the region. Busby, Perkins and Will Architects Co. is the result of an August 2004 merger between Peter Busby and Associates of Vancouver and Chicago's Perkins & Will (which was declared Firm of the Year by the American Institute of Architects in 1999 and has collaborated with Busby and Associates on several projects in the

last few years, has a 70-year history and large projects in more than 40 countries). Still based in Vancouver, Busby, Perkins & Will also has offices in Calgary and Seattle. Busby says the merger gives him “a bigger pool of people to convert to sustainability and access to larger clients and more clients who will hear the story of sustainable architecture.”

#### **CARMANAH TECHNOLOGIES**

Carmanah, based in Victoria, BC, is a world leader in the design, manufacture and supply of patented, proprietary solar-powered LED lighting solutions. To date, they have an installed base of more than 100,000 lights; they employ more than 100 people and are growing at double digits. They are illustrative of the growth of a new sector in self-contained lighting systems. Carmanah is winning contracts all over North America and Europe and have already created new competitors in BC. They are a significant employer in Victoria providing well-paid manufacturing and engineering positions. Carmanah’s first products were self-contained lighting for navigation of waterways. It is a BC company building on one of the province’s resource based core competencies. In 2003 they were ranked the 90<sup>th</sup> largest high-tech firm in BC.<sup>54</sup>

#### **DAY 4 ENERGY**

Day4 Energy is a Burnaby-based company that has developed a new kind of Photovoltaic (PV) technology. Formed by John MacDonald, (one of the founders of MacDonald Dettwiler and a recipient of the Order of Canada) together with Professor Leonid Rubin (a well-known Russian scientist), Day4 Energy's PV technology is expected to significantly reduce the cost of PV power systems, making solar energy generation cost-effective in a wide range of locations and applications where previously it was considered unsuitable or too expensive. Day4 Energy is privately held and is currently working with utilities such as BC Hydro and Arizona Public Services to deploy prototypes of systems based on their new PV technology for field-testing. Day4 employees include scientists from Russia and Germany as well as Canadian employees attracted to BC to work on this technology and develop a renewable energy business.

#### **DELTA Q**

Delta Q provides power management solutions for the industrial and specialty electric vehicle industry that has a value of approximately US\$10 billion. Their technology saves more than 15 per cent of the energy traditionally used to recharge an electric vehicle such as a golf cart or forklift. The founding partners are former Xantrex employees.

### **DYNASTY MOTORCAR CORPORATION**

Dynasty Electric Car Corporation designs, manufactures and markets zero-emission, electric Low Speed Vehicles (LSV's) for urban, recreational and light commercial markets such as planned and gated communities, destination resorts, industrial complexes and universities. They manufacture and assemble many of their vehicles in the lower mainland. Sales are growing across North America as demand for “urban” vehicles grows. Dynasty grew out of the ashes of Kelowna-based Western Star. The Dynasty vehicle integrates many BC-manufactured components. Dynasty is illustrative of the province’s nascent alternative transportation industry and the expertise of the BC supply chain in that sector.

### **E-ONE MOLI ENERGY TECHNOLOGY**

E-one Moli is the only high-volume manufacturer of cylindrical lithium-ion rechargeable cells in North America. They were purchased by a Taiwanese company but kept research and manufacturing in BC. Their early acquisition illustrates the attractiveness of BC tech firms to outside purchasers. Primarily driven by a lack of funding these acquisitions are often the only method for the founder to take the company to the next step in its growth. In 2003 Moli reported revenues of \$43 million and were the 21st largest high tech firm in BC.<sup>55</sup>

### **GREENLIGHT POWER TECHNOLOGIES**

Greenlight is a world leader in testing and diagnostics of fuel cells. With more than 400 test stations, Greenlight (founded in Saanich as ASA Technologies) has the largest installed base in the world. Greenlight’s equipment has become a critical tool for fuel cell technology developers, allowing fuel cell stacks to operate as part of a fully integrated power system. Greenlight has focused on this area since 1992 and counts most fuel cell manufacturers as clients. In January 2003 Hydrogenics Corporation, a designer and manufacturer of fuel cell technology, acquired Greenlight Power Technologies, Inc., in a transaction valued at approximately \$US19 million. Hydrogenics, Toronto based, continues to manufacture and research in Burnaby, BC. One of the original founders of Greenlight has gone on to create a VC firm in BC.

### **HOMEWORKS**

Homeworks is a subsidiary of EAGA Partnerships, which has created a sustainable model for efficient delivery of residential energy services. In the United Kingdom, EAGA has created more than 500 jobs in the past 15 years. In addition, they have a network of more than 400 contractors who deliver energy efficiency to the residential sector. Homeworks is now working with BC Hydro in Victoria on a project designed to harmonize the delivery of

residential energy services, using its model that integrates public and private partnerships to the delivery of residential energy services. The Homeworks concept focuses on strengthening and easing the delivery of energy services to the consumer. The Victoria program, if successful, could be a model for future programs throughout British Columbia. Homeworks' takes a leadership role in the delivery of energy technologies, using a model that lends itself to long-term investment and capacity building in the energy services sector.

#### **KEEN ENGINEERING**

Keen Engineering is a professional consulting engineering firm with more than 200 staff and 10 offices in Canada and the U.S.. The company has one of the largest portfolios of completed green projects in North America, and have completed projects in more than 15 countries. Keen offers: Mechanical Design Services, which has been the core of Keen business for 40 years; Electrical Design Services; Sustainable Building Services that bring specialized green knowledge to designs; an Energy Services Group that delivers on Keen's corporate commitment to create a sustainable community in all their designs and helps existing building clients reduce ongoing energy costs; and a Fuel Cell Design Group that responds to the needs of the fuel cell industry, with more than 100 projects done for Fuel Cell support facilities. Keen Engineering designs have won numerous sustainable design awards.

#### **LEGEND POWER SYSTEMS**

Legend Power Systems Inc. (LPSI) has exclusive Canadian rights to the The Electrical Harmonizer™ energy saving device; Legend Power Systems Corp. has exclusive U.S. marketing and distribution and patent rights. LPSI's business focus is on increasing customers' profits through a significant reduction in total facility electrical consumption and maintenance costs. Developed in Japan over 10 years ago, with more than 300,000 units installed in Japan, Hong Kong and China, the Electrical Harmonizer™ is able to reduce facility electrical bills an average of 7 to 12%, while substantially reducing maintenance costs. This is accomplished through an innovative approach to Power Quality Management and Conservation Voltage Regulation. The company has been accepted for a partnership with the US Department of Energy's ENERGY STAR program in its efforts to promote the highest level of energy efficiency and environmental awareness amongst business and institutional customers. Some of Legend's installations include Fortune 500 national chain stores.

### **QUESTAIR**

QuestAir is a developer and manufacturer of compact gas purification equipment. Using a technology called Pressure Swing Adsorption (PSA), QuestAir developed an ultra-compact purification unit that can be placed on board a fuel cell vehicle to purify hydrogen gas produced by an on-board device (from natural gas or methanol). While automotive companies have moved away from on-board production of hydrogen, QuestAir has expanded their market by applying their compact, efficient technology to gas purification in refineries. Significantly, QuestAir recently developed a unit for use in purifying gas emitted by landfills, enabling that gas to be fed into natural gas pipelines. In December, QuestAir had a successful initial public offering and is now listed on the Toronto Stock Exchange.

### **PELLET FLAME, PINNACLE STOVE, PREMIUM PELLET**

These three pellet manufacturers represent part of a large and growing market for export of biomass in the form of pellets into European markets. These markets have aggressive renewable energy objectives and are relying on biomass to help meet them. The industry is important to Northern BC and First Nations in that region for the jobs it creates and the innovation in pellet production equipment it generates. In BC, biomass accounts for 23% of all the energy used.<sup>56</sup> Leveraging the local expertise in cogeneration and Biomass conversion can continue to move BC toward being a leader in the sector.

### **POWER MEASUREMENT**

Now celebrating its twentieth year, BC-based Power Measurement is a global provider of advanced metres and enterprise energy management systems. For utilities, Power Measurement supplies advanced metres and supporting software. The company's products can collect data from customers and from generating stations, substations, and grid interties. For industrial and commercial users, Power Measurement promises to identify energy-intensive activities, pinpoint power problems and supervise facilities through a command-and-control center. They represent a classic convergence company that leveraged BC's strength in software and hardware into utility and industrial applications. In 2003 they reported revenues of over \$60 million and were the fourteenth largest high-tech firm in BC with more than 250 employees.<sup>57</sup>

### **POWERTECH LABS INC.**

Powertech Labs is a world-renowned technology centre located in Surrey, BC. A wholly owned subsidiary of BC Hydro, Powertech provides an extensive range of leading-edge consulting, testing and R&D services to electric power, auto and gas industries, and others. Powertech has a wide

array of technical expertise in various specialized aspects of electrical, civil, mechanical, chemical, metallurgical and materials engineering disciplines. It has several specialized well equipped laboratories: high voltage, high power, high current, mechanical, materials, coatings, chemistry and civil engineering laboratory. Considered a leader in high-pressure gas storage and fueling technology, Powertech has deployed the first station on the Hydrogen Highway – the first 10,000 psi gaseous hydrogen fueling station in the world – partnering on this and other related projects with Shell, ChevronTexaco, BP, BOC, Fuel Cells Canada, Toyota, Nissan, Ford, Daimler Chrysler and Hyundai. Powertech provides a variety of services related to Alternative Energy technologies and is collaborating with industry in the development of a local ocean energy capability. With a worldwide recognition for its expertise in power system stability and control, Powertech also provides analytical tools and consulting services for the design and secure operation of interconnected electric power systems.

#### **RAILPOWER**

Railpower develops hybrid goat and yard locomotives. RailPower's equipment cuts diesel fuel use and greenhouse gas emissions by 40 to 70 per cent compared to conventional yard locomotives. It also reduces smog-precursor oxides of nitrogen (NOx) and particulate emissions by 80 to 90 per cent. Railpower forms part of the growing expertise within the province in alternative transportation technology. They are a leader in their sector and have sales across North America. Railpower recently announced that it had won a grant from the Texas Emissions Reduction Program (TERP) for the development of one pre-production branch line hybrid locomotive for use in Texas. This draws attention to BC as a leader in the field and opens doors for other local power technology companies who want to pursue similar grants in the U.S.

#### **SIEBER ENERGY INC**

Sieber Energy Inc has the initial commercial objective to develop the SieWAVE™ Energy Accumulator, a patented clean renewable energy generation technology that will extract free energy from offshore ocean waves for the production of electricity, for water treatment and desalination, and for refrigeration. The company is working on establishing a network of academic research supporters and companies with the capability to assist in manufacturing, installation and energy generation. Sieber Energy intends to have demonstrable pre-commercial devices that are competitive with other wave energy capture that are being pursued elsewhere. Sieber Energy Inc is building business designing, developing, manufacturing, installing, servicing and licensing the manufacture of ocean renewable energy devices and plants. Sieber will be a supplier to



plant operators who sell electricity, water or hydrogen. Sieber will develop alliance relationships with companies who provide turbines/generators, desalinators, hydrogen electrolyzers and other specialised technologies that exploit capture of energy by SieWAVE™ technology.

#### **SPS ENERGY SOLUTIONS**

SPS Energy Solutions (also known as Soltek Powersource Ltd.) provides complete power solutions for the renewable energy market. Located in Victoria, BC, SPS has offices across North America and has distribution partnerships with some of the world's leading companies in the renewable energy market. SPS has industry-leading R&D and manufacturing and in-house engineering. It offers industrial, home, and mobile energy solutions. In March 2004, the company was awarded contracts for 40kw of solar modules for nine grid-tie systems across Canada. This represents a growth of 50 per cent over the entire industry-wide total of 27kW of on-grid distributed generating systems installed in all of 2002, according to the annual industry survey published by Natural Resources Canada. Dave Egles, president, notes that SPS' progress in 2004 in bringing solar into the mainstream is a significant step toward Canada's renewable energy commitment.

#### **TANTALUS**

Founded in 1989, Tantalus designs, manufactures, and markets two-way, real-time data communications networks to monitor and control electric, gas, and water utilities. Their products are beginning to gain acceptance as one way to create effective demand side management programs. They exemplify the innovation that can take place when BC's wireless, IT and Power Technology sectors work together. Their CEO is from Telus and a number of their executives from Dynapro Systems, now a division of 3M.

#### **TIR SYSTEMS**

TIR designs and manufactures solid-state lighting in Burnaby, BC. The energy savings from this technology are fueling double-digit growth for the company whose president comes from another successful local company, Motorola Wireless. TIR is an excellent example of the depth of British Columbia's engineering talent and the versatility of BC entrepreneurs. In 2004 TIR was named the BC Technology Industry Association's emerging company of the year. Their 2004 revenue was Cdn\$30 million, representing a growth rate of 34 per cent over the previous year. They have a strong IP portfolio that will help them continue to grow their business. TIR has 150 employees.

### **VIZON SciTEC**

Originally founded in 1944, Vizon began as a publicly funded contract research institution called BC Research. In 1993, it was privatized. In 2004, they became Vizon SciTec. Vizon has played an important role in the BC economy, having spun off numerous companies including Azure Dynamics. They have 80 highly educated employees on their 185,000-square-foot facility at UBC. Significantly, their laboratories are an incubator to over 20 companies involved in biotechnology, green energy, chemical industrial processes, and pharmaceuticals.

### **WESTPORT INNOVATIONS**

Westport Innovations develops technologies that allow diesel engines to operate on alternative fuels such as natural gas, propane and hydrogen. Their initial technology came out of work done at UBC. Westport offers: high-performance, low-emission alternate-fuel engines through its joint venture Cummins Westport; advanced fuel technologies; global technology alliances with BMW, Ford, Isuzu and MAN; infrastructure support through partnerships with alternative fuel providers (Clean Energy Fuels, Iqara, Ruhrgas, Japan Gas Association); government partnerships to source funding benefits. Westport has been recognized as the world leader in gaseous fuel engine technology. Its facilities in Vancouver total more than 78,000 square feet of laboratory and office space. It has numerous key market customers and partners: Yuchai, Renault, Beijing Sinogas, and LA Transit. The company is part of a growing expertise in transportation. Westport and its joint venture with Cummins, Cummins Westport Inc. are both headquartered in Vancouver.

### **XANTREX TECHNOLOGY**

Based in Burnaby, BC, Xantrex Technology Inc. (TSX:XTX) is a world leading developer, manufacturer and marketer of advanced power electronics products. Xantrex began operations in 1983 as a niche manufacturer in the Programmable Power products market. Beginning in 1999, Xantrex expanded into the Distributed and Mobile Power market segments and grew in the Programmable Power market. Xantrex is one of the most successful companies in British Columbia's and Canada's power technology sector, measured by revenue of US\$143.1 million in 2004, and it is profitable. It has grown at an annual compound rate of 60% for the past six years. Xantrex employs more than 500 people worldwide, with more than 300 in BC. Xantrex's strategy is to become the world leader in its chosen markets by evolving from a key enabling products supplier to a systems solution provider. Geographically, Xantrex's strategy is to expand its strong North American presence into Europe, Latin America, Africa and Asia. At its headquarters in Burnaby Xantrex conducts a significant amount

of its research and product development and has a significant manufacturing plant. Other Xantrex facilities are located in Arlington, WA; Livermore, CA; Elkhart, IN; Barcelona, Spain; Reading, UK; and Beijing, China.<sup>58</sup>



The report was prepared by The Center for Smart Energy with the oversight of Mossadiq Umedaly. CSE is a research advisory firm helping companies and regions pursue their best opportunities in the emerging smart energy sector. CSE develops markets for smart energy opportunities through research, events, outreach and strategic advice to help position innovations for success. Clients include leading smart energy companies, investors, utilities and policy makers.

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