

British Columbia's **Green Economy**



Building a Strong Low-Carbon Future
February 2010



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This report has been funded in part by the British Columbia Labour Market Partnership Program (LMPP). The LMPP is an employment program that provides financial assistance to organizations to encourage, support and facilitate labour force adjustments and human resource planning activities which are in the public interest.

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About GLOBE

The GLOBE Foundation of Canada is a Vancouver-based, not-for-profit organization dedicated to finding practical business-oriented solutions to the world's environmental problems.

Formed in 1993, we've helped companies and individuals realize the value of economically viable environmental business opportunities through our conferences and events, research and consulting, project management, communications and awards program.

We're a leader in championing green initiatives and leveraging sustainable ventures into mutually rewarding opportunities for enterprise and the environment. From urban sustainability to climate change, we're helping change the world by degrees.

For more information on the GLOBE Foundation, please visit our website at:

www.globe.ca



Working towards a greener future.

PREFACE

This report is based on in-depth research undertaken by the GLOBE Foundation to identify core components of the green economy in British Columbia, and to estimate the potential economic opportunities associated with building a low-carbon future.

The concept of a “green economy” has become very popular in current political and social discourse, and the term has come to mean different things to different people. While much attention is being paid to the potential economic impacts of clean and renewable energy, the GLOBE Foundation recognizes that “green” elements are present in all industry sectors in the province and as such, they must be included in the assessment of the green economy.

The analysis in the pages that follow focuses on six key sectors that supply the bulk of the products and services that contribute to the green economy in BC. The analysis provides a foundation or framework for the measurement and quantification of the economic and employment impacts of current green activity in all regions of the province. The analysis then reaches out to include those activities and trends present in the high-carbon elements of the BC economy that are in transition toward lower-carbon operations, as they too are part of the green economy.

In addition, this report highlights some leading BC-based companies in each of the six key sectors, touching on their innovative technologies and often visionary approaches to sustainable business practices that have resulted in domestic and international market success.

The findings in this report draw upon the vast body of research carried out by (or for) such agencies as the BC Climate Action Secretariat (including a series of reports by MK Jaccard and Associates, Inc.), the Ministry of Energy, Mines and Petroleum Resources (as part of the BC Energy Plan), the Ministry of Small Business, Technology, and Economic Development, the Business Council of British Columbia, the Vancouver Economic Development Commission, and many others.

The report also references research conducted in the United Kingdom, the European Union, the United States, and elsewhere in Canada, including research by such organizations as the Environmental Careers Organization (ECO) Canada, the Pembina Institute, the Pew Charitable Trusts, the United Nations Environment Programme (UNEP), and a host of other agencies exploring the enormous opportunities associated with the green economy.

As well, the GLOBE Foundation drew upon its own extensive body of research, including its 2007 milestone report entitled *The Endless Energy Project*. This facts-based report details how it is possible for BC to become energy self-sufficient through renewable sources and energy conservation by 2025, without diminishing the quality of life BC residents have come to enjoy.¹

The GLOBE Foundation also undertook considerable original research to develop estimates of the GDP and employment impacts of the green economy, as well as the associated trade balances for green commodities, drawing upon the resources of the Canada Revenue Agency (CRA), Statistics Canada, and BC Statistics.

This report is the culmination of Phase 1 of a project funded in part by the *Labour Market Partnerships* program. Phase 2 of the project, scheduled for completion in the spring of 2010, will explore in greater depth the business opportunities and labour market impacts associated with BC's green economy and the province's transition to a lower-carbon future.

Figure Highlight 1

Direct GDP and job contributions to BC's green economy by Development Region in 2008

1 Vancouver Island/Coast

GDP: \$1,500 million
FTE Jobs: 15,877

Key Sectors:

Clean & Alternative Energy
Energy Management
Green Building
Environmental Protection
Carbon Finance
Knowledge

2 Mainland/Southwest

GDP: \$7,150 million
FTE Jobs: 75,703

Key Sectors:

Clean & Alternative Energy
Energy Management
Green Building
Environmental Protection
Carbon Finance
Knowledge

3 Thompson/Okanagan

GDP: \$1,103 million
FTE Jobs: 10,730

Key Sectors:

Clean & Alternative Energy
Energy Management
Green Building
Environmental Protection
Knowledge

4 Kootenay

GDP: \$490 million
FTE Jobs: 5,188

Key Sectors:

Clean & Alternative Energy
Environmental Protection
Knowledge

5 Cariboo

GDP: \$357 million
FTE Jobs: 3,778

Key Sectors:

Clean & Alternative Energy
Environmental Protection
Knowledge

6/7 North Coast/ Nechako

GDP: \$176 million
FTE Jobs: 1,869

Key Sectors:

Clean & Alternative Energy
Environmental Protection
Knowledge

8 Northeast

GDP: \$378 million
FTE Jobs: 4,004

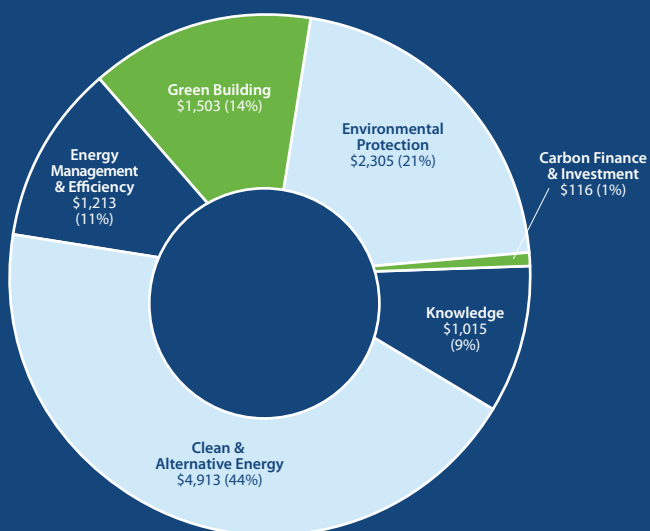
Key Sectors:

Clean & Alternative Energy
Environmental Protection
Knowledge



Figure Highlight 2

Direct GDP contributions by sector to BC's green economy in 2008 (\$ millions)



HIGHLIGHTS

The Green Economy – With a global market value of nearly US \$5.2 trillion, the world's green economy is growing faster than the economy as a whole, with a profound shift in focus toward emerging green technologies and skills in the areas of alternative and renewable energy, energy efficiency, and green building.

Gross Domestic Product – The six key sectors of BC's green economy contributed roughly \$15.3 billion to provincial gross domestic product (GDP) in 2008—\$11.1 billion of direct and \$4.2 billion of indirect—and accounted for approximately 10.2 percent of the province's total GDP for that year. Combined, the province's Clean and Alternative Energy and Energy Management and Efficiency sectors were responsible for \$6.1 billion in direct GDP in 2008—equal to more than half of the total direct green GDP in the province.

Employment – BC's green economy was responsible for nearly 166,000 direct and indirect full-time equivalent (FTE) jobs in 2008—equal to 7.2 percent of total provincial employment. The largest number of green jobs can be found in the areas that include wholesale trade for green products, professional environment-related services and research, administrative and support services, green construction, and public transit and ground passenger transportation.

Regional Contributions – The economic and employment impacts of the green economy are distributed widely throughout all of BC's Development Regions. The main beneficiaries are the Mainland/Southwest, Vancouver Island/Coast, and Thompson-Okanagan regions, which

together account for nearly 90 percent of the province's green GDP generated from the six key sectors. However, large growth potential exists in other regions as communities and businesses adopt renewable energy, bioenergy, and green practices leading to the creation of green jobs and new wealth.

Green Resource Opportunities – BC's abundant natural resources will continue to form the core of the province's competitive advantage in the new green economy for some time. Low-carbon natural resources such as hydro, wind, and wave energy, biomass, as well as vast reserves of natural gas, will be the fuel that drives the province's low-carbon energy future.

Green Economic Sectors – While BC has strengths in many areas of the green economy, the Clean & Alternative Energy, the Energy Management & Efficiency, the Green Building, and the Environmental Protection sectors show the greatest potential for future GDP and job generation.

Growth Potential – A range of growth scenarios for the green economy suggest that GDP from BC's green sectors could grow from \$15.3 billion in 2008 to between \$20.1 billion and \$27.4 billion in 2020. This would represent from between 10.8 percent and 14.1 percent of total provincial GDP, assuming that total GDP grows at its projected average annual rate of 2.2 percent to 2020. In terms of green jobs in BC, a shortage of labour market supply poses the greatest threat to potential growth. With an average annual green labour force growth rate of 2.6 percent, direct and indirect FTE jobs in BC's green economy would grow from 166,000 in 2008 to 225,000 by 2020.

Figure 1.1
BC's GHG emissions by sector in 2007

Source: BC Greenhouse Gas Inventory Report, July 2009

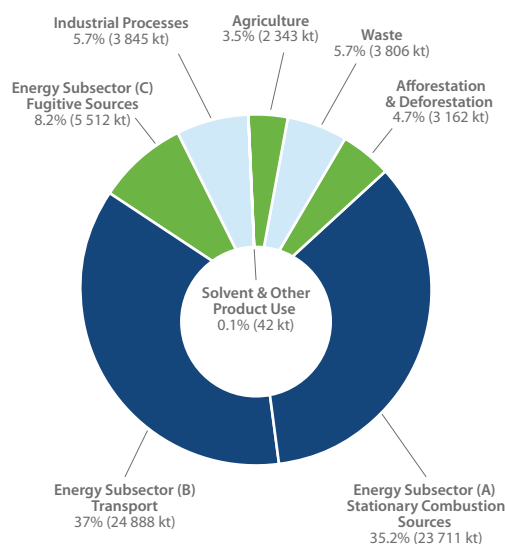


Figure 1.2
The sectors and sub-sectors of BC's green economy

Source: GLOBE Foundation

Clean & Alternative Energy

- Renewable Energy
- Bioenergy
- Hydrogen & Fuel Cells

Energy Management & Efficiency

- Energy Management & Power Electronics
- Energy Saving Lighting & HVAC
- Advanced Batteries, Energy Storage & Charging Systems
- Engines, Power Saving Automotive Equipment & Hybrid Technology

Green Building

- Architecture, Community Design & Green Infrastructure
- Construction & Building Materials
- Sustainable Development, Property Management & Real Estate

Environmental Protection

- Pollution Mitigation, Control & Remediation
- Waste Management, Reduction & Recycling
- Water Conservation & Technologies
- Carbon Capture, Storage & Sequestration
- Environmental Consulting

Carbon Finance & Investment

- Carbon Finance & Offsets
- Investment & Venture Capital

Knowledge

- Education & Training
- Research & Development
- Information & Communication Technology
- Legal & Accounting
- Public Administration & Support Organizations

1. THE GREEN ECONOMY

What is the green economy?

The green economy is a fast-growing economic development model that focuses on the creation of green jobs, the promotion of real, sustainable economic growth, and the prevention of environmental pollution, global warming, resource depletion, and ecological degradation. Integral to the green economy are those elements of traditional economic sectors that are in transition to lower-carbon energy production and increased energy conservation in order to reduce greenhouse gas (GHG) emissions into the biosphere.

Spurred on in countries with ambitious GHG emission reduction targets, the green economy is being realized through the adoption of lower-emission operating practices, innovative new engineering processes, and the deployment of green technologies. The education of a new generation of managers and the training of the labour force on low-carbon or green practices are also important factors in society's transition toward systemic changes that promote sustainability.

BC's green economy is one that is powered by green technologies and practices in every dimension of society and as such, one that generates green jobs, creates more sustainable businesses, and stimulates low-carbon investments province-wide.

In BC, the transition to a green economy is well underway due to forward-thinking initiatives by the provincial government and many municipal governments, to the genius of scientific and educational institutions, to evolving public attitudes that demand change, and to the actions of visionary enterprises in the private and non-profit sectors.

Traditional industry sectors in BC's green economy—including forestry, agriculture, mining, oil and gas, manufacturing, wholesale and retail, hospitality and tourism, healthcare, construction, transportation, and power-generation—are lowering their GHG emissions by switching to alternative fuels and renewable power, by increasing their energy efficiency, and by adopting innovative practices that increase sustainability and promote competitiveness.

In BC, due in part to the relatively high level of clean electrical energy supplied by hydropower, the biggest opportunities for reducing GHG emissions are in the areas related to transportation, energy, and the built environment (i.e. buildings, roads, and infrastructure), as illustrated by Energy Sub-sectors A and B in Figure 1.1. Achieving these reductions in the immediate future will require some industries to switch to lower-emission fuel alternatives—through the adoption of biofuels or lower-carbon natural gas in place of gasoline or coal, for example.

Because the term "green" is somewhat sweeping and difficult to quantify, this report focuses on six key sectors and 22 sub-sectors (outlined in Figure 1.2) that make up the bulk of the supply-side of BC's green economy through the provision of green products and services. Some of these sub-sectors are deeply embedded in traditional industries in BC. For example, bioenergy is an integral part of the forestry and agriculture industries, as is the emerging area of carbon capture and storage within the oil and gas industry. Other sub-sectors are incorporated into multiple industries—for example, energy management and environmental consulting.

As BC's traditional industries transition to more sustainable, lower-carbon operating practices, they will increasingly seek to incorporate the products and services supplied by many of these six key sectors into their everyday operations.

What are green jobs?

The United Nations Environment Programme (UNEP) defines green jobs as those positions in agriculture, manufacturing, research and development, administration, and the service sector that contribute substantially to preserving or restoring environmental quality.² This includes jobs that directly or indirectly help to protect ecosystems and biodiversity; reduce the use of energy, materials, and water consumption; “de-carbonize” the economy; and minimize or avoid waste and pollution.

As illustrated in Figure 1.3, jobs in energy efficiency, clean energy, and environmentally-friendly production have increased in importance in the US over the last decade.

In BC's current economy, many green jobs exist in sectors such as pollution control and remediation, water supply, and waste management. In the transition to a lower-carbon, green economy, the lines between environmental jobs and jobs in more traditional sectors will become increasingly blurred. While environmental careers will continue to exist, job descriptions for traditional careers like engineers, architects, property managers, construction workers, financial advisors, and ICT specialists, to name a few, will increasingly incorporate aspects of sustainability and green practices in order to address the need for reducing GHG emissions.

How big is the global market for green products and services?

On a global scale, the market value of the green economy is estimated to be worth nearly US \$5.2 trillion.³ Despite the recent economic downturn, the global market for environmental goods and services grew by four percent in 2008, and continued to grow through 2009.

Figure 1.4 provides the total market value for the twenty largest green economies. Due in part to its small population, Canada was ranked 13th in terms of market value, worth US \$89 billion in 2008 and making up less than two percent of the global total. Of particular importance for BC is that the top three green markets are also the province's top three export destinations.

The United States and China, the world's two largest emitters of GHGs, are also the largest markets in terms of value, and both are alive to the opportunities associated with a greener future. A recent study suggests that the total market size for green technology in China could grow to US \$1 trillion by 2013, which would account for approximately 15 percent of that country's GDP.⁴ Japan also plans to increase the scale of its environmental business market to 100 trillion yen (US \$1.06 trillion) by 2015 in a bid to create 2.2 million jobs.

The largest markets by value can be found in the areas of alternative fuels (including fuels for vehicles) at 30 percent, building technologies at 13 percent, and wind power at 11.5 percent.

With potential annual revenues for green products and services predicted by HSBC Global Research to reach over US \$2 trillion in 2020, even small niches could be worth hundreds of millions of dollars to companies in BC.⁵

Figure 1.3
Growth of jobs in the US “clean energy” economy from 1998 to 2007
Source: The Pew Charitable Trusts (2009), the Clean Energy Economy

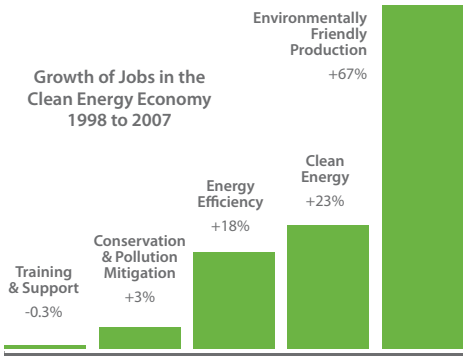


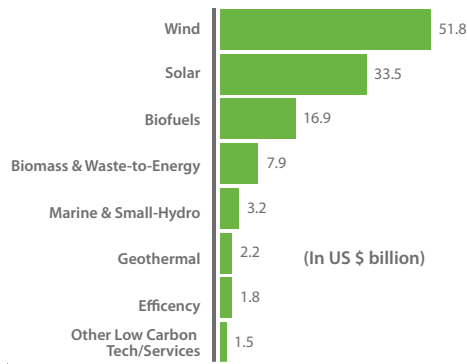
Figure 1.4
Market values for the top 20 largest green economies
Source: Innovas Report, 2009

Country	Market Value (US \$ billions)	% Global Total
1. United States	1,050	20.61
2. China	686	13.47
3. Japan	319	6.26
4. India	319	6.25
5. Germany	214	4.18
6. United Kingdom	178	3.50
7. France	155	3.04
8. Spain	137	2.73
9. Italy	135	2.69
10. Brazil	131	2.61
11. Russian Federation	127	2.53
12. Mexico	91	1.81
13. Canada	89	1.78
14. South Korea	82	1.63
15. Indonesia	72	1.44
16. Taiwan	58	1.15
17. Australia	51	1.01
18. Argentina	46	0.91
19. Thailand	45	0.89
20. Iran	45	0.89

What sectors present the biggest opportunities?

Figure 1.5
Global new investments in green technologies in 2008

Source: UNEP, SEFI and New Energy Finance (2009),
Global Trends in Sustainable Energy Investment 2009



Advancements in the green economy are closely tied to investment in green technologies. In 2008, global investment in green technologies was biggest in wind, solar, biofuels, and biomass and waste-to-energy (see Figure 1.5).⁶ Also in 2008, investment in new clean energy sources outstripped investment in fossil fuel technologies for the first time. Global venture capital funding for green technologies in the first three quarters of 2009 amounted to US \$3.94 billion, with the largest third quarter investments in solar, biofuel, gasification, and cleaner coal technologies.⁷ Projected investments of US \$630 billion by 2030 are expected to result in the creation of over 20 million jobs in the renewable energy sector alone.⁸

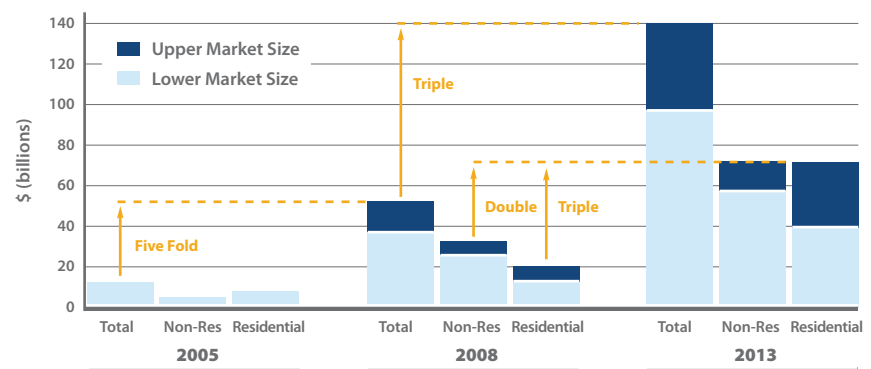
Significant global opportunities have been identified in water treatment and distribution, wind farm and wind turbine development, solar photovoltaic (PV) systems and equipment, energy efficient windows, and alternative fuels (including lower-emission vehicles).⁹

Technologies that promote energy conservation and efficiency present some of the largest opportunities, with worldwide investment in the “smart grid” and other “smart” devices expected to be worth US \$200 billion from 2008 to 2015.¹⁰ The number of smart meters installed globally is predicted to grow by more than 500 percent by 2015, representing a market value of US \$3.9 billion. Shipments in North America alone are estimated to reach 15 million units in 2012, with the Obama administration recently announcing US \$3.4 billion in smart grid grants.¹¹

Green building is the fastest growing sector of the construction industry growing by approximately 6 percent per annum. The US market value could be worth US \$140 billion by 2013 (see Figure 1.6).¹² The percentage of the building market dedicated to green building is expected to double from 6 to 12 percent between 2008 and 2013. This will result in the generation of US \$554 billion in GDP and 7.9 million jobs in the US over the next four years.

Figure 1.6
The US market for green building could reach US \$140 billion by 2013

Source: McGraw-Hill Construction, 2008.



BC already has significant strengths in some of the areas highlighted above, including bioenergy and gasification, smart metering, water treatment, and green building. Focusing on advancing green technologies in these areas will be the keys to the continued growth of BC’s green economy and will, in-turn, lead to the creation of new wealth and new jobs.

What countries are leading the charge to develop green economies?

Countries that have adopted aggressive GHG emission reduction targets coupled with strong policies that encourage investment and trade in green products and services over the last decade now lead the global green economy (see Figure 1.7).¹⁴

Denmark currently ranks first in the world for green technology development and job creation, with effective policies that have helped the country to become a leader in green technology exports and in attracting foreign investment. From 1990 to 2006, economic activity in Denmark increased by more than 40 percent, while carbon dioxide (CO₂) emissions were reduced by more than 13 percent.¹⁵ Investment policies are aimed at fostering and developing businesses, improving availability of venture capital, and supporting research and development—especially in high-growth sectors—and have attracted major multi-national corporations. Feed-in-tariffs and ambitious targets for the adoption of renewable energy and co-generated heat and electricity have resulted in a proliferation of regional-based independent power producers and the supply/value chains to support them.

Germany has also developed considerable strengths in the low-carbon economy with green technologies leading the way. Germany ranks first in the EU as the largest producer of renewable energy, with high installations of wind and solar PV technologies. In less than four years, Germany has created 250,000 direct jobs in renewable energy and is now focusing on increasing energy efficiency by developing regional smart grids and installing 100,000 mini power plants in homes throughout the country.

Although the United Kingdom accounts for only 3.5 percent of the world's green market value, it is one of the most-proactive nations in making the transition to a green economy. Government leaders are seizing the opportunity as a national development strategy with the *UK Low Carbon Transition Plan* that sets a roadmap to increase green projects and create new jobs in manufacturing, construction, and within the country's business sectors.¹⁶

With respect to competitiveness, France, Japan, the UK, South Korea, and Germany are best placed today to deliver prosperity for their citizens in a lower-carbon economy—Canada ranks 7th overall (as shown in Figure 1.8).¹⁷

However, the rate at which countries are improving their green economic competitiveness is potentially more important than their current position. In South Korea, for example, President Lee Myung-Bak has called for a “paradigm shift” towards low-carbon economic growth. South Korea is looking to create jobs and boost the country's international market share of green technology products through its *Green New Deal*.

Export opportunities exist in all sectors of the green economy, in particular, in areas related to green technology and renewable energy production. Germany is currently the top exporter of green products with a 16 percent share of the international trade volume, followed by the US (15 percent) and Japan (9 percent).¹³ Denmark is the largest exporter of clean energy technology—specifically wind turbines.

In addition to large markets, many of BC's biggest trading partners have been investing millions through green stimulus spending into research and development, commercialization, and the deployment of new green technologies (see Figure 1.9). Spending by China and the US accounted for a combined total worth US \$333 billion. As Canada's Pacific Gateway, British Columbia is perfectly positioned as an export hub to benefit from the coming “green revolution”.

Figure 1.7

The top ten countries in 2009 in terms of green technology strengths and job creation

Source: <http://www.cleantech.com>

Rank	Country	Clean-tech Strengths
1	Denmark	Wind, energy efficiency
2	Germany	Solar, green building, smart grid
3	Sweden	Energy efficiency
4	UK	Tidal/wave, vehicles, knowledge
5	Israel	Water, vehicles
6	Switzerland	Hydro, smart grid
7	US	Renewable, biofuels, green building, smart grid
8	UAE	Renewables, green building
9	China	Solar, wind, vehicles, green building
10	Canada	Hydro

Figure 1.8

Canada currently ranks 7th in terms of green economic competitiveness

Source: The Climate Institute & E3G (2009), G20 Low Carbon Competitiveness Report

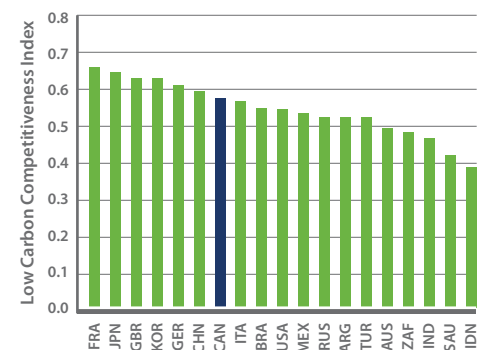


Figure 1.9

Green stimulus regional rankings

Source: HSBC Estimates

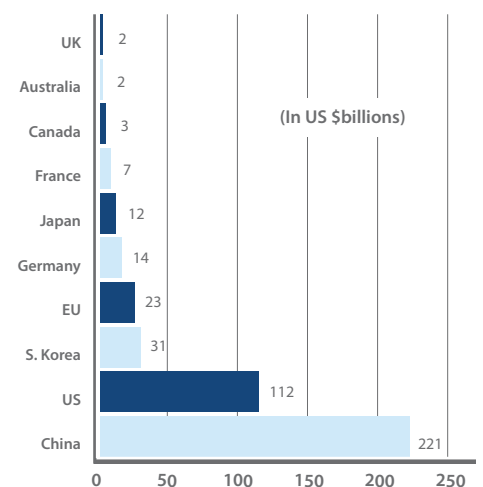
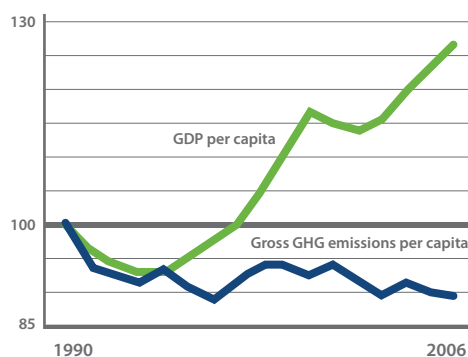


Figure 1.10

California's economic growth has been successfully decoupled from the state's GHG emissions since the mid-1990s

Source: California Green Innovation Index Report, 2009



What are other leading states and provinces doing?

On a regional level, several US states and Canadian provinces are positioning themselves as green leaders by encouraging economic development and adopting policies that include financial incentives, tax rebates, and clean energy initiatives, as well as tougher standards for renewable energy, energy efficiency, and vehicle emissions. The leadership in these jurisdictions has succeeded in attracting top talent and investments in the green economy.

In the US, four states stand out in this regard: California, Colorado, Oregon, and Massachusetts. California is the leader in terms of investment and jobs, accounting for half the total venture capital (VC) invested in the US (\$6.5 billion from 2006 to 2008) and over 125,000 clean energy jobs.¹⁸ Attractive public policies that include feed-in tariffs and financial incentives, combined with the most aggressive GHG emission reduction programs in the US, have allowed California's economy to prosper without any increase in emissions (see Figure 1.10).¹⁹

Colorado has succeeded by capitalizing on its natural resources, which includes sun and wind, to become a hub for renewable energy technology development. The state's competitive business tax structure rewards investment and innovation. Combined with an educated workforce and a proactive clean-technology industry association, Colorado has attracted nearly 200 green technology firms including Vestas Wind Systems—the world's leading supplier of wind turbines—that has opened four plants with an investment of US \$600 million.

Oregon—a state with similar strengths and assets to BC (as illustrated in Figure 1.11)—has become a powerhouse for the development of energy efficiency and renewable energy technologies by using strong environmental policies while showcasing its high quality of living to attract and retain creative minds. With a clear vision to make Oregon the national leader in renewable energy development, the state aggressively pursued key anchor companies—including SolarWorld, Vestas, Iberdrola, Sanyo, and Nissan—whose investments in the regional economy have resulted in the formation of technology clusters and well-developed value chains.

In Massachusetts, strong partnerships in green technology research at universities like Harvard, Boston, Tufts, Northeastern, and MIT have helped attract US \$1.2 billion in venture capital funds from 2006 to 2008.

In Canada, Ontario has recently passed a milestone *Green Energy and Green Economy Act* which places the province at the forefront of all jurisdictions in North America with respect to the promotion of renewable energy and the reduction of GHG emissions. The Act is expected to create over 50,000 jobs in the next three years and will help the province reach its goal of achieving 25,000 megawatts (MW) of installed renewable energy capacity by 2025. The green legislation, that includes feed-in tariffs for renewable energy, has won the province international attention as a leader in the green economy, resulting in investments by multi-national corporations, such as Samsung, totalling close to \$10 billion.

Each of the above examples illustrate how these jurisdictions have developed and applied policies and programs to that take advantage of the state or province's particular green assets and trading relations to achieve their defined goals. Moving forward, it is important that BC policy-makers realize the importance of a clear and stable policy framework—one that capitalizes on the province's unique strengths and that provides investors with the certainty they need to make the investments in key sectors essential for green economic prosperity.

Figure 1.11

Strengths in Oregon's green economy are similar to those in BC

Source: Carbon Free Prosperity 2025 (2008), Clean Edge Inc. & Climate Solutions

Strengths / Assets
Prevalent Green Culture and Regional Quality of Life
Supportive Regional Government Policies for Renewables and Efficiency
Abundant, Cheap Electricity (Attracts Manufacturing)
Significant Natural Resource Base (Wind, Solar, Waves, Biomass)
Massive Export Market Opportunities



Some of the public policies helping to drive the transition to a green economy in BC are described below:

BC Climate Action Plan

The Plan outlines strategies and initiatives to take BC approximately 73 percent towards meeting the goal of reducing GHG emissions by 33 percent by 2020.

BC Energy Plan

The Energy Plan is designed to make the province energy self-sufficient by 2016 with at least 90 percent of the province's energy coming from renewable sources. The strategic energy plan sets ambitious targets around the development of clean energy, conservation, and efficiency, and outlines plans to invest in advanced energy innovation.

BC Bioenergy Strategy

The BC Bioenergy Strategy includes \$25 million for the BC Bioenergy Network—an industry-led initiative that acts as a catalyst for deploying near-term technologies in eight opportunity areas and leverages funding to support BC-focused technology and applications. Since the beginning of 2009, the network has invested \$5 million into research and development for new technologies.

Greenhouse Gas Reduction Targets Act

The GHG Reduction Targets Act includes requirements to create a carbon neutral public sector by 2010 and to reduce the carbon intensity of transportation fuels by 10 percent by 2020.

BC Carbon Tax

North America's first carbon tax based on GHG emissions from fossil fuel combustion encourages low-carbon economic development while reinvesting revenue into targeted tax cuts for individuals and businesses, making the carbon tax revenue-neutral.

BC Energy Efficient Building Strategy

BC's Energy Efficient Building Strategy is predicted to reduce GHG emissions equal to 1.8 million tonnes per year of CO₂e in 2020 and to save BC residents \$3.4 billion over 12 years through the implementation of the Energy Efficiency Act applied to homes, communities, and commercial, industrial, and government buildings.

BC Brownfield Renewal Strategy

The Strategy helps reduce risk and uncertainty in brownfield redevelopment and creates more streamlined approvals for brownfield projects by contributing funding to land owners or developers in relation to brownfield sites. The Strategy is backed by a \$10 million Brownfield Renewal Fund.

Innovative Clean Energy Fund

The \$25 million a year Innovative Clean Energy (ICE) Fund encourages the development of clean energy and energy efficient technologies in the electricity, alternative energy, transportation, and oil and gas sectors in communities throughout the province. The Fund showcases "pre-commercial" energy technologies that have international market potential and demonstrates the commercial viability of these new energy technologies.

The province's long-term competitive advantage is based on the fact that many of the components of a green economy exist already. These include:

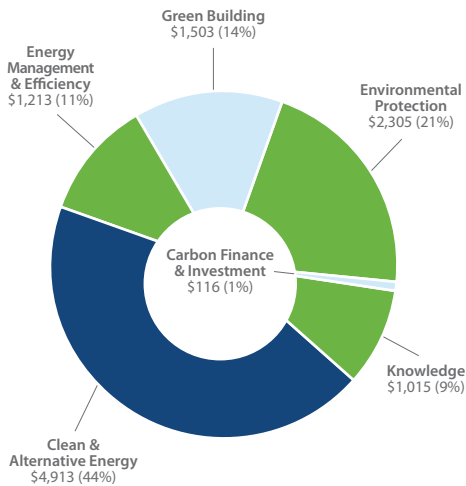
- progressive policies and programs to attract investments and to move to a new "greener" economy (see sidebar)
- a basic low-carbon electricity supply system, which is the main asset upon which the province can build its manufacturing sector
- a full spectrum of alternative and renewable energy resources, many of which are ready to be harnessed
- an abundant supply of conventional and unconventional natural gas
- a host of locally-available technology options available to propel the short- and medium-term transformation toward a greener economy
- clusters of green technology and advanced energy companies with extensive value chains
- a world-class quality of life that attracts a skilled and diverse workforce—Vancouver consistently ranks as one of the world's most livable cities
- advanced education and training programs and a high concentration of research facilities focused on green technology research and
- a strategic location as Canada's Pacific Gateway, perfectly positioned for export opportunities to rapidly expanding green economies in Asia.

These key strengths, coupled with growing concerns with respect to energy security, climate change, and future economic growth, provide BC with a wide range of economic opportunities in the global marketplace for green energy, technologies, products, and services.

2. CONTRIBUTION TO BC'S ECONOMY

How much GDP is contributed by the sectors considered part of BC's green economy?

Figure 2.1
Direct GDP contributions by sector to BC's green economy in 2008 (\$ millions)
Source: GLOBE Foundation



Note: Green GDP and job numbers presented in this report are based on the six sectors described in Figure 1.2. The direct and indirect contributions of the related value/supply chains in terms of GDP and jobs were revealed through Statistics Canada's Input-Output model using NAICS codes and relevant intensity ratios.

While every effort has been made to accurately measure BC's green economy, the GLOBE Foundation recognizes that the economic contributions made by some sectors may not be fully captured due to the limitations of this sectoral framework approach. For this reason, GDP and job numbers are considered conservative estimates. For more details on this study's methodology, see the Technical Notes section at the end of this report.

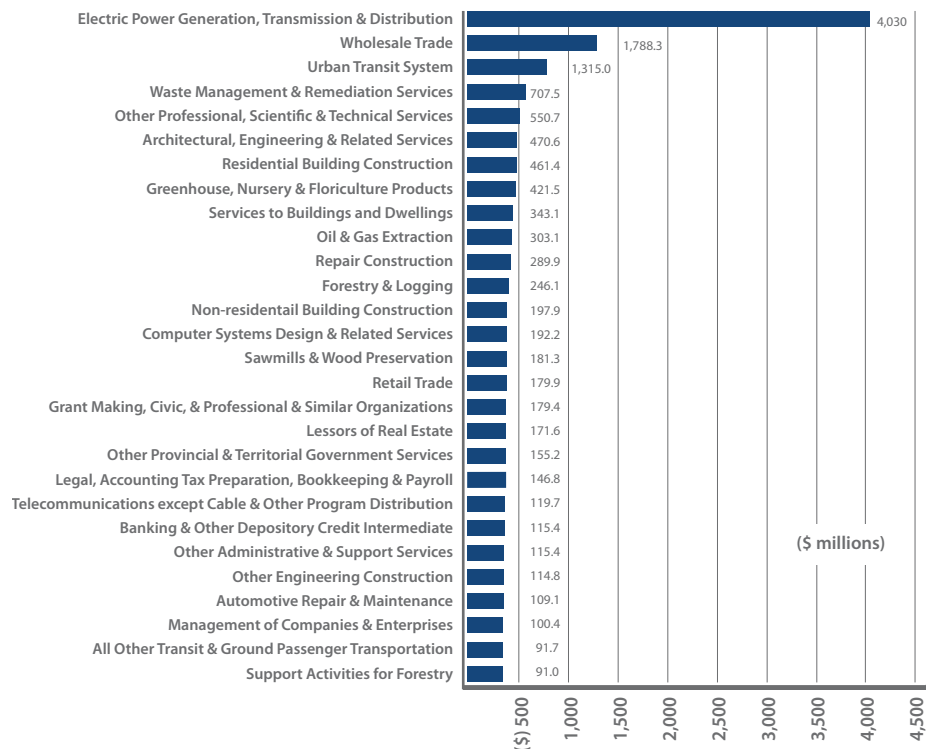
The six key sectors of BC's green economy contributed roughly \$15.3 billion to provincial gross domestic product (GDP) in 2008—equal to \$11.1 billion of direct GDP and \$4.2 billion of indirect GDP, with an average GDP multiplier of 1.38. As a percentage of the total economy, BC's green sectors accounted for approximately 10.2 percent of the province's total GDP for that year.²⁰

As illustrated in Figure 2.1, BC's energy-related sectors (Clean and Alternative Energy and the Energy Management and Efficiency) were responsible for more than \$6.1 billion in direct GDP in 2008—equal to more than half (55 percent) of the total green GDP in the province. The Environmental Protection sector was second in size at \$2.3 billion.

On an aggregated industry level, Electric Power Generation, Transmission, and Distribution accounts for \$4.0 billion of the total \$15.3 billion in GDP (nearly 27 percent) attributed to the green economy in 2008 (see Figure 2.2). This shows the enormous benefit that hydroelectric power provides to the province's green economy. At \$1.8 billion and \$1.3 billion respectively, the Wholesale Trade and the Urban Transit System sectors were the second and third largest contributors to provincial GDP in 2008.

Revenues for corporations operating in the six key sectors of BC's green economy were also significant at \$18.3 billion in 2008.

Figure 2.2
GDP contributions by sector to BC's green economy in 2008
Source: GLOBE Foundation



How many jobs are involved in BC's green economy?

The total number of direct full-time equivalent (FTE) jobs associated with the key sectors of BC's green economy is 117,160—equal to 5.1 percent of total provincial employment. Adding indirect jobs, the total FTE jobs generated by and through BC's green economy add up to 165,690. Gross Domestic Product per FTE job is equivalent to \$92,162 with an average employment multiplier of 1.41.

While the Clean and Alternative Energy sector is the largest in terms of green GDP generation, because this sector is more capital than labour intensive, other sectors of BC's green economy are actually responsible for more employment. As illustrated in Figure 2.3, the Environmental Protection sector was responsible for approximately 32,700 direct FTE jobs in 2008, equivalent to more than one-quarter (28 percent) of all green jobs in the province. The Energy Management and Efficiency sector was the second largest in terms of employment in the province's green economy, responsible for approximately 24,800 direct FTE jobs in 2008—due in part to elements related to transportation.

Aggregated by industry NAICS, Wholesale Trade is considered the largest category for jobs in BC's green economy, with a total of nearly 24,000 direct and indirect jobs (see Figure 2.4). Professional, Scientific, and Technical Services was the second largest job category associated with the green economy, accounting for just over 23,000 direct and indirect jobs in the province in 2008.

Other leading job categories include Administrative and Support Services (17,516 FTE jobs); Construction (17,101 FTE jobs); and Transit and Ground Passenger Transportation (15,288 FTE jobs).

Figure 2.4
Direct and indirect full-time equivalent jobs associated with BC's green economy
Source: GLOBE Foundation

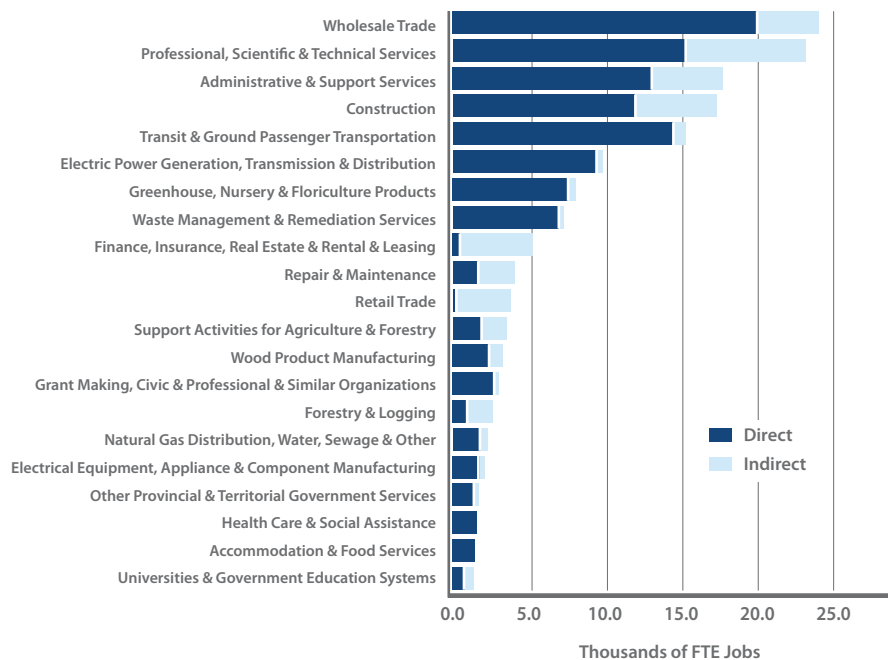


Figure 2.3
Direct full-time equivalent jobs in BC's green economy by sector
Source: GLOBE Foundation

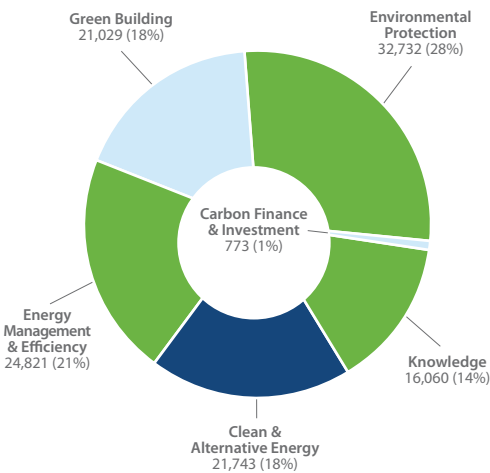


Figure 2.5
2008 revenues for BC's green commodity imports and exports
Source: GLOBE Foundation

Category	Exports	Imports
Electrical Energy	\$573	\$613
Waste Water Management	\$187	\$406
Renewable Biomass	\$147	\$212
Solid Hazardous Waste	\$91	\$179
Renewable Energy Plant	\$90	\$118
Electrical Transmission & Distribution	\$86	\$140
Heat Energy Management	\$79	\$170
Monitoring & Analysis	\$53	\$128
Potable Water Management	\$26	\$82
Other Recycling Systems	\$24	\$13
Oceanographic & Surveying	\$18	\$26
Air Pollution	\$15	\$40
Total All Countries	\$1,390	\$2,128
Total Excluding Electrical Energy	\$817	\$1,515

Figure 2.6
Trade balances for green commodities
in BC in 2008

Source: GLOBE Foundation

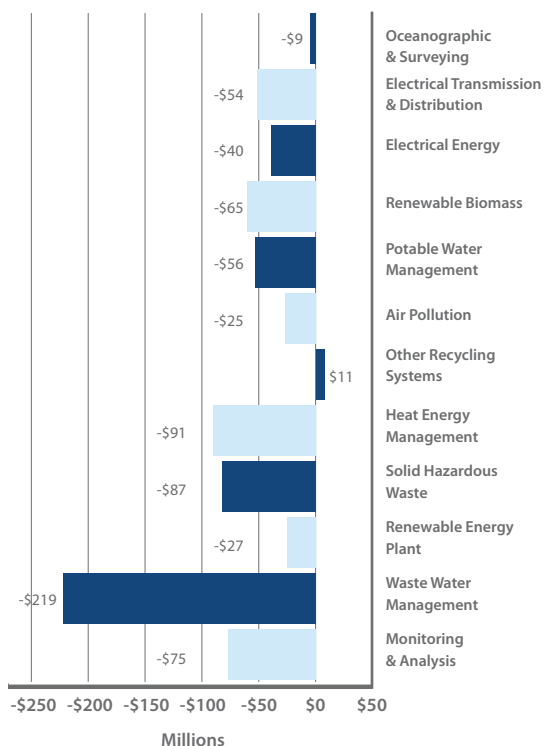
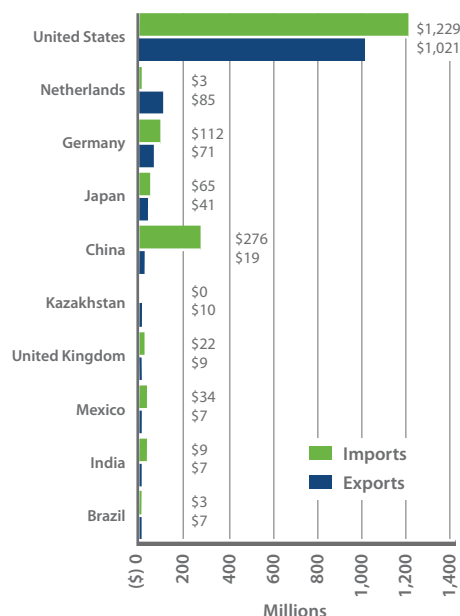


Figure 2.7
Top ten countries for green commodity
trade with BC in 2008

Source: GLOBE Foundation



What is BC's current trade balance in green products?

Exports from the sectors involved in the supply of green products in BC generated \$1.39 billion in revenues (see Figure 2.5) and contributed approximately \$786 million to provincial GDP in 2008—approximately 3.4 percent of all BC merchandise exports by value. Electrical Energy was BC's largest green commodity export in 2008, accounting for 41 percent of the value of all green commodity exports. Wastewater Management technologies and Renewable Biomass products were second and third for exports, at 13 and 11 percent respectively.

On the import side, a total of \$2.13 billion worth of green products were imported into BC in 2008 (see Figure 2.5). This represents 4.9 percent of all BC merchandise imports. While Electrical Energy is also BC's biggest import at \$613 million in 2008, it is important to note that much of this energy is not "clean" in nature, and comes from coal plants in Washington State and Alberta. In terms of green products, Wastewater Management technologies were the largest imported commodity category at more than \$400 million in 2008.

Historically, the import of manufactured goods to BC has been paid for in part by the province's natural resource-based exports. While BC's service-based exports remain strong, the decline of BC's natural resource-based industries in recent years (in particular forestry) has resulted in a net trade deficit. Since 2004, the international trade deficit for BC's green commodity sectors has grown larger and now sits at \$3.4 billion.

In 2008, trade balances for green commodities were all negative with the exception of Other Recycling Systems, which was valued at a credit of \$11 million (see Figure 2.6). While the export of Wastewater Management technology is big in BC and is responsible for a relatively large number of jobs in the province, imports still outweigh exports in this category. Wastewater Management technology is responsible for the largest trade deficit of all categories, accounting for approximately 30 percent of the 2008 deficit—equivalent to \$219 million of the \$738 million deficit. The overall analysis suggests that BC tends to import the technologies it needs to export its raw energy products.

By country, BC's largest trading partner in green products is the United States, accounting for \$1.02 billion in exports (73 percent of all green commodity exports) and \$1.23 billion in imports (58 percent of all imports), as illustrated in Figure 2.7. Asian countries accounted for 6.5 percent of exports from BC and 23 percent of imports. EU countries accounted for 14 percent of exports from BC and 10 percent of imports into the province.

To fully realize the benefits of the green economy, it will be essential for BC to develop new foreign markets and to diversify its export base. To do this, the province must focus on new opportunities for domestic manufacturing of green products that are demanded by its trade jurisdictions and increase exports of these products where possible.

Due to the limitations of Statistics Canada's data on services, which collects information only at the national level, it is not possible to isolate and report on trade in services related to BC's green economy. However, it is important to recognize that BC has considerable strengths in many of its green service sectors—including architecture, engineering, research, ICT, legal, accounting, and environmental consulting—and has been exporting this knowledge base for years. The export of green services in some ways compensates for the province's weakness in the manufacturing and exporting of green products.

What is the potential economic impact from growth in BC's green sectors?

Research undertaken for this project suggests that BC's economic future under a low-carbon regime is particularly promising. In Canada, wind and solar power investment is growing annually at double digit rates and in BC, investment in electric power generation is growing at 8.9 percent annually.

While all sectors of BC's green economy show considerable growth potential, bioenergy solutions, alternative fuels for vehicles, energy management technologies (including smart technologies), and green building products and design services, appear to show the largest immediate opportunities.

Considering both regional and global perspectives, the long-term growth potential for jobs in BC's green economy is also very encouraging, leading the GLOBE Foundation to predict that green jobs in the province will grow faster over the next decade than jobs as a whole. Good to excellent opportunities present themselves in the areas of renewable energy, bioenergy, energy management and power electronics, energy saving lighting and HVAC, green building, environmental protection, education and training, research, and information/communication technologies (see Figure 2.8).

A range of growth scenarios for the green economy suggest that GDP from BC's green sectors could grow from \$15.3 billion in 2008 to between \$20.1 billion and \$27.4 billion in 2020. This would represent between 10.8 percent and 14.1 percent of total provincial GDP, assuming that total GDP grows at its projected average annual rate of 2.2 percent to 2020. In addition, if BC is able to successfully develop its manufacturing base in green products, import substitution gains could further grow GDP in this emerging area of the province's economy.

In terms of green jobs in BC, a shortage of labour market supply poses the greatest threat to potential growth. With an average annual green labour force growth rate of 2.6 percent, direct FTE jobs in BC's green economy would grow from nearly 166,000 in 2008 to 225,000 by 2020. These numbers could be increased through the "greening" of traditional careers, increased education and training programs for green trades, and by easing labour supply constraints for key occupations through increased immigration, for example.

Figure 2.8
Estimated growth potential for green jobs in BC to 2020

Source: GLOBE Foundation

Sector	Sub-Sector	Long-Term Job Potential in BC
Clean & Alternative Energy	Renewable Energy	Good to Excellent
	Bioenergy	Excellent
	Hydrogen & Fuel Cells	Good
Energy Management & Efficiency	Energy Management & Power Electronics	Excellent
	Energy Saving Lighting & HVAC	Excellent
	Advanced Batteries, Energy Storage & Charging Systems	Good
	Engines, Power Saving Automotive Equipment & Hybrid Technologies	Good
Green Building	Architecture, Community Design & Green Infrastructure	Excellent
	Construction & Building Materials	Good to Excellent
	Sustainable Development, Property Management & Real Estate	Good to Excellent
Environmental Protection	Pollution Mitigation, Control & Remediation	Good to Excellent
	Waste Management, Reduction & Recycling	Excellent
	Water Conservation Technologies	Excellent
	Carbon Capture, Storage & Sequestration	Unknown
	Environmental Consulting	Good to Excellent
Carbon Finance & Investment	Carbon Finance & Offsets	Unknown
	Investment & Venture Capital	Good
Knowledge	Education & Training	Good to Excellent
	Research & Development	Good to Excellent
	Information & Communications Technology	Excellent
	Legal & Accounting	Good
	Public Administration & Support Organizations	Good

Note: The estimated long-term job potential for BC is based on domestic and global employment trends revealed through secondary research. Rankings are relative to potential BC labour market demand and do not consider labour market supply. A more detailed analysis of BC labour market trends related to the green economy will be undertaken in Phase 2 of this project.

Figure 3.1

Direct GDP and job contributions to BC's green economy by Development Region in 2008

Source: GLOBE Foundation



1 Vancouver Island/Coast

GDP: \$1,500 million
FTE Jobs: 15,877

Key Sectors:

Clean & Alternative Energy
Energy Management
Green Building
Environmental Protection
Carbon Finance
Knowledge

2 Mainland/Southwest

GDP: \$7,150 million
FTE Jobs: 75,703

Key Sectors:

Clean & Alternative Energy
Energy Management
Green Building
Environmental Protection
Carbon Finance
Knowledge

3 Thompson/Okanagan

GDP: \$1,103 million
FTE Jobs: 10,730

Key Sectors:

Clean & Alternative Energy
Energy Management
Green Building
Environmental Protection
Knowledge

4 Kootenay

GDP: \$490 million
FTE Jobs: 5,188

Key Sectors:

Clean & Alternative Energy
Environmental Protection
Knowledge

5 Cariboo

GDP: \$357 million
FTE Jobs: 3,778

Key Sectors:

Clean & Alternative Energy
Environmental Protection
Knowledge

6/7 North Coast/ Nechako

GDP: \$176 million
FTE Jobs: 1,869

Key Sectors:

Clean & Alternative Energy
Environmental Protection
Knowledge

8 Northeast

GDP: \$378 million
FTE Jobs: 4,004

Key Sectors:

Clean & Alternative Energy
Environmental Protection
Knowledge

3. REGIONAL IMPACT

What regions in BC are the biggest contributors to the province's green economy?

While all of the Development Regions (DR) in BC contribute to both provincial GDP and jobs within the green economy, the contribution is heavily weighted toward the urban centres found in the south and south-western parts of the province (DRs 1, 2, and 3), as illustrated in Figure 3.1.

In terms of regional contributions to green jobs, Figure 3.2 illustrates that the Mainland/Southwest Development Region was responsible for nearly two-thirds (62 percent) of direct FTE jobs in BC's green economy in 2008. The Vancouver Island/Coast region was second in size, contributing approximately 16 percent of the direct provincial FTE jobs. This is partly due to the higher populations living in the southwest of the province, but also due to their better access to business, education, and research clusters, infrastructure (i.e. roads, the electricity grid), and trade routes that allow these regions to grow with fewer hurdles.

However, it is important to note that green jobs as a percentage of the employed labour force in 2008 were highest in DRs 4 and 8 at 7.3 and 10.5 percent respectively. Other regions ranged from between 4.0 and 5.3 percent of the employed labour force. This would indicate that green jobs, as a source of employment, are particularly important in regions 4 and 8.

While the northern regions in the province will continue to rely on natural resource-based primary industries for some time, these industries are undergoing rapid transformation through the adoption of green technologies and more sustainable operating practices. In turn, this is leading to new jobs that will help these traditional economic sectors become more sustainable and more competitive in the global marketplace.

While many northern communities have awakened to new opportunities made possible by renewable and alternative energy sources, including waste-to-energy and district heating, there is room for additional green technologies and practices to be incorporated into these regions. This, in turn, will lead to the formation of extended green supply chains to support these efforts.

In general, there is great potential for increased wealth and job creation in the more northern Development Regions through further development of the regions' Clean and Alternative Energy, Energy Management and Efficiency, Green Building, and Knowledge sectors.

What initiatives are helping to drive BC's green economy at the regional level?

As of January 2010, 176 out of 184 local governments in BC have signed the *Climate Action Charter* to become carbon neutral by 2012. This provides a huge opportunity to leverage BC companies that offer green technologies, products, and services to help these municipalities reach their climate action goals.

In addition, many municipalities throughout the province are establishing themselves as front-runners on the path to a more sustainable, low-carbon future, aided in part by the provincial government and by organizations such as the Union for British Columbia Municipalities (UBCM), the Fraser Basin Council, the Canadian Urban Institute (CUI), and Smart Growth BC.

Dawson Creek is a prime example. A city of approximately 12,000 people in the Peace River region of north-eastern BC, Dawson Creek has adopted a vision to promote social, cultural, economic, and environmental vitality and reduce the city's environmental footprint. The city is actively embracing solar PV and wind energy technologies, increasing its energy conservation and water efficiency and related educational programs, implementing more green spaces within city limits, and hybridizing and downsizing its public vehicle fleets (see Figure 3.3).

Prince George, Squamish, Maple Ridge, and Oliver have all committed to the *Smart Growth on the Ground* initiative that is helping to transform the cities into future vibrant green communities using sustainable design and construction plans (see Figure 3.4).

Other municipalities are taking advantage of their strengths in natural resource by adopting low-carbon strategies that benefit their communities. Revelstoke and Quesnel have adopted district energy systems powered by biomass to heat their public buildings. The Haida First Nation has plans to develop a 396 MW offshore wind farm at the northern tip of the Queen Charlotte Islands that is expected to generate enough electricity to power 130,000 homes. The project, which recently earned its Environmental Assessment Certificate, is estimated to create 200 jobs during construction and 50 permanent jobs for maintenance and operations.

Thanks in part to the forward planning of city officials surrounding the 2010 Winter Olympic Games, both Whistler and Vancouver have leveraged this opportunity to create greener, more sustainable cities. *Whistler2020* is a community development plan that is helping Whistler to become one of the most sustainable communities in North America by the year 2020.

In October 2009, the City of Vancouver launched its plan to become the greenest city in the world by 2020. *Vancouver 2020: A Bright Green Future* sets out ten clear goals that include creating 20,000 green jobs in the city, implementing a city-wide composting program, increasing green spaces, improving the energy efficiency of buildings, and increasing options for walking, biking, and public transit throughout the city. One of the key elements of Vancouver's plan is the creation of low-carbon zones in the city, which will become centres for green technology research, development, commercialization, and product demonstration. These zones will promote trade between Vancouver and other jurisdictions. Vancouver is making energy conservation and building retrofits a top priority, in-line with its green building code. This, again, presents enormous opportunities to promote BC companies through the procurement of green products and services.

Figure 3.2
Direct FTE jobs by Development Region within BC's green economy in 2008

Source: GLOBE Foundation

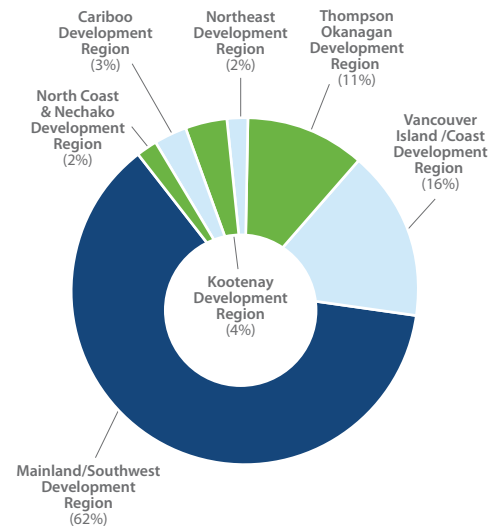


Figure 3.3
The City of Dawson Creek is embracing the green economy on a municipal level

Source: <http://www.planningforpeople.ca>



Figure 3.4
Community members take part in a charette to plan their city's future land use as part of Smart Growth on the Ground in Oliver

Source: <http://www.sgog.bc.ca>





Photo: Neil Openshaw

Figure 3.5
Grouse Mountain's 65-meter wind turbine towers over the City of Vancouver

Source: <http://www.grousemountain.com>

In addition, the City of North Vancouver has set a remarkable example by developing a framework for low-carbon, sustainable economic growth that spans a 100-year period.

Several BC government initiatives are creating jobs and helping municipalities transition to a greener economy. The *LocalMotion* initiative has provided \$40 million for 122 projects including bike paths, walkways, and greenways. The *LiveSmart BC* program assisted in paying for 40,000 residential energy audits and 11,000 retrofits.²¹ In 2009, *Trees for Tomorrow* invested over \$3 million into projects related to planting thousands of trees throughout the province.

Contributions of close to \$47 million from the *Innovative Clean Energy (ICE) Fund* have resulted in 34 demonstration projects province-wide, representing a total project value worth over \$174 million. Continuing to build on this highly successful program, a third \$25-million call for project applications was recently issued.

The *BC Community Water Improvement Program*, the *Municipal Rural Infrastructure Fund*, and the *Building Canada Fund* are other great examples of provincial initiatives with a regional focus.

Private sector initiatives around the province are also helping. As a symbol of its commitment to greener operations, Grouse Mountain's ski resort erected a 65-meter wind turbine in the summer of 2009, which has the potential to power one-third of its electricity needs (see Figure 3.5).

It will be important to continue aligning provincial policies with regional and private sector efforts in order to help create jobs and boost local economies.

4. BC'S GREEN NATURAL RESOURCE OPPORTUNITIES

What opportunities exist for BC's natural resource-based sectors in the green economy?

While many new economic opportunities are to be had from the emerging green sectors in the province, the transition toward lower-carbon processes and practices in many of BC's traditional economic sectors also represent important areas of opportunity in terms of job creation, wealth generation, and GHG emissions reductions.

As BC continues its transition to a greener economy, the province's abundant natural resources—including its large renewable energy potential, its sustainable forest-based products and biomass reserves, and vast deposits of low-carbon natural gas—will form the foundations of wealth and job creation, particularly in province's northern and more remote regions. With proper regulation and monitoring to ensure that future development and exploitation of these natural resources proceeds with as little environmental impact as possible, these industries can play an even bigger role in the province's transition to a lower-carbon future. In addition to the province's renewable energy, its forest-based resources, and its natural gas reserves, the adoption of low-impact practices in the mining, agriculture, and aquaculture industry sectors are helping them become more cost competitive and low-carbon in nature.

Renewable Energy

British Columbia is rich in renewable energy resources and the province is well-positioned for clean energy technology research, development, and deployment. Hydro power, wind energy, geothermal, and other natural sources of energy, such as solar, wave, and tidal energy have the lowest environmental impacts of all sources of renewable energy and all are readily available here in BC.

As illustrated in Figure 4.1, the potential in BC for producing energy from wind and hydro alone has been estimated at over 33,500 megawatts (MWs). BC Hydro has identified 16 prospective geothermal sites in the province, of which the six most likely prospects collectively have an estimated geothermal potential of over 1,000 MW. From a wave energy perspective, the NRC Canadian Hydraulics Centre estimates that there is 37,000 MW of offshore ocean wave capacity on Canada's Pacific Coast.²² In addition, the Ocean Renewable Energy Group (OREG) estimates 29,000 MW of nearshore wave energy potential along BC's coastline and 4,000 MW of tidal energy potential.

While only a fraction of these potential resources are currently recoverable due to technological, physical, and economic constraints, there is still enough exploitable potential in the near- and distant-term to provide the basis for long-term technology development and a manufacturing base in some areas. In addition, the well-planned development of local renewable energy sources can help many remote communities throughout the province to reduce their dependency upon power sourced from dirty and expensive diesel generators.

Figure 4.1
BC has a massive potential for generating renewable energy in all the Development Regions in BC
 Source: BC Ministry of Energy, Mines, and Petroleum Resources and the Western Energy Zones – Phase 1 Report by the Western Governors' Association & US DOE.



1 Vancouver Island/Coast

Hydro	2,787 MW
Geothermal	180 MW
Wind	1,533 MW

2 Mainland/Southwest

Hydro	4,542 MW
Geothermal	440 MW
Wind	1,744 MW

3 Thompson/Okanagan

Hydro	1,445 MW
Geothermal	32 MW
Wind	4,250 MW

4 Kootenay

Hydro	1,729 MW
Geothermal	32 MW
Wind	290 MW

5 Cariboo

Hydro	1,076 MW
Geothermal	32 MW
Wind	902 MW

6/7 North Coast/Ne­chako

Hydro	1,383 MW
Geothermal	800 MW
Wind	4,408 MW

8 Northeast

Hydro	1,170 MW
Geothermal	16 MW
Wind	6,256 MW

Figure 4.2

BC's estimated bioenergy potential from various sources

Source: BIOCAP Canada Report, 2008

Biomass Feedstock	Resource Size (dry tonnes/year)	Bioenergy Potential (petajoules/year)	Potential % of current BC fossil fuel demand replaced
Municipal Solid Waste	948,450	15.2	1.6%
Sustainable Agriculture	3,266,505	52.1	5.7%
Sustainable Forestry	17,114,615	273.8	29.8%
Mountain Pine Beetle (20 year resource)	11,014,618	176.2	19.2%
Total	32,344,188	517.4	56.2%

Disaster Relief: Environmental Benefits of Building with BC Wood Technology



In June 2008, the Province of British Columbia and the Government of Canada announced the \$8 million Canada-BC Wenchuan Earthquake Reconstruction Project. Using wood-framed construction, this project helped rebuild communities in China damaged by the massive May 2008 earthquake. These structures will all use high-quality Canadian wood materials that will demonstrate the benefits of modern wood frame construction technology, including seismic stability, energy efficiency, reduced environmental impact, flexible design, and fast construction.

Last September, the Xiang'e Primary School in Dujiangyan of Sichuan Province, one of the hardest-hit areas, opened to 370 children. The next phase of the project will be the construction of the Mianyang Special Education School for the Disabled and the Beichuan Elderly Care Center in Leigu Town.

With the effects of climate change predicted to increase the severity and frequency of storms, BC's forestry and wood product sectors have the potential to help with future disaster relief efforts.

Biomass & Green Forestry

British Columbia's forest industries have made enormous strides in recent years to become more sustainable and more environmentally aware in terms of their business practices and operating procedures. With the current shrinking of BC's forestry industry, the sector has been adopting efficiency in energy consumption and operations as a key to survival and is searching for new business opportunities—including using biomass feedstock for energy purposes and creating new green building materials from forestry products.

In terms of biomass, BC leads the nation with 50 percent of the biomass electricity generating capacity. The province has a long history of deriving energy from biomass sources—the province's pulp and paper industry has used its own by-product, "black liquor", as an energy source for many years, and sawmills have burned wood waste to provide heat for kiln drying.

Biomass resources in BC offer meaningful opportunities to create new green energy facilities. They can provide cheaper and more sustainable energy to remote communities, support district energy systems and municipal GHG management plans, create local employment, and expand emerging export markets.

As shown in Figure 4.2, the potential for BC bioenergy production is massive, with the possibility of replacing over half of the fossil fuel used in the province. The GLOBE Foundation's *Endless Energy Project* report assessed BC's biomass resource—that includes biofuels, heat, and electricity—to represent 47 percent of the province's total renewable energy potential.

While BC's forestry industries annually produce well over 2 million tonnes of by-product wood waste and forest residues that can be transformed into energy uses, there is also the potential for using some of the dead standing timber from mountain pine beetle-ravaged forests. With approximately half of the lodgepole pine in the province's timber harvesting land base affected by the beetle—roughly 15 million hectares, equivalent to three times the area of Denmark—this dead wood can be used for various heat and power generating purposes, as well as for a burgeoning wood pellet industry.

It is important to note, however, that while BC's ultimate biomass resource potential is large, the current economics in terms of harvesting and transporting standing timber for electricity production presents a significant barrier to producing bioenergy. While mill and harvest residues lower the cost of bioenergy production, feedstock prices remain the largest variable cost for a bioenergy plant's operations. The cost for biomass relative to conventional and other alternative fuels is therefore key to success in the industry. Assessments are underway to determine the technically recoverable and marketable resource potential—including a study on bio-pathways by the Forestry Products Association of Canada.

In addition to using biomass for energy purposes, green forestry products contribute widely to the green economy in BC. The province's Forestry Innovation Investment (FII) was set up in 2003 to help support, position, and promote BC's environmentally sustainable forestry sector and continues to provide market research and new applications for sustainable forestry products. One interesting cross-industry opportunity includes the use of pre-fabricated wooden building materials from lumber or wood waste in the construction of emergency shelters (see sidebar).

Export opportunities for lumber are growing in overseas markets with more than 30 percent of BC's lumber by volume being shipped to Asia. China is now BC's second largest customer after the US. These immense export opportunities for green building products and services can be levered by means of high-profile demonstration projects to serve as real-life examples in BC of potentially

exportable products and services. By promoting BC's sustainable forestry products to new markets elsewhere, the province can position itself favourably to meet the future demands for low-carbon building products.

Oil & Natural Gas

In order to become more competitive, many companies in the oil and gas sector are actively working to lower their carbon footprints and to adapt to greener operating practices. Important gains are being realized in terms of reduced water use in oil and gas extraction activities, and in lowering the ecological footprint of otherwise damaging operations.

Carbon Capture and Storage (CCS) represents an important area of opportunity in terms of reducing GHG emissions while continuing to provide significant economic benefits from the exploitation of BC's fossil fuels during the transition toward a lower-carbon economy. Technologies for the sequestration of CO₂ have been used for years to enhance oil recovery from difficult to reach or nearly depleted oil reservoirs. New approaches to the sequestration and on-line CO₂ capture processes offer new opportunities for the province's oil and gas sector. While British Columbia is not as dependent as other provinces on fossil fuels to generate electricity, there is great need for the deployment of such technologies in the Peace River district and other areas where oil and gas activity plays a major role in the local economy.

Natural gas in particular can serve as a "bridge fuel" in place of higher emitting fossil fuel alternatives in the movement toward a low-carbon economy. Natural gas is the cleanest of all fossil fuels—it produces less than half as much carbon pollution as coal and a quarter less than gasoline (see Figure 4.3).

With BC's vast conventional and unconventional reserves of up to 1,000 trillion cubic feet of gas-in-place—the Horn River and Nechako Basin areas are examples—natural gas can serve as a low-carbon resource opportunity for both transportation and for export to other economies around the world.

BC companies involved in the manufacturing of natural gas engines and the infrastructure needed to support such a shift in energy use could assist in the development of green transportation corridors throughout the province. The use of natural gas as the preferred fuel for on- and off-road trucking, taxi, urban transit services, and coastal shipping, as well as for district heating systems in commercial and residential settings, has the potential to create many new direct and indirect jobs, as well as to lower GHG emissions.

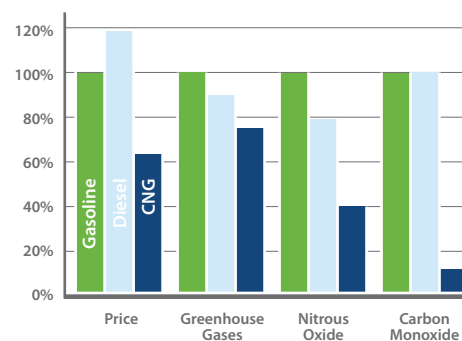
In addition, the export opportunities for natural gas and related technologies are huge. Currently, close to 80 percent of the natural gas produced in the province is exported. With over 9 million natural gas vehicles (NGVs) in use today in over 80 countries, the proposed \$3 billion Kitimat liquid natural gas (LNG) terminal could offer immense export opportunities to growing Asian and global markets.

Mining

Similar gains are being realized in British Columbia's very active mining sector. Mineral producers are working hard to reduce the level of electricity required for lighting, ventilation, and raw material processing, and many have introduced sophisticated energy management systems in this regard.

Figure 4.3

Compressed natural gas (CNG) is the cleanest fossil fuel and costs less than both gasoline and diesel



Cautionary Note: It is important to note that the potential exploitation of BC's vast renewable energy resources and the further development of lower-carbon fossil fuels, while beneficial in terms of greenhouse gas emissions reductions, are not without ecological or environmental risks or impacts.

Public concerns over regulatory issues related to transparency and privatization have been raised in recent years, as evidenced with the development of some of the province's low-carbon run-of-river hydro projects and with respect to exploration activities to find and secure new mineral and gas deposits.

British Columbia is renowned for its natural beauty and equally renowned for the environmental ethic that has spawned a thriving array of clean technology clusters and environmental organizations.

While the transition to a lower-carbon future will not be without social, economic, and ecological risks and challenges, the determination of BC's residents to preserve the environment and their high quality of life serves as a reassuring reminder that we have the capacity to meet the future responsibly.



This sector will be of particular interest in Phase 2 of this project given that current forecasts predict severe shortages of skilled workers—such as geologists, mining engineers, heavy duty equipment mechanics, accountants, surface electricians, metallurgical engineers, millwrights, maintenance supervisors, and mechanical engineers—since these are the skilled workers that are critical to the successful implementation of low-carbon solutions in this sector.

Agriculture & Aquaculture

Most agricultural and aquaculture operations in BC have relatively low (or diffuse) levels of GHG emissions and the adoption of ecologically-sensitive practices in these sectors is well advanced. Farm management practices designed to reduce GHG emissions are well-known to most producers in the province. For example, no-till and low-till practices that increase carbon sequestration in soils have been widely adopted.

Still, opportunities remain to improve practices for emission reduction and to lower dependency on expensive, high-carbon fossil fuels, particularly for small- and medium-sized operations which constitute the bulk of companies in these sectors. To this end, many agriculture and aquaculture operators are looking at innovative waste-to-energy plants, bioenergy systems, more sustainable practices with respect to fertilizer use, and other means to reduce costs and to become more energy efficient.

Initiatives such as the *Environmental Farm Plan* and *Beneficial Management Practice Programs* include climate change components. The 2009/2010 Beneficial Management Practices Program provides an opportunity for BC farmers to receive cost-share funding to adopt practices and/or technologies that reduce or remove GHG emissions.

In all, BC's traditional natural resource sectors will continue to play an important, if not dominant role in the province's low-carbon future. How these natural assets are used to lower emissions and create new jobs and wealth will hinge on the policies and programs put into place to realize the green economy.

5. PROFILE OF BC'S EMERGING GREEN SECTORS

British Columbia has an active green economy, with hundreds of companies throughout the province involved in the development of new green technologies and the implementation of innovative low-carbon practices. As of July 1, 2009, there were 38 green technology companies from BC listed on the Toronto Stock Exchange (TSX) and the TSX Venture Exchange, with a combined market capitalization worth \$1,128 million.²³

This section provides a brief profile of the six key “supply-side” sectors of BC’s green economy (listed in the box below for reference).

Clean & Alternative Energy Sector

Independent power producers (IPPs) are helping to diversify BC’s clean energy mix and are putting the province at the forefront of low-carbon energy generation and green technology development. At present, there are close to 50 operating IPP projects in BC with the potential to generate over 5,000 gigawatt hours (GWh) per year of clean energy—equivalent to nine percent of BC’s annual electricity consumption.²⁴

While IPPs in BC have come under public criticism for the privatization of power production in the province, regionally-based IPP projects are helping **BC Hydro** meet its increasing demand for electricity through low-emission sources while keeping the costs to tax payers low.

In addition, IPPs create employment opportunities for communities province-wide. According to a recent study, BC’s IPP sector could attract \$26 billion in investment over the next decade—which could result in 90,000 person-years of construction employment for BC residents and more than 9,100 full-time jobs to support the operations.²⁵ Many IPP projects also create jobs for First Nations’ communities and help people in remote parts of the province achieve energy self-sufficiency (see Figure 5.1). With increased transparency, regulation, and environmental monitoring, future clean energy projects can be developed with minimal impacts in order to meet all of BC’s incremental electricity needs.

The Clean and Alternative Energy sector is the largest contributor to BC’s green economy in terms of GDP, at nearly \$5 billion, and accounted for more than 21,000 direct FTE jobs in 2008. The sector is divided into three sub-sectors: Renewable Energy; Bioenergy; and Hydrogen and Fuel Cells.

The green economy in BC is divided into six key supply-side sectors, profiled in Section 5:

- Clean & Alternative Energy Sector
- Energy Management & Efficiency Sector
- Green Building Sector
- Environmental Protection Sector
- Carbon Finance & Investment Sector
- Knowledge Sector

Figure 5.1

Environment Minister Barry Penner meets with In-SHUCK-ch First Nation members at a BC run-of-river hydro power project site near Harrison Lake

Source: <http://www.env.gov.bc.ca>



Company Profile 1 Plutonic Power Corp.



Plutonic Power is a clean energy company currently developing a suite of renewable energy projects in British Columbia. The company's flagship project, the 196 MW East Toba and Montrose project, is currently under construction, with operation to begin in 2010. The 144 MW Dokie Wind Project is slated for construction in January 2010, with operation to begin in 2011.

Plutonic's renewable energy projects are a key part of British Columbia's renewable energy development plans and will significantly contribute to BC's current energy needs. Plutonic Power is committed to continuously working with First Nations, stakeholder groups, and local communities in the development of its clean energy projects.

Source: <http://www.plutonic.ca>

Figure 5.2

Clean Current Power's tidal turbine generator at Race Rocks, off Victoria

Source: <http://www.cleancurrent.com>



Renewable Energy

Renewable energy includes power produced from naturally replenished sources, including hydro, wave and tidal forces, wind, solar, and geothermal—all of which are found in abundance in BC.

Hydro

Hydro projects, which vary in size from large to micro in size, present opportunities for low-emission power generation in BC's Development Regions 1, 2, and 6.

Hydro power has long been the main source of electricity in the province, with BC Hydro generating over 93 percent of its electricity from dams, many built in the 1950s through to the 1970s. These projects have provided clean power to BC residents for decades and have allowed electricity rates to remain some of the lowest in North America.

Recently, the BC government has shifted in favour of smaller, more regionally-based hydro power projects throughout the province. Approximately 35 run-of-river projects now operate in BC and about a dozen more are under construction. Key players in this realm include **Run of River Power, Syntaris Power, Synex Energy, EPCOR Utilities, Dependable Turbines,** and **Plutonic Power** (see Company Profile Box 1).

According to a 2005 BC Hydro study, there are more than 900 potential small and micro hydro sites in BC with a potential small hydro capacity in excess of 2,500 MW. However, most of these projects will not proceed due to environmental restrictions and/or a lack of economic feasibility.

Wave & Tidal Energy

Wave and tidal energy is an area with huge future potential in BC. The ICE Fund has allowed **Pacific Coastal Wave Energy** to move forward on a project to generate electricity at a four MW demonstration facility, near the remote community of Ucluelet on Vancouver Island.

Other leading BC companies include **Canoe Pass Tidal Corporation** that is developing the first grid connected tidal project near Campbell River and **Syncwave Systems**, a joint BC – Texas initiative that is testing the first generation of its Power Resonator wave generator near Tofino.

In addition, Canada's first free-stream tidal power project was re-installed at the Race Rocks site, offshore from Victoria in October 2008. The project uses a 65 kW tidal turbine generator developed by North Vancouver's **Clean Current Power Systems**, and converts surrounding ocean currents and tidal energy to electric power (see Figure 5.2). Clean Current Power Systems has also developed and successfully licensed a large scale two MW tidal generator to Alstom with its first deployment scheduled in the Bay of Fundy.

Wind Energy

In terms of wind energy, four areas in BC are undergoing intensive study for the development of wind projects—the North Coast, Vancouver Island, the Peace Region, and the Southern and Eastern Interior. Twenty-five companies are pursuing wind power projects in BC, including **Aeolis, Finavera Renewables, Thunder Mountain Wind, Naikun Wind Energy Group, Sea Breeze Power,** and **AltaGas Income Trust**—who has recently completed and connected the first large-scale wind project in BC with the \$200-million 102 MW Bear Mountain Wind Park in the Southern Peace Region.

Company Profile 2 Day4 Energy Inc.



Founded in 2001 in Burnaby, **Day4 Energy** is Canada's largest designer and supplier of cutting-edge, cost-effective solar electric modules and system solutions, with customers throughout Europe and North America.

In 2008, the company achieved over \$76 million in revenues. With a staff of more than 100—90 based out of the Burnaby facilities—Day4 Energy is quickly becoming a leading supplier of solar power solutions worldwide.

The company was awarded a \$500,000 research grant by Canada's National Research Council (NRC) in 2009 and has recently announced the completion of a 2.4 MW roof-mounted PV power plant for Gunther Heiss Solar GmbH & Co. KG in Germany.

Source: <http://www.day4energy.com>

Solar Power

In the realm of solar power generation, numerous companies in BC, including **Taylor Munro Energy Systems** and **Alpha Technologies**, are involved in installation, project management, customization, and engineering. **Day4 Energy** has successfully developed proprietary solar PV technologies that represent a fundamental change in the way both PV cells and modules are built (see Company Profile Box 2). However, nearly all solar PV panel manufacturing happens abroad since economies of scale are important in this area.

An area that shows particular promise in BC is solar thermal / hot water with SolarBC offering home owner grants for panel installations.

Geothermal Energy

Often referred to as the sleeping giant of the renewable energy sub-sector, geothermal resources in BC have great potential to contribute to the green economy. Although companies such as **Magma Energy** and **Ram Power** (formed through the recent business combination of **Western GeoPower** and **Polaris Geothermal**) have yet to develop viable commercial projects in BC, they have been widely successful on the international stage.

Bioenergy

The bioenergy sub-sector accounts for the highest number of companies (over 200) in the Clean and Alternative Energy sector, with clusters dispersed throughout all of the Development Regions.

Over the last few decades, BC has developed world class bioenergy technologies, which currently supply 67 percent of the forest industry's energy requirements. More recent technological innovations have greatly widened the scope for the use of biofuels, biomass, and waste-to-energy systems for electricity and heating, creating additional jobs in communities that have suffered in recent years.

British Columbia has significant capacity in wood pellet production with more than ten plants active in pellet production. Companies, such as **Pacific Bio-Energy** and **Pinnacle Pellet**, are demonstrating key linkages that can be expanded for the province.

In 2010, BC is expected to produce 3 million tonnes of wood pellets.²⁶ While local wood pellet companies are in advanced stages of commercialization, over 90 percent of BC wood pellets are currently exported, primarily to Europe and Asia for district heating and energy purposes.²⁷

In addition to wood pellets, BC's biodiesel production could reach 125 million litres per year if all potential sources of feedstock were used. This includes, for example, an industrial supply chain that originates from equipment involved in the culturing and harvesting of marine algae oil for biodiesel.

A catalyst for biofuel production in BC is public policy, including the *BC Bioenergy Strategy*, which is aiming for 50 percent or more of BC renewable fuel requirements to be met by BC biofuel production by 2020. The *BioFleet Program* encourages and supports the use of biodiesel fuel in vehicle fleets across the province.

In addition, the *Ethanol BC Program* is funding research to convert wood, including beetle-killed trees and other wood residues, into ethanol and other value-added products. **Lignol Energy**, which specializes in non-food cellulosic biomass feedstock production, recently completed the first end-to-end production of cellulosic ethanol from its industrial-scale biorefinery pilot plant in Burnaby, thanks in part to BC's *ICE Fund* (see Company Profile Box 3).

Nexterra Energy has installed direct-fired boiler biomass gasification systems throughout the province, as well as internationally, and estimates an addressable \$3 billion market of more than 500 facilities in North America alone (see Company Profile Box 4).



Established in 1964, **Lignol Energy** is a Vancouver-based company specializing in the conversion of wood and biomass feedstock to fuel-grade ethanol and biochemicals through the construction of biorefineries.

The company, now in its second phase of operations with more than 30 full-time employees, has been awarded \$4.7 million in funding from SDTC and \$1.2 million from the BC Bioenergy Network to continue its work. The company also received \$30 million from the US Department of Energy to build an \$88-million cellulosic ethanol plant in Colorado.

Source: <http://www.lignol.ca>



Vancouver-based, **Nexterra Systems Corp.** is a leading developer and supplier of biomass gasification solutions which enable industrial and institutional customers to generate renewable heat and power from low cost biomass fuels.

Founded in 2003, and now with a staff of 55, Nexterra's sales to date include projects at the University of South Carolina, Dockside Green, the US Department of Energy's Oak Ridge National Lab, Kruger Products, and Tolko Industries.

To expand their product deployment, Nexterra has established strategic relationships with several key parties including GE Energy, Johnson Controls Inc., and Andritz Separation.

Source: <http://www.nexterra.ca>



Catalyst Power uses anaerobic digestion for agricultural purposes, **Richway Environmental Technologies** uses municipal solid waste to produce energy through combustion, and **Paradigm Environmental Technologies** has a waste water treatment facility that produces electricity from waste water sludge. Others still like **Maxim Power** are recovering decomposition gases from landfills to produce both power and heat.

BC is well positioned for the medium- to long-term with some experts hoping to make BC the Silicon Valley of the bioenergy world.

Hydrogen & Fuel Cells

Over the last 30 years, the BC Lower Mainland (DR 2) has become a regional cluster for the design, development, and manufacturing of hydrogen and fuel cell technologies. Investments in the province represent 75 percent of Canadian fuel cell and hydrogen-based research and development expenditures.²⁸ Industry has invested over \$100 million a year over the last seven years on hydrogen research, development, and demonstration.

Upwards of 35 organizations, employing 1,200 people are involved in the design and manufacturing of fuel cells, which range from fuel cells that power buses and fork-lifts, to micro fuel cells that power laptops and cell phones. BC's expertise in developing solutions for medium- to longer-term markets, such as the automotive market, is considered world leading.

One of BC's fuel cell industry leaders is the **Automotive Fuel Cell Corporation (AFCC)**, a joint venture between Daimler, Ford Motor Company, and Ballard Power Systems. The AFCC represents an important step towards commercially viable vehicles using hydrogen fuel cells, having powered more than 150 zero-emission vehicles to date. Other BC companies include **Ballard Power Systems** (see Company Profile Box 5), **Angstrom Power**, and **Sacre-Davey Innovations**.

BC's *Hydrogen and Fuel Cell Strategy* envisions the province as the world's pre-eminent hydrogen economy by 2020. As part of a key demonstration project named the 'Hydrogen Highway' and targeted for full operation by 2010, **Powertech Labs** (BC Hydro's research arm) established the world's first fast-fill, high-pressure hydrogen fuelling station (see Figure 5.3). To help in the successful implementation of the *Hydrogen Highway Project*, a federal-provincial partnership will be investing \$89 million for additional fuelling stations and the world's first fleet of 20 fuel cell buses.

In addition, the *Vancouver Fuel Cell Vehicle Program (VFCVP)* is testing five Ford Focus fuel cell electric vehicles as well as hydrogen re-fuelling systems. The VFCVP is a three year \$8.7 million joint initiative between the Government of Canada, Canadian Hydrogen and Fuel Cell Association, Ford Motor Company, and the Province of British Columbia. The Ford Focus is a third-generation hybrid-electric vehicle that uses Canadian-made Mark 902 series fuel cell engines by Ballard Power.²⁹

While the supply chain is not as extensive as in the bioenergy sub-sector, multiple peripheral companies operate and provide such products as testing equipment and cooling systems. A large research base also exists within this sub-sector that includes the National Research Council's Institute for Fuel Cell Innovation, as well as several university centres for excellence like the Clean Energy Centre at the University of British Columbia (UBC). Success in this sub-sector can be attributed to strong partnerships between industry, governments, and academia.

Energy Management & Efficiency Sector

The Energy Management and Efficiency sector includes approximately 24,800 direct FTE jobs in BC and generated more than \$1.2 billion in GDP in 2008. The sector includes some of the largest areas of opportunity for developing green technologies used to reduce GHG emissions in BC—especially

Figure 5.3
Powertech's fast-fill, high-pressure hydrogen fuelling station

Source: <http://www.powertechlabs.com>



in the areas of transportation and the built environment. In addition, this sector will play a key role in helping BC Hydro meet its goal of having 75 percent of the province's incremental power needs met through conservation by 2020.

The sector is divided into four sub-sectors: Energy Management and Power Electronics; Energy Saving Lighting and Heating, Ventilating, and Air Conditioning (HVAC); Advanced Batteries, Energy Storage, and Charging Systems; and Engines, Power Saving Automotive Equipment, and Hybrid Technologies.

Energy Management & Power Electronics

Concentrated in the Lower Mainland, the energy management and power electronics sub-sector is perhaps the most commercially advanced energy technology-based sub-sector, estimated to be generating well over \$600 million in annual revenues.³⁰ Companies such as **Xantrex Technology, SmartCool Systems, Delta Controls, Legend Power Systems, Power Measurement, NxtPhase T&D, and Tantalus Systems** (see Company Profile Box 6) are leaders in their field.

The outlook for this sub-sector, that includes transmission and smart grid hardware and technologies, as well as metering, testing, and control systems, is exceptionally strong as distributed and networked energy providers look to reduce energy consumption and stabilize the power supplied by renewable sources (for both on- and off-grid systems).

Rising energy costs are driving the demand for energy management technologies that include controls and smart meters. As residential, commercial, industrial, and utility customers become more energy aware and efficient, this sub-sector will continue to grow. There is also a potentially lucrative global export market that is extremely diverse in terms of industrial applications. BC is perfectly positioned to tap into this opportunity area.

This sub-sector also allows for immense opportunities for cross-industry collaboration and supply chain development with the implementation of increased and varied renewable energy projects.

Energy Saving Lighting & HVAC

Cluster concentrations exist in BC in the areas of lighting as well as heating, ventilating, and air conditioning (HVAC) systems design, with a focus on industrial, commercial, and residential customers. This sub-sector has strong linkages to the Green Building sector.

BC companies such as Vancouver's **Sempa Power Systems** and Victoria's **Carmanah Technologies** (see Company Profile Box 7), are actively involved in serving niches in both the domestic and the international marketplace.

As existing property retrofits grow and new green building developments emerge, the supply chain of energy saving lighting and HVAC systems could be customized and integrated more or less immediately. This would also tie in with the energy management sub-sector to include control, metering, and testing products.

In addition, established companies, such as **Exchangenergy**, are involved in the design and management of geothermal exchange systems for building and residential purposes. Huge potential exists as companies involved in contracting for heating and cooling become involved in retro-fit operations that include geothermal applications. The Canadian GeoExchange Coalition and the Residential Industry Training Organization have recently developed programs for specific geothermal skill sets that could benefit traditional trades people, including plumbers for example.

This sub-sector has immense opportunities for high growth involving industry and public research collaboration with the possibility for integrating these energy-saving technologies into public,



Photo: Scott McAlpine

Tantalus provides data communications networks for smart grid applications, including advanced metering, demand response, and distribution automation. TUNet (Tantalus Utility Network), deployed at utilities across North America, is a single platform for a rapid and reliable two-way exchange of information that enables electric, water, and gas utilities to automate processes, reduce costs, improve business operations, and deliver top-tier customer service and conservation programs.

In 2009, Tantalus was recognized by Deloitte as one of Canada's top 15 Green Technology firms. The company is also involved in BCIT's intelligent microgrid project, helped in part by the ICE Fund.

Source: <http://www.tantalus.com>



Based in Victoria, **Carmanah Technologies** is a leader in solar LED lighting innovation and performance, and the leader in industrial solar roof-top grid-tie solutions in Canada. Established in 1996, Carmanah has thousands of clients worldwide—resulting in over US \$30 million in revenues in 2009—and a global staff of more than 100.

Carmanah sets the standard and breaks the boundaries of the solar power lighting industry. Notable clients include the Canadian Coast Guard, NATO, Lockheed-Martin, the US Military, airfields and waterways around the world, and a number of cities in California.

Source: <http://www.carmanah.com>



Burnaby-based **Delta-Q Technologies** develops and markets high-efficiency, integrated power conversion and power management products—including AC-DC battery chargers and DC-DC converters—for OEMs of electric and hybrid drive vehicles. Their products significantly improve the performance of today's electric drive vehicles, delivering lower system costs for OEMs and lower operating costs for users.

Founded in 1999, Delta-Q's engineering team consists of experienced power electronics, software, regulatory compliance, quality and mechanical engineers, and technologists. The company's solid core of expertise is one of the reasons that Delta-Q was awarded BC Technology Industry Association's "Emerging Company of the Year" in 2006.

Source: <http://www.delta-q.com>

residential, and commercial structures. District heating systems, so common in Europe, could reduce energy consumption and provide opportunities for fuel switching from natural gas to biomass feedstock and other waste-to-energy options.

From a public sector perspective, energy saving solar lighting technologies serve extremely diverse uses from marine navigation, to traffic signals, to outdoor lighting. Continuing to promote the adoption of these technologies through demonstration projects will encourage export sales and cluster development in the sub-sector, while improving power consumption throughout the province.

Advanced Batteries, Energy Storage & Charging Systems

With over 30 years in advanced battery development, British Columbia has a solid core of expertise in the production and commercialization of technologies in this area. Considerable work continues in both battery chemistry and materials, as well as in packaging and systems control. This sub-sector is becoming an increasingly important player as energy storage, in combination with the renewable energy sub-sector, becomes central in storing power during peak production times and supplying electricity during lulls.

While the sector continues to focus on research and development for greater energy storage capabilities, various projects have been deployed around the Lower Mainland in the area of transportation. **E-One Moli Energy** is using its battery technology in electric scooters and bikes, while **Delta-Q's** chargers and converters are being used in various electric and hybrid cars (see Company Profile Box 8). In addition, Richmond-based **Cadex Electronics** is focused on providing a complete line of advanced battery test and service products.

Engines, Power Saving Automotive Equipment & Hybrid Technologies

An agglomeration in low-carbon technology research and development for fuel cells and re-fuelling infrastructure has led to the consolidation of companies involved with energy-efficient engines, vehicle production, and power saving automotive equipment.

Strong BC-based companies are involved in research, development, and marketing of engines and fuel systems that use compressed natural gas (CNG), liquefied natural gas (LNG), and hydrogen-enriched compressed natural gas fuels. One leading example is **Westport Innovations** (see Company Profile Box 9). Other top BC companies in this area include **Azure Dynamic**, **Dynasty Electric Car**, and **Technocarb Equipment**.

This sub-sector continues to present immense opportunities for proto-type integration with corporate vehicle and public transport fleets. The BC government has set a great example. Since 2005, the provincial government has tripled the size of its hybrid fleet and since 2007, all new cars purchased or leased by the BC government must be hybrid vehicles. In addition, BC Hydro, the Province of British Columbia, and the City of Vancouver have signed an agreement with **Mitsubishi Canada**, allowing them to demonstrate three of North America's first production-ready, highway-capable pure electric cars, known as the Mitsubishi i MiEV.

To support this sub-sector, a supply/value chain has developed that includes companies that design and manufacture the infrastructure needed to power these vehicles. One example is **IMW Industries**—named BC's exporter of the year in 2009—that makes CNG fuelling systems for vehicles and industrial applications.

The need for reducing BC's emissions from the transportation sector in context with greening Canada's Pacific Gateway provides additional opportunities for integrating new engine and power-saving technologies used for the transport of goods.



Westport Innovations is a leading developer of automotive engines and fuel systems that use natural gas, biomethane, and hydrogen. As such, the company and its joint ventures has sold over 25,000 engines in 25 countries, helping municipal and commercial fleets of buses and trucks transition from diesel to natural gas.

The 200-employee, Vancouver-based company was founded in 1995 following a spin-off from a UBC research project. Strong partnerships with companies like Cummins, PACCAR, Volvo, and Weichai Power have allowed Westport to develop a wide market base, with over \$121 million in revenues in 2009.

Source: <http://www.westport.com>

Green Building Sector

The green building sector crosses multiple industries and includes everything from architecture and engineering, to community design and urban planning, to construction and green building material supply, to property management and real estate (see Figure 5.4). This extensive value chain contributes enormously to the provincial economy in terms of both GDP and jobs—equivalent to \$1.5 billion in GDP and approximately 21,000 direct FTE jobs.

In recent years, an Integrated Design Process (IDP) has developed where architects, engineers, contractors, and other stakeholders work together during the planning phase to create synergies and to identify creative solutions. This revolutionary approach has had very positive results in energy and cost savings.

BC has become a hub for green building and community design, with internationally-recognized projects like Victoria's Dockside Green, considered one of North America's most sustainable mixed-use residential communities. In addition to the technology-based research, development, and commercialization activities related to green building, BC has a deep reservoir of individuals and organizations skilled in energy-efficient design, engineering and architecture, trades training, as well as in policy development and planning focused on lowering the energy intensity of human activities.

In addition, a large support network has developed within the province that is dedicated to expanding consumer, producer, and investor knowledge about the opportunities and trends associated with sustainable building design. Organizations include the Construction and Residential Construction Industry Training Organizations, the Canadian Home Builders Association, the Cascadia Region Green Building Council, the Canadian Green Building Council, the Light House Sustainable Building Centre, the Urban Development Institute – Pacific Region, City Green, the EcoSmart Foundation, and the International Centre for Sustainable Cities.

Currently in BC, there are more than 1,260 LEED Accredited Professionals, certified by the Canadian Green Building Council, with over one-quarter (28 percent) of all LEED certified projects in Canada found in BC (see Figure 5.5).³¹ In addition, there are 83 companies offering the *Built Green Program* and over 2,400 homes enrolled in the program in BC (see Figure 5.6).³²

The number of education and training programs involved in BC's Green Building sector has grown from a total of 14 in 2006 to over 40 in 2009, offering a variety of part-time, technical, and vocational programs.³³ Examples include BC Institute of Technology's (BCIT) courses in Architectural and Building Engineering and Light House's Green Construction Training Program.

Figure 5.4

The comprehensive value chain that operates within BC's Green Building Sector

Source: Lighthouse Sustainable Building Centre Report, 2007

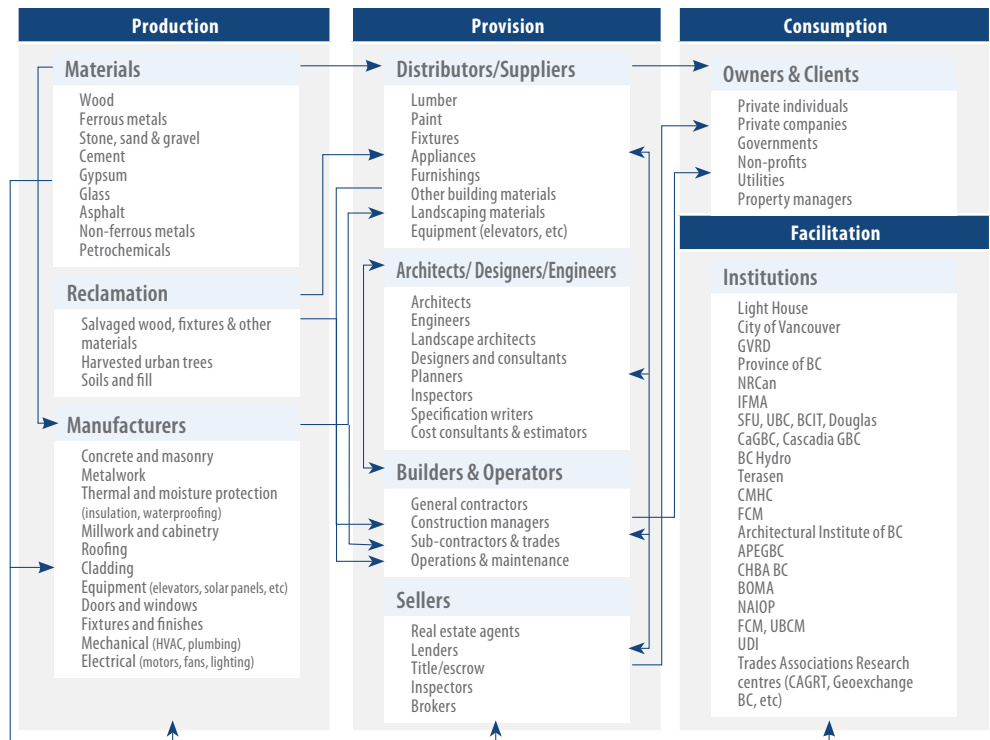


Figure 5.5

BC accounts for 28 percent of all LEED-certified projects in Canada

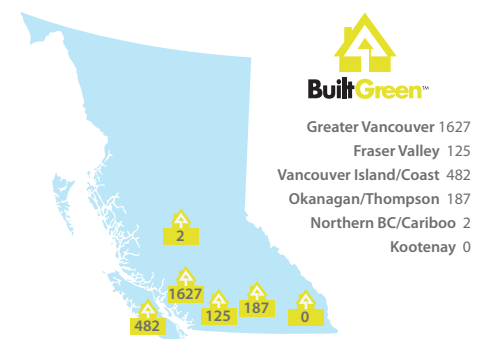
Source: CaGBC Website, 2009

LEED Certification	Total in BC	Total in Canada	% of Canadian Projects in BC
Certified	7	36	19%
Silver	26	58	28%
Gold	21	62	34%
Platinum	2	10	20%
Total	46	166	28%

Figure 5.6

BC has over 2,400 homes enrolled in the Canadian Home Builder's Association Built Green Program

Source: Built Green™ BC, September 2009





**BUSBY
PERKINS
+ WILL**

Established in 1984 in Vancouver, **Busby Perkins + Will** is an integrated architecture, interiors, and planning firm recognized for its leadership in architectural excellence and sustainable design.

With more than \$17 million in architectural fees in 2009 and a staff of over 80 in Vancouver, Busby Perkins + Will is considered one of North America's leading green design firms with the largest portfolio of Built Green projects in Canada, including Dockside Green, the highest scoring LEED Platinum project in the world.

The firm also researches, educates, and is heavily involved in the development of public policy and sustainability guidelines.

Source: <http://www.busbyperkinswill.ca>

Historically, the built environment has been responsible for a significant percentage of the energy consumed (and the GHG emissions produced) in the province. While new building designs are reducing energy consumption, some of the biggest opportunities for lowering GHG emissions lie in BC's existing building stock. Considered "low-hanging fruit", energy audits and building retrofits can help conserve power, increase efficiency, and save money.

BC's Green Building sector is divided into three sub-sectors: Architecture, Community Design, and Green Infrastructure; Sustainable Construction and Building Materials; and Sustainable Development, Property Management, and Real Estate.

Architecture, Community Design & Green Infrastructure

Concepts that incorporate new energy-efficient technologies and design features like green roofs, natural lighting, heating, and ventilation, as well as landscaping, are expected to become the norm as municipal building codes are greened.

Major architectural firms in BC have been actively incorporating green building practices into their core competencies. Of the top 25 firms listed in Business in Vancouver's 2009 *Book of Lists*, 15 were engaged in green building design services. These companies employed 910 LEED-certified staff and billed for over \$97 million in architectural fees in 2007. They include **Bing Thom Architects, Bunting Coady Architects, Omicron, Stantec, and Busby, Perkins + Will** (see Company Profile Box 10).

BC is also a centre for innovative green design with a number of large community developments that incorporate sustainable planning, design, and resource-efficient technologies. The 2010 Winter Olympics has been successful at showcasing green projects in the Lower Mainland and as a result, BC has more LEED projects than any other province in Canada. One example is the Millennium Water development, which will temporarily serve as the Athlete's Village in Vancouver during the Games (see Figure 5.7).

Green infrastructure projects are also an important component to sustainable development. In September 2009, the federal government announced that \$130 million would be made available, under its \$1 billion *Green Infrastructure Fund*, to help finance the proposed *Northwest Transmission Line* (NTL), a 335 kilometre high-voltage transmission line that will extend the grid into the northwest portion of the province. The transmission line will benefit remote communities by providing them with the potential to access clean electricity and reduce their reliance on diesel generators.

Also, in February 2009, the federal government announced its *Evergreen Line* project as part of the *ecoTransport Initiative*. The project involves installing a new 11-kilometre rapid transit line in the Lower Mainland that's expected to create more than 8,000 direct and indirect jobs during construction, as well as new economic opportunities and improved quality of life in Metro Vancouver. While the project is important for helping to reduce emissions by increasing public transit options, it is currently on hold until additional public and/or private funding can be sourced.

Figure 5.7
Millennium Water, serving as the 2010 Winter Games Athlete's Village, is one of Canada's first LEED-Gold certified mixed-use residential communities

Source: <http://www.millenniumwater.com>



Construction & Building Materials

While the construction industry in BC was hit hard by the economic slowdown in 2009, with more than 30,000 jobs lost, the green construction industry continues to see growth in the number of contractors and industry professionals making the shift to educate themselves and their staff on new sustainable building practices. With the slowdown of new construction, LEED has developed a new rating system that focuses on existing buildings, encouraging property owners and managers to work with the construction sub-sector to improve building operations and increase energy efficiency through retrofits.

In addition, BC's new green building code (see sidebar) is providing an opportunity for the province's construction sector to gain a competitive advantage in North America as it develops a foundation of knowledge in emerging green building trends and techniques. Companies including **Sun Rivers Construction**, **SupErb Construction**, and **Cittá Group** are leading the province with their *Built Green™* project portfolios.

BC's new six-storey wood frame regulation—while not at the level of Berlin, Germany and London, England, which allow eight and nine stories respectively—should also provide a much needed boost for the province's struggling forestry sector. While Austria and Germany currently use wood in up to 80 percent of their home construction, BC uses around 15 percent. This suggests there is tremendous potential associated with increased applications for wood in construction due to the low GHG emissions associated with its production.

New building materials are also helping BC's green forestry sector. Product innovations using pine beetle-killed trees or other reclaimed wood products are possible, including wood fibre insulation—like that used in Germany's low-energy *PassivHaus* building technique—as well as for eco-friendly doors and window frames.

Both provincial and federal funds have invested more than \$400,000 into research in Prince George – Peace River to investigate training and commercialization opportunities for Mountain Pine Beetle Wood Concrete Product (MPBWCP). This environmentally-friendly product provides a significant value-added alternative to pulp, and is a unique and attractive alternative building product.³⁴ Additional funding from the *Mountain Pine Beetle* program is helping the University of Northern BC (UNBC) reach the commercialization stage for the MPBWCP. Once the product is ready for commercialization, possibilities to incorporate it into residential and commercial building practices exist.

Sustainable Development, Property Management & Real Estate

While still very much a niche area, sustainable development and real estate are expected to grow substantially in coming years as BC builds and markets new eco-conscious developments.

Leading development companies include **Concert Properties**, **Windmill Development Group**, **Adera**, **Century Group**, **Turner Lane Development**, and **Wesgroup**.

In addition, new design features and energy efficient technologies will require property managers to have experience in low-emission building maintenance and energy management. BC Hydro's unique *Energy Manager Program* is set up to do just this, because even with the latest technologies implemented, buildings are only efficient if managed properly.

The BC Green Building Code



The Province of British Columbia has recently taken steps to green the BC building code, one of only a few provinces to do to date. The revised code focuses first on water and energy efficiency—two areas where immediate measurable improvements can be made. The next areas of improvement include grey water recycling, the use of lighting sensors, and the reuse of existing buildings.

The Ministry of Housing and Social Development mandated in September 2008 that single-family, multi-family, and smaller commercial buildings have more energy-efficient insulation or achieve an EnerGuide rating of 77. This will increase to a rating of 80 in 2010.

Larger buildings must meet the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) 90.1(2004) standard—an internationally recognized standard for energy efficiency in buildings.

Incorporating district heating, community design features, and green technologies into future building codes provides an opportunity for economic development through the promotion of BC companies involved in the green economy while increasing energy efficiency within communities.



Vancouver-based **BioteQ** is a water treatment company that applies green technologies to treat wastewater contaminated with dissolved heavy metals and sulphate, producing saleable by-products and clean water that can be discharged safely into the environment.

The company, founded in 1998, has since been named one of Canada's Top 50 Most Socially Responsible Corporations. In 2008 alone, BioteQ treated close to 10 billion litres of wastewater, and removed close to 3 million pounds of metal contaminants from the environment. Clients include international resource firms in Canada, the US, China, Australia, and Mexico, as well as the US Environmental Protection Agency (EPA).

Source: <http://www.bioteq.ca>

Environmental Protection Sector

British Columbia has a robust and diverse Environmental Protection sector providing a wide range of goods and services to measure, prevent, limit, minimize, or correct environmental damage to water, air, and soil, as well as problems with waste. This sector in BC generated over \$2.3 billion in GDP in 2008 and is the province's largest green job generator, responsible for more than 32,700 direct FTE jobs.

This export-oriented sector consists of two distinct but interdependent areas: a predominantly high-technology component comprised mainly of small firms producing environmental goods in growing and evolving industry niche markets; and an environmental consulting, engineering, research and development (R&D), and related services component.

BC companies that are making significant inroads in the national and international marketplace for environmental goods and services include **Aquaguard**, **BI PureWater**, and **BioteQ Environmental Technologies** (see Company Profile Box 11) in the area of water management; **Sybertech Waste Reduction** and **Machinex Recycling Services** in the areas of waste and recycling; **ARA Safety** and **Aqua-Guard Spill Response** in terms of emergency response services; and **NxtGen Emission Controls**, providing integrated particulate and NOx reduction technologies for diesel and gasoline engine manufacturers.

Many leading environmental protection, consulting, and engineering companies in BC are branch offices of national or international corporations – for example, **Worley Parsons**, **Golder Associates**, **Hazco**, **AMEC**, **Quantum Environmental Group**, and **Newalta**. In the case of Golder Associates, the company started out as small Canadian operation that has expanded into a world-wide leader in the global environmental marketplace. **Hemmera**, which originated in BC, now offers services throughout Western Canada (see Company Profile Box 12).

With close to 9,000 contaminated sites in BC, companies in this sector play an important role in BC's green economy. Current estimates put the number of "brownfields"—defined as abandoned, vacant, derelict, or underutilized commercial or industrial properties where past actions have resulted in contamination and where there is an active potential for redevelopment—at between 4,000 and 6,000, including urban, rural, and waterfront locations across the province. The Selkirk Waterfront in Victoria and Pacific Place in Vancouver are two examples. As new eco-density strategies are developed across the province, the clean-up and re-development of these sites will be essential, helped in part by the province's \$10 million *Brownfield Renewal Funding Program*.

Another aspect of the Environmental Protection sector involves the protection of air from pollutants, including CO₂. Forest and agricultural lands, when managed properly, will act as carbon sinks and sequester or store CO₂. When practiced in a sustainable fashion, forestry and farming—including silviculture regeneration and soil management practices—are helping to reduce GHG emissions through carbon sequestration.

Until the world has shifted away from its dependence on fossil fuels, carbon capture and storage (CCS)—once the technology has been proven commercially viable—will be important, especially for BC regions involved in oil and gas extraction (natural gas in particular). A Memorandum of Understanding on CCS has been signed between BC, Alberta, and Saskatchewan to strengthen internal trade, innovation, and international marketing efforts. So far in BC, a \$12-million exploratory CCS project is underway near Fort Nelson as a partnership between the



Hemmera is an established environmental services firm that is recognized for its strong client focus, diverse expertise, and technical excellence. The company provides climate change and sustainability planning services for a variety of sectors, and environmental planning for renewable energy projects.

Hemmera has been involved in the renewable energy sector from the beginning, with broad experience that includes geoechange, solar, wind, tidal, wave, and run-of-river. Hemmera's expertise is recognized as some of the best in the industry and the strength of its team has made them the firm of choice for some of the highest-profile environmental projects in Western Canada.

Hemmera is headquartered in Vancouver and has over 130 staff members.

Source: <http://www.hemmera.com>

provincial government and **Spectra Energy**. If proven viable, the project has the potential to capture in the range of one million tonnes of annual CO₂ emissions from the natural gas plant and store them in two kilometre deep saline reservoirs—which would be the equivalent of taking 250,000 cars off the road every year.

While the environmental protection sector in BC remains small on a global scale, it has the capability to compete in the international environmental marketplace. The experience of a number of BC green technology and service firms shows that small companies can become larger and often world leaders in their niches with the right combination of technology, financing, and market development support.

Carbon Finance & Investment Sector

The Carbon Finance and Investment sector, sometimes considered part of the Knowledge sector, is discussed as an independent sector in this report because of the increasingly important role it is playing in the global green economy. However this sector is still relatively small in terms of GDP and jobs in the province.

Carbon Finance & Offsets

Carbon finance (which includes carbon management and carbon markets) is a growing industry as the world begins to regulate and market carbon as a commodity. By placing a price on carbon—whether through a carbon tax or by means of a cap-and-trade market mechanism—the entire infrastructure of commodity trading comes into play.

British Columbia has the financial institutions in place to put into effect a vibrant carbon trading regime. This is partly due to the province taking an essential first step toward effective carbon management and becoming the first jurisdiction in North America to place a broad-based tax on carbon.

BC is also a leading participant in the *Western Climate Initiative*, a carbon trading regime that is set to become operative either within the context of a North American carbon trading regime, or as part of a Canadian regime in partnership with other schemes starting in 2012.

In addition, the BC Climate Action Plan provides opportunities for businesses to purchase carbon credits, generated by GHG reduction projects, to cancel out their own carbon emissions. The **Pacific Carbon Trust**, a Crown corporation designed to facilitate the carbon offset aspect of its *Green Economy Initiative*, was created to serve the needs of BC government ministries, all of which will be required to offset their carbon emissions starting in 2010 under the *Greenhouse Gas Reduction Targets Act*. The Trust will purchase carbon credits from private suppliers and then sell them to government ministries and businesses allowing these public and private entities to become carbon neutral.

A number of companies in the province, including **Carbon Friendly Solutions** and **Offsetters** (see Company Profile Box 13), play key roles in aggregating offsets and helping other companies develop GHG reducing projects for carbon offset purposes.

An example of a carbon offset supplier is **Lafarge Cement**, a company considered to be one of BC's biggest GHG emitters. Lafarge has been able to reduce emissions by selling carbon offsets that it generated by switching from high-emission coal used in cement production to biomass. The sale of the carbon offsets helped to fund the cost of making the switch and reduce the risks involved with introducing an alternative fuel.



The 2010 Winter Games in BC will be the first “carbon neutral” Olympics in history. A total of 300,000 tonnes of direct and indirect CO₂ emissions caused by activities surrounding the Games will be offset through investments in verified emission reduction projects that involve adopting low-carbon technology and improving energy efficiency.

Some of the proposed offset projects include fuel cell development for transit buses, energy efficiency systems, as well as biomass gasification and hydrogen fuelling stations to reduce industrial use of gasoline and electricity.

All projects in the 2010 portfolio are high-quality offsets consistent with the standards applied by BC provincial greenhouse gas regulations, and have been designed to meet or exceed the highest international standards for carbon accounting and offsetting.

Company Profile 13 Offsetters

Offsetters, founded in 2005, is Canada's first and leading carbon management provider. Offsetters helps individuals and companies understand, reduce, track, and offset their climate impact. Headquartered in Vancouver, Offsetters is the first ever Official Supplier of Carbon Offsets to an Olympic Games and will be providing the Vancouver Organizing Committee for the 2010 Olympic and Paralympic Winter Games (VANOC) with carbon credits sourced from clean technologies developed in BC's Lower Mainland. In 2009, Offsetters was also selected by the Pacific Carbon Trust as the largest initial supplier of carbon offsets to the BC Crown Corporation.

Source: <http://www.offsetters.ca>



Chrysalix Energy Venture Capital is a medium-sized private venture capital firm that was founded in 2001 in Vancouver, BC to invest and support “game changing clean technology companies.”

The company is one of the top five clean technology venture capital firms in the world, and with over 100 years of collective experience in the energy industry and venture capital business, the team at Chrysalix can innately anticipate success.

Its portfolio includes more than 25 companies, including fellow BC companies Day4Energy, LightBasedTechnologies, Angstrom Power, Exro, and General Fusion, as well as EnerWorks and Cyrium from Ontario, Bridgelux, Hydropoint, Brammo, and others from the US, and Epyon from the Netherlands.

Source: <http://www.chrysalix.com>

There are also other opportunities for using carbon offsets to drive the new green economy. Companies in the forestry, mining, oil and gas, manufacturing, water management, and agriculture/aquaculture sectors can look to reduce their emissions through carbon offsets, allowing them to become more competitive and develop more sustainable business models.

As BC’s public sector, communities, and businesses strive to become carbon neutral over the next few years, the importance of offsets in BC will increase dramatically providing increased opportunities for BC companies that provide low-carbon technologies and solutions to prosper.

Investment & Venture Capital

As to investment promotion, Canada in general and BC in particular offer attractive investment climates—including tax benefits and other incentives related to the green economy.

From 1999 to February 2007, VC deals for the alternative energy and environmental technology sectors in BC amounted to \$360 million, or 12 percent of total VC disbursements for the province for this period. This figure does not include angel or private equity investors that are not registered as a VC company.

Several VC firms are specifically involved in investments related to BC’s green economy. **Chrysalix Energy Venture Capital**, for example, manages funds that finance early-stage clean energy technologies through strategic partnerships with investors (see Company Profile Box 14). The partnerships also help with knowledge sharing, portfolio development, and to increase opportunities and connections. **Yaletown Venture Partners** specializes in early-stage VC investment in clean-tech and IT companies (see Company Profile Box 15). In addition, banks like **Vancity Capital** are adopting policies that encourage investments in green technologies, projects, and businesses.



Yaletown Venture Partners was founded in 2001 and is headquartered in Vancouver. Yaletown is an early-stage, venture capital investor focused on IT and clean technology investments in Western Canada and the US Pacific Northwest. Current BC-based clean technology portfolio companies include NxtGen Emission Controls, Redlen Technologies, and CoolEdge Lighting.

Yaletown currently manages \$150 million in two private venture capital funds. Yaletown is backed by leading institutional and private investors in Canada and the United States, and by a network of successful technology entrepreneurs, executives, and angel investors. Yaletown is actively making new investments from its current fund, Yaletown Ventures II.

Source: <http://www.yaletown.com>

The provincial government is also active through its \$90 million *BC Renaissance Capital Fund*. With a partial focus on green technology development, the aim of this initiative is to stimulate both the quantity and quality of VC under management in the BC market, to help develop world-class anchor companies, and to continue building on the province’s culture of innovation.

One distinctive asset for BC is Vancouver’s inclusion as an *International Financial Centre* (IFC), which provides for certain exemptions from taxation for specified international financial and related transactions. Exemption from BC income tax is available through the IFC program for eligible international business activities from a location in BC for up to 100 percent of BC corporate income taxes. “Green patents” are eligible to receive a refund of up to 75 percent of BC corporate income taxes paid. Qualifying green patents include areas related to wastewater treatment, fuel cell technology, and power generation using the forces of nature, such as wind, solar, and tidal.

There are several ways to stimulate investment in green technologies and services. They include expanding the eligible patents to include biomass related areas (including gasification, anaerobic digestion, pyrolysis, wood pelletization, biofuels); incorporating carbon accounting, carbon pricing, and consultation for environmental services as qualifying activities; and providing specialist exemptions for carbon traders to encourage them to transfer to BC.

In addition, the Scientific Research and Experimental Development (SR&ED) program is a federal tax incentive program designed to encourage research and development in Canada. Qualifying non-Canadian companies are eligible to receive tax credits of 20 percent of qualified expenditures.

Knowledge Sector

BC has a well-developed “green” Knowledge sector, with a variety of expertise in the areas of education and training, research and development, information and communications technology, and accounting and law. While making up approximately 9 percent of BC’s green economy—contributing \$1 billion to provincial GDP in 2008 and responsible for 16,000 direct FTE jobs—the importance of these supporting services will increase with the transition to a greener economy, and in many ways, the following sub-sectors are helping to facilitate the shift.

Education & Training

British Columbia’s universities and colleges provide education and training in all areas of the green economy with specific programs designed to facilitate the transition of core sustainability concepts into the workplace. BC’s university and educational clusters, with Faculties of Science, Applied Science, Engineering, Forestry, Land and Food Systems, and Arts and Social Science (to name a few), provide a variety of programs from the certificate level through to doctorate degrees (see Figure 5.8).

The province’s \$56.25 million *Leading Edge Endowment Fund* has created 29 permanent endowed chairs at BC universities and colleges in areas that include the environment and technology. These positions include 20 permanent Leadership Research Chairs aimed at attracting top talent, and nine Regional Innovation Chairs to spur technology transfer at smaller institutions.

The provincial government is also working closely with industry associations, training authorities, and educational institutions to develop adequate courses, certifications, and programs for emerging sectors such as bioenergy and wave and tidal technologies.

In 2007, the Ministry of Advanced Education announced \$10 million for a major expansion of the MITACS internship program. This funding launched *ACCELERATE BC*—BC’s graduate research internship program. So far, more than 1,300 internships have been offered in BC. One successful example of this program is a University of Victoria (UVIC) engineering graduate student who undertook a four-month internship with SyncWave Energy. The student worked to further develop the company’s prototype wave power generator, which will produce clean energy for isolated coastal communities and off-shore installations.

Figure 5.9

Four students from India, who participated in MITACS’s Globalink Program in 2009, visit the Vancouver Aquarium

Source: <http://www.mitacs.ca>



Figure 5.8

List of some of the post-secondary programs that relate to BC’s green economy

Institution	Programs/Courses
BCIT	Sustainable Energy Manager Associate Certificate (SEMAC) Bachelor of Technology in Ecological Restoration Sustainable Resource Management (SRM) Environmental Engineering
Camosun College	Environmental Technology
Douglas College	Building Sustainability & Energy Management
Emily Carr	Courses in education for sustainability and green design
Kwantlen	Horticulture research & development programs
Langara College	Environmental Studies Cont. Studies Environmental Stewardship
Northern Lights College	Solar Hot Water course, Energy House development and course cluster (under development)
RRU	Offers 10 Environment and Sustainability programs: 3-Certificate, 4-Masters, 2-Bachelor, and 1-Diploma
Selkirk College	Natural Resource Management Program Integrated Environmental Planning Technology Program Renewable Energy Certificate Program
SFU	Sustainable Community Development Certificate Program School of Resource & Environmental Management Department of Chemistry
UBC	Master of Engineering in Clean Energy Resource Management and Environmental Studies (RMES) *Offered through IRES School of Community and Regional Planning (SCARP) Social, Ecological, Economic Development Studies (SEEDS) Department of Forestry
UNBC	Natural Resource and Environmental Studies (NRES)
UVIC	Sustainable Energy Systems Design School of Earth & Ocean Science
VIU	Green Building & Renewable Energy Technician (GBRET) Renewable Energy Technologies Certificate (one of four sustainability related certificates offered)

Figure 5.10

List of some of the facilities dedicated to research in BC's green economy sectors

Institution	Region	Facility	Sector
BCIT	2	Centre for Architectural Ecology - Collaborations in Green Roofs & Living Walls	Green Building
		Centre for Energy Systems Applications (CESA)	Renewable/Alternative Energies
		Photovoltaic Applied Research Lab (PEARL)	Renewable/Alternative Energies
FP Innovations	2	FERIC, PAPRICAN, Canadian Wood Fibre Centre (CWFC)	Green Building (Building materials)
Hydrogenics Corporation	N/A	Hydrogenics Test Systems	Renewable/Alternative Energies
Kwantlen	2	Bio-control Product Development lab	Environmental Protection
Northern Lights College	8	Centre for Clean Energy Technologies	Energy Sectors
NRC Canada	2	Institute for Fuel Cell Innovation (NRC-IFCI)	Renewable/Alternative Energies
Okanagan College	3	Centre for Excellence in Green Building Technology	Green Building
Powertech Labs	2	21 Advanced Performance Testing Laboratories	Renewable/Alternative Energies
SFU	2	4D Labs	Renewable/Alternative Energies
		Canadian Industrial Energy End_Use Data and Analysis Centre	Energy Management/ Renewable Energies
		Energy and Materials Research Group (EMRG)	Renewable/Alternative Energies
		Faculty of the Environment (Proposed)	Environmental Protection
		Centre for Sustainable Community Development (CSCD)	All sectors
UBC	2	Clean Energy Research Centre (CERC)	Renewable/Alternative Energies
		Centre for Interactive Research on Sustainability (CIRS)	Green Building
		Centre for Advanced Wood Processing (CAWP)	Green Building (Building materials)
		Institute for Resources, Environment & Sustainability (IRES)	Environmental Protection
		UBC Electric Power and Energy Systems Group	Energy Sectors
UFV	2	Centre for Environmental Sustainability	Environmental Protection
UNBC	5	Northern Forest Products and Bioenergy Innovation Centre	Renewable/Alternative Energies & Green Building (Building Materials)
UVIC	1	Institute for Integrated Energy Systems (IESVic)	Renewable/Alternative Energies

Another unique initiative is MITACS's *Globalink Program*, designed to provide top third and fourth year science and technology students from around the world with the opportunity to travel to BC and become involved in advanced research and development projects (see Figure 5.9). In 2009, successful students from India enjoyed their experiences so much, that many plan to return to BC for their graduate studies, sparking the interest of other like-minded students back in India to consider BC for their future educations.

New programs are also beginning throughout the province. In the fall of 2009, a Masters of Engineering degree program in Clean Energy will be offered at UBC. This innovative program is the first of its kind offered in Canada, and one of only a few worldwide. The program is expected to help attract bright international minds and help BC build its clean energy knowledge base.

Vancouver Island University (VIU) is introducing a Renewable Energy Technologies Certificate and Selkirk College has a new Renewable Energy Certificate Program. BCIT's School of Construction and the Environment is offering a Bachelor of Technology in Ecological Restoration. This four-year degree program is the first of its kind in Canada.

Okanagan College announced its \$28 million *Centre of Excellence for Sustainable Building Technologies and Renewable Energy Conservation* in April 2009. The new net-zero energy facility is designed to attract international attention and draw students to its expanded trades, technology training, and professional development programs.

The BC government is supporting an inventory of training for renewable and alternative energy occupations. In addition, the province is working with institutions to expand strategic programs related to the green economy and is offering co-operative education placements for students who take energy-related programs in the areas of alternative and renewable energy, as well as energy efficiency and power engineering.

Research & Development

Innovation is one of the most important components in advancing the green economy, as so much of the shift depends on new technologies and processes. British Columbia's high concentration of public institutions and universities are forming synergies with private industry-based facilities to become leaders in the area of research and development (see Figure 5.10 for a list of facilities).

Canada's **National Research Council (NRC)** is actively involved in projects related to clean and alternative energy technologies. The NRC Institute for Fuel Cell Innovation in Vancouver works with universities, government agencies, and companies to develop and test new hydrogen and fuel cell systems in BC.

In 2008, the **Pacific Institute for Climate Solutions (PICS)** was established with a \$90 million endowment. This partnership between UBC, UNBC, UVIC, and Simon Fraser University (SFU) has recently partnered with **NEPTUNE Canada** and Victoria's **VENUS Project** to further extend its inter-disciplinary reach into ocean sciences.

In addition, the *Community Economic Diversification Initiative (CEDI)* will invest more than \$33 million over two years towards projects in communities most at risk from the mountain pine beetle infestation, having already invested over \$150,000 to help UNBC conduct market research for commercializing a new pine beetle wood-based concrete product.³⁵

Kwantlen University's new \$7.3 million bio-control product development lab and geothermal research greenhouse opened in 2009. UNBC's \$15-million *Northern Forest Products and Bioenergy Innovation Centre*, funded in part by the ICE Fund and scheduled to open in late 2010, plans to implement applied research and development in bioenergy solutions with a focus on regional sustainability. The ICE Fund is also financing the province's first smart grid project at BCIT (see sidebar).

UBC's *Centre for Interactive Research on Sustainability (CIRS)*, which began construction in August 2009, will be one of the most innovative, high performance buildings in North America, offering cross-disciplinary research and educational opportunities (see Figure 5.11). When it opens in 2011, CIRS will be a centre demonstrating leading edge research on sustainable design practices, products, systems, and policies.

Sustainable Development Technology Canada (SDTC) has also been active in funding research and development projects in BC. Green power developers in British Columbia were recently awarded \$23 million for six projects under the SDTC umbrella relating to the development of renewable fuels, hydrogen and fuel cells for public transportation, and smart grid technologies.

Industry also plays a role in research. Companies including Genome BC, Powertech Labs, FP Innovations, and Lignol Energy are actively involved in the development of new technologies and low-carbon solutions.

However, private sector investment in R&D in BC remains relatively low. Opportunities exist for increased partnerships between industry and academia to boost research and commercialization efforts in many areas of the green economy here in the province.

BC's First Smart Grid Project



This new research project, funded by BC's ICE Fund and BC Hydro and located at the BCIT Technology Centre in Burnaby, focuses on developing solutions to automate the current electrical power grid of utilities and build a smarter, more secure power grid. An intelligent grid will allow power devices to communicate through a central system, making "smart" decisions to optimize power distribution and transmission.

The initial phase of the project includes installing smart meters, sensors, and controls on campus. A web-based Energy Management System will monitor these devices, enabling active management of power by helping to time demand cycles to coincide with off-peak resources. The project also works in partnership with Tantalus Systems Corp., described in Company Profile Box 6.

Figure 5.11

UBC's CIRS research facility is designed to find solutions to the challenges of urban development faster and more effectively than ever before

Source: <http://www.cirs.ubc.ca>





Founded in 2006, **Pulse Energy** is an energy management software company based in Vancouver. Having grown from two to 40 full-time employees in the last three years, the company is achieving success around North America with its innovative solutions that reduce energy use in buildings.

With its software recognized as one of the top three energy visualization products by the U.C. Berkeley Centre for the Built Environment, Pulse Energy's technology is used in hundreds of facilities in organizations such as the University of British Columbia, Grouse Mountain, the Lawrence Berkeley National Labs, and leading North American green architect Busby, Perkins + Will. Pulse Energy is one of a handful of companies invited to represent Vancouver's Green Capital campaign, and to be profiled by the BC Government as a clean technology leader.

Source: <http://www.pulseenergy.com>

Information & Communications Technology (ICT)

The development of software-based smart technologies that enhance energy efficiency, increase reliability, redesign systems of operation, and reduce costs is set to revolutionize the way business is done. By helping to improve energy efficiency in electricity transmission and distribution, in buildings and factories, and in the transportation of goods, an estimated US \$946 billion could be saved globally in 2020 alone.³⁶

In addition to reducing emissions and saving energy in other sectors, ICT's potential to replace high-carbon physical products and activities with virtual low-carbon equivalents, such as digital books and advanced video-conferencing, is massive.

British Columbia has a well-established and very active ICT sector, with approximately 6,000 companies across the province that employ close to 46,000 people.³⁷ In 2008, the sector contributed \$6.4 billion to provincial GDP and had the highest ICT GDP growth rate in the country at 3.4 percent.³⁸ Although only a small percentage of these companies are directly focused on low-carbon projects, one example is **Pulse Energy**, a leading BC company designing energy management software (see Company Profile Box 16). **Energy Aware Technology** is another example, having invented a "PowerTab" energy monitor that helps homeowners reduce their electricity consumption.

No other sub-sector can supply technology capabilities to energy efficiency across such a range of other sectors or industries. While growth in this sub-sector will inevitably result in increased emissions from its own use of power, the energy efficiencies and GHG emission reductions it will deliver to other sectors are expected to be five times greater. The ICT sub-sector can play a big role in BC's green economy if initiatives are taken to capitalize on the opportunities. Exports for ICT proprietary technology and knowledge are also seen to offer enormous potential.

Legal & Accounting

The transition to a greener economy is facilitated through the services from both the legal and accounting professions. For example, successful initial public offerings (IPOs) for growing green technology companies are negotiated through the existing legal framework, and accountants in the areas of carbon management, emission credit tracking, and energy audits will become an essential part of business in the future.

In addition, many legal firms in the province are currently involved in transactions related to environmental remediation, pollution control, as well as investment and financing for environment-related projects, such as wind farms and other renewable energy developments.

While BC-based firms specializing in environmental law are low in number—**West Coast Environmental Law** as one example—several major national firms that specialize in environmental law operate in BC, including **Borden Ladner Gervais LLP**, **Davis LLP**, **Farris, Miller Thomson's Environmental Law Group**, **Blakes Environmental Group**, and **Gowlings**. Key companies operating in BC providing accounting and financial management expertise related to the green economy are the international firms **KPMG** and **PricewaterhouseCoopers**.



Public Administration & Support Organizations

Public administration and government initiatives are helping to build British Columbia's low-carbon economy by supporting the province's many green companies and organizations through funding, as well as communication and outreach activities. New regulations and laws are, in part, driving the demand for green products and services and encouraging behavioural shifts toward lower-carbon lifestyles.

In addition, BC is the birth place of many organizations dedicated to protecting the environment and to promoting low-carbon activities, both in the province and abroad. In 1976, British Columbia—and more specifically Vancouver—was host to the first Habitat event, which became the genesis of the present day United Nations Human Settlements Programme, **UN-HABITAT**. Organizations like **Greenpeace** and the **David Suzuki Foundation**, both founded in BC, play large roles in promoting environmental and conservation initiatives. The **GLOBE Foundation of Canada** pushes the envelope for promoting green technology and sustainable business. Dozens of other BC-based non-profit environmental organizations also exist, including the **Georgia Straight Alliance** and the **Raincoast Conservation Foundation**.

Associations, councils, and other supporting organizations are also active in promoting the green economy in the province, including the **BC Environment Industry Association**, the **BC Community Forest Association**, the **BC Agriculture Council**, the **Association for Technology Professionals in BC**, the **BC Sustainable Energy Association**, **GeoExchange BC**, **SolarBC**, the **BC Water and Waste Association**, the **Recycling Council of BC**, the **Wilderness Tourism Association**, the **BC Business Council**, and the **BC Economic Development Association** to name a few.



6. THE TRANSITION TO A GREENER ECONOMY

A Voice for the Private Sector



The BC CleanTech CEO Alliance is a group of industry leaders drawn from British Columbia's leading clean energy technology companies. Together, the Alliance accelerates the growth of the industry and further establishes BC as a global leader in clean energy and low-carbon technologies.

As a voice for industry, the CleanTech CEO Alliance actively pursues opportunities in BC's low-carbon economy by encouraging attractive policy development and providing recommendations to the public, government, and other private stakeholders in order to leverage relationships with global partners and the investment community.

Members include Nexterra Energy, Ballard Power, Lignol Energy, Sempa Power, Tantalus Systems, McCarthy Tetraault, Chrysalix Energy Venture Capital, Day4 Energy, Westport Innovations, Offsetters, Powertech Labs, Corinex, and DPoint Technologies.

How can the transition to a green economy be accelerated?

Policies and programs will be needed to facilitate investment in those areas where BC has the potential for significant competitive advantage. In order to provide the right signals to private sector investors seeking to capitalize on BC's low-carbon assets, clarity is needed through long-term policies that facilitate the transition to a greener economy.

Strategies that lower the risks to investors, encourage local manufacturing, and expedite the commercialization and deployment of green technologies are essential if BC is to succeed in the highly competitive, international marketplace. The *ICE Fund* is a great example of a program that is helping to showcase BC's green technologies, while at the same time, generating regional opportunities and creating a "re-spending effect" that, otherwise, would be lost when BC companies sell their products and services solely in foreign markets.

Because of BC's relatively small domestic market, industry and local governments must work in concert to increase purchasing power and to create a larger domestic market for BC's small- and medium-sized enterprises (SMEs)—which make up 98 percent of BC's economy—in order to help them in the commercialization of green technologies. It will also be important that all levels of government work together to encourage green initiatives and create synergies between regions within the province.

From a private sector perspective, companies must come together to form strong partnerships. The *BC CleanTech CEO Alliance* is one excellent example where companies are demonstrating the benefits of working together to enlarge the market (see sidebar).

Continuing to promote a culture in the province that thrives on innovation is essential. Encouraging private sector R&D, technology transfer, and commercialization through university project spin-offs, for example, will help build success for entrepreneurial communities throughout the province.

Creating and promoting new and unique courses and programs like UBC's *Masters of Engineering in Clean Energy* will help to attract young, talented minds into key low-carbon sectors. MITACS's

Globalink program is an excellent example of how collaborative research partnerships can attract and retain talent, and encourage the entrepreneurial-minds that will form the backbone of BC's future green economy. Further efforts to attract engineering and other graduate research students, who will help BC's burgeoning industries, could provide a huge boost for the province in its efforts to become a hub for low-carbon activity and innovation.

BC is well-endowed with the R&D facilities, the institutional knowledge base, the innovative private sector assets, and the network of support services necessary to navigate to a low-carbon future. What will be needed is an integrative policy framework that ties all of these pieces into a coherent forward-looking strategy.

How can BC effectively compete in a global green marketplace?

BC has long been viewed as a wellspring of innovative technologies and well-educated knowledge workers. Through a number of broad-based program initiatives, BC has reached out to the world in order to facilitate trade and the exchange of low-carbon ideas, technologies, and skills. The *Pacific Gateway Initiative* and the *Asia Pacific Strategy* are two prime examples where BC has recognized the importance of integrating its economic future with the fast-growing economies of the Asia Pacific countries, as well as others in North America.

Continuing to build relationships with other jurisdictions and developing a comprehensive global marketing plan will be crucial in further developing BC's green economy. The *Pacific Coast Collaborative* is one example where BC has succeeded in establishing close ties with neighbouring states to undertake joint actions related to clean energy, regional transportation, research and development, and innovation. The State of California and the Province of British Columbia have also been working together to reduce GHG emissions since the signing of an MOU on climate change in 2007 (see Figure 7.1). Additional inter-provincial/state partnerships that encourage trade within the green sectors should be sought.

Attracting foreign companies to invest capital in key low-carbon areas throughout the province—including bioenergy, transportation, renewable energy, energy efficiency, and ICT—through initiatives like the *BC Renaissance Capital Fund*, will be an important component in moving toward a greener future. Such anchor investments will, in-turn, encourage the formation of clusters and promote further development of supply/value chains.

The 2010 Winter Olympic Games is serving as an important showcase for BC's green initiatives. Other events such as GLOBE 2010 (see sidebar), where the world comes to BC looking for low-carbon solutions first-hand, are important for bringing new investors to the province.

However, the international marketplace for green products and services is highly competitive. Many other economies that are larger in size than BC's, and more diversified in terms of established manufacturing capabilities, already have deep roots in these lucrative markets. In order to succeed, BC must continue to reach out to the world to showcase the innovative technologies and sustainability solutions that not only will be part of the province's economic future, but that can also be exported to other parts of the world.

BC needs to sharpen its message to the rest of the world and take the steps needed to showcase the wealth of its assets and the breadth of its ingenuity. The world will take notice of what BC has to offer toward realizing a low-carbon future; but the message must be well-packaged and delivered effectively.

Figure 7.1

Premier Gordon Campbell and California Governor Arnold Schwarzenegger reaffirm their commitment to working together at the Governors' Climate Summit in 2009

Source: <http://www.gov.bc.ca>



The GLOBE Conference Series



Founded in 1990, the biennial GLOBE Conference and Exposition is a highly anticipated event held in Vancouver where leaders of business and government from many countries come together to deal with matters of environmental stewardship and sustainable development.

At the last event—GLOBE 2008—over 11,000 participants were on hand, including more than 2,100 delegates from 71 countries and over 400 exhibitors from around the world showcasing leading edge green technologies and sustainability solutions.

With a specific focus on "Building a Global Low-Carbon Economy", GLOBE 2010 will build on the success of what is recognized as one of the world's most influential and prestigious international environment industry happenings.

For more information, visit www.globe2010.com.

The greener future.



7. IN CONCLUSION

The transition to a green economy that is happening worldwide is accelerating. The acceleration is due in part to the need for managing the GHG emissions that contribute to global warming; the need to mitigate shortages in key resources such as water and fossil fuel energy sources; the need to protect against rising prices for basic commodities; and the need to create new job opportunities as the world recovers from the worst economic downturn in decades.

These same factors will influence BC's economy, but this province is more fortunate than many jurisdictions because of its abundant wealth in natural resources and well-established low-carbon assets. As nations around the world develop new, greener economies through massive stimulus spending and policy shifts, BC has a great deal to gain by positioning itself effectively for the emerging low-carbon future.

The green economy in BC—worth \$15.3 billion to provincial GDP in 2008 and responsible for nearly 166,000 direct and indirect FTE jobs—must incorporate and build on the strengths of the province's existing economy, in particular, on the foundation of its vast green, natural resources. At the same time, the transformation of all economic sectors in the province toward business practices, tools, and markets where low-carbon activity, energy efficiency, and conservation are the guiding principles must be promoted. It is important that while designing this new economy, efforts are taken to consider the environmental impacts of the transition and to ensure that the methods used minimize the negative effects while encouraging regional stability and durability.

British Columbia is on the cusp of a great low-carbon future; but the time to act is now. The survival of people on this planet depends on the actions taken today to manage resources more efficiently and to reduce the harmful GHG emissions that are causing climate change around the world. The good news is, the opportunities are endless and the benefits are enormous.

Phase 2 of this project will include a review of the policies and programs that are helping to build the green economy in BC and will provide a detailed analysis of the labour market opportunities associated with building a strong low-carbon future.

Links to More Information

Association for Technology Professionals in BC (ASTTBC)

<http://www.asttbc.org>

BC Bioenergy Network

<http://bcbioenergy.ca>

BC Environment Industry Association

<http://www.bceia.com>

BC Government Climate and Energy links

<http://www.env.gov.bc.ca/epd/climate/links.htm>

BC Ministry of Environment

Climate Change Branch

<http://www.env.gov.bc.ca/epd/climate/index.htm>

BC Sustainable Energy Association

<http://www.bcsea.org>

BC Water and Waste Association

<http://www.bcwwa.org>

Biodiesel Association of Canada

<http://www.biodiesel-canada.org>

Canada Green Building Council

<http://www.cagbc.org/index.htm>

Canadian Bioenergy Association

<http://www.canbio.ca/canbio.php>

Canadian Hydrogen and Fuel Cell Association

<http://www.h2fcc.ca>

Canadian Hydropower Association

<http://www.canhydropower.org>

Canadian Renewable Fuels Association

<http://www.greenfuels.org>

Canadian Solar Industry Association

<http://cansia.ca/Default.aspx?pageld=139831>

Canadian Wind Energy Association

http://www.canwea.ca/index_e.php

Community Energy Association

<http://www.communityenergy.bc.ca>

GeoExchange BC

<http://www.geoexchangebc.com>

Independent Power Producers Association of BC

<http://www.ipdbc.com>

National Brownfield Association BC

<http://www.brownfieldassociation.org/Chapters/BritishColumbiaChapter/tabid/98/Default.aspx>

Pacific Institute for Climate Solutions

<http://www.pics.uvic.ca>

SolarBC

<http://www.solarbc.ca>

Sustainable Development Technology Canada

<http://www.sdtc.ca>

TECHNICAL NOTES

The direct and indirect impact of the green economy in BC was estimated using data from the Canada Revenue Agency (CRA) and Statistics Canada's Inter-Provincial Input-Output (I-O) Model.

The CRA tabulated aggregate revenues and taxable income for those corporations operating in BC whose six-digit North American Industry Classification System (NAICS) codes were considered to be part of the green economy. The data was tabulated from single-jurisdictional corporations that operated exclusively in BC and for the BC activity for multi-jurisdictional corporations that, while operating in the province, have a head office in another province. The data does not include revenues or taxable income for non-corporate businesses, such as sole proprietorships and partnerships, for corporations reporting less than \$5,000 in revenues, nor for industry groups with less than ten corporations.

In order to estimate the actual green economy revenues and taxable income that corporations contributed, the GLOBE Foundation applied intensity ratios, or estimated percentages of total activity, for the relevant NAICS codes, based on in-depth research and consultations related to the various green sectors.

The CRA data includes revenues from both business operations and extraordinary revenues, including the sale of corporate assets and revenues from equity and currency markets. It has been assumed that these non-operational revenues were relatively insignificant.

The CRA revenue data was then converted into GDP and jobs using Statistics Canada's I-O Model, based on the I-O tables. The I-O tables—which are based on NAICS—are the most comprehensive and detailed statistics on transactions involving production activity, as well as intermediate and final consumption of goods and services in the market economies of each province and territory, encompassing persons, businesses, government, and non-government organizations (NGOs), and entities outside its jurisdiction that give rise to imports or exports (inter-provincially or internationally).

The I-O Model simulates the economic impact on the business sectors of an expenditure on a given basket of goods and services or the output of one of several industries. The simulation results from a "shock" to an I-O Model will show the direct and indirect impacts, as well as which industries benefit the most, the number of jobs created, rough estimates of indirect taxes, and subsidies generated.

To obtain a copy of the detailed methodology applied to estimate the size of BC's green economy, as well as a list of the NAICS codes and intensity ratios that were used to estimate green GDP and job numbers, contact the GLOBE Foundation.

END NOTES

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