SUSTAINABILITY LABOUR MARKET TRENDS: A CANADIAN AND INTERNATIONAL PERSPECTIVE

REPORT FOR

UBCv WORKING GROUP ON ACADEMIC PROGRAMS OF THE PRESIDENT'S ADVISORY COUNCIL ON SUSTAINABILITY

and the

CAMPUS SUSTAINABILITY OFFICE

UNIVERSITY OF BRITISH COLUMBIA

PREPARED BY:

Coro Strandberg
Principal, Strandberg Consulting

Strandberg
CONSULTING

6325 Sperling Avenue
Burnaby, BC
V5E 2V3
www.corostrandberg.com

SUSTAINABILITY LABOUR MARKET TRENDS: A CANADIAN AND INTERNATIONAL PERSPECTIVE

TABLE OF CONTENTS

SUSTAINABILITY LABOUR MARKET TRENDS: A CANADIAN AND INTERNATIONAL PERSPECTIVE

REPORT FOR UBC

Background

UBC has established a Working Group on Academic Programs of the President's Advisory Council on Sustainability to develop an academic sustainability plan and identify potential course and degree options at UBCv on sustainability. To this end, they have engaged Strandberg Consulting to prepare a "summary report of highlights and key conclusions of Canadian and international sustainability labour market trends", which is the subject of this current report.

This will be followed by employer and thought leader interviews on emergent sustainability labour market trends and a student survey to determine priority student sustainability education needs. Together, the four research components will be compiled into a Sustainability Market Research Report, which will be used to inform the Working Group's discussion and priority-setting on new courses and programs on sustainability at the undergraduate and graduate level. The following is a high level review of the published literature on sustainability labour market trends in Canada and globally.

Focus and Methodology

For the purposes of the sustainability market research literature review, the author compiled a list of publications, including journal articles, reports and studies that were available through online research during the period of December 15 - 31, 2008. Key sources included Google, Google Scholar, SFU Journal Database (including major databases like EBSCO) and Environmental Careers Organization (ECO Canada). A search was conducted in Mandarin but did not reveal any substantive labour market trends research publications. The focus of the research was on recent sustainability labour market trends that affected employment prospects for those with undergraduate and graduate degrees.

It should be acknowledged that the statistics reported in this study were compiled prior to the current economic downturn and therefore do not reflect more recent labour market prospects for the national and global economy generally and sustainability employment specifically. Another challenge of the research is the evolving understanding of what characterizes a green or environmental job. For example, a practice considered "green" and environmentally responsible today may be considered "brown" tomorrow.

Further, efforts to identify "social" labour market trends from within the sustainability field were unsuccessful. Trends research appears to be available primarily for the environmental sector. Thus, this paper focuses on environmental employment trends within the sustainability sector. No attempts were made to identify "economic" sustainability labour market trends.

In an effort to focus the research, the study attempts to compile occupational trends in environmental employment, not specific skills trends. Additionally, the study focuses on the *demand* for environmental labour, not the *supply* of environmental professionals.

With these caveats, the following is a summary of the major trends and research conducted in Canada and globally on environmental employment with respect to the recent period and forecasts for the coming decades.

Context and Structure of Report

Environmental employment is predicted to grow considerably in the years ahead. This confidence is driven by a number of factors, including:

- Environmental regulation
- Growing public and consumer awareness
- Business need to reduce costs and liabilities
- Baby boomer retirements
- Increase in energy and commodity prices
- Growth in emerging economies such as China and India
- Growth in clean tech investing
- Deteriorating infrastructure
- Smart growth development with population growth and city migration
- Growing interest in ecosystem services
- Declining natural resources and need for eco-efficiency
- Technological innovation

Environmental employment is a difficult field of study, as it is a function of emergent new professional occupations and the greening of many current occupations. Further, environmental work is very cross-sectoral and multi-disciplinary by nature. Recent attempts have been made by the Canadian Council for Human Resources in the Environment Industry (CCHREI) and ECO Canada to exhaustively classify environmental positions, competencies and tasks, see for example the report "Expansion, Update, and Maintenance of the National Occupational Standards for Environmental Employment (2003) Final Report" by the CCHREI (2004).

Indeed there is no one universal definition of environmental employment, let alone undergraduate and graduate level occupations of study. This complexity which characterizes the field of environmental employment is a function of the global transition to a more sustainable future. We are in the infancy of what some predict to be the third industrial revolution, necessitating experimentation and innovation from which will emerge winners and losers. The academic winners will be those who successfully predict, and build the education and training infrastructure for, the industrial transition to a post-carbon, low impact economy.

To help educators bridge this academic gap, this paper will first provide a definition of environmental employment, followed by an overview of general environmental employment trends in Canada and internationally. Next will be a summary of labour market classifications in this field, with more detailed classifications in Appendices A and B. The trends section is divided into two components: the first focuses on the

composition of recent environmental labour market trends which describe the current state of play, and the second section looks at forecasts and predictions for future environmental employment trends into the coming decades, including in Canada and internationally. This is followed by some specific recommendations for educators to meet the growing needs for clean energy education found in the literature and lastly, overall report conclusions.

1. Definitions

A number of definitions of environmental employment were found in the research. One major difference, possibly more nuanced than substantive, is the reference to "green jobs" versus "environmental employment". Primarily the term "green jobs" is used in general contexts, in efforts to influence high level public and industrial policy, in lobbying for investments in a green economy and for grass-roots mobilizing. On the other hand, "environmental employment" is used in contexts where detailed analysis and forecasting is required for educational programming, employee career pathing and employer human resource planning.

ECO Canada, arguably the definitive Canadian resource on the environmental labour market, defines an environmental employee as "someone working in any activity associated with:

- Environmental protection
- Conservation and preservation of natural resources
- Environmental sustainability" (ECO Canada, 2008, p. 15)

Any individual whose tasks are associated with these activities are considered to be engaged in environmental employment. The CCHREI (2004) also follows this definition of environmental employment. (p. 6) The Council comments that "environmental employment may and does exist in industries other than the environment industry and explains why CCHREI's classification of environmental occupations contains so many jobs and occupations that may also be considered part of other industries." (p. 6)

(To illustrate the cross-sectoral nature of environmental work, about 57% of companies in an environmental employer survey conducted by ECO Canada in 2007 indicated that their employees perform work in all three of the environmental sectors noted in ECO Canada's definition above. (ECO Canada, 2008, p. 52))

The CCHREI (2004) has developed and updated a set of National Occupational Standards (NOS) for environmental employment to keep abreast of "current and emerging environmental work performed by Canadian environmental practitioners" (p. iv). The Standards contain 281 environmental competency statements, each describing one specific environmental task, organized into 36 clusters of related competencies and 11 functions or groups of related clusters. The NOS also contain 34 *enabling* competency statements, further organized into 7 clusters. (p. v)

Consistent with this focus on the environmental aspect of sustainability, it is intriguing to note that definitions were not provided for terms like sustainability and sustainable development in any of the research used for this report, albeit these terms were used in a number of studies. This adds a layer of complexity to tracking labour market trends in

this field. The next section looks at general trends in environmental employment in Canada and abroad.

2. General Environmental Employment Trends

2.1 Canada

According to ECO Canada, Canada produces over $18.5 billion in environmental goods and services (ECO Canada, 2008, p. 7). This is the engine behind Canada's environmental employment numbers. Based on a 2007 study it was estimated that Canada employs over 530,000 environmental employees (equivalent to 3.2% of its labour force) (ECO Canada, 2008, p. 21.)

ECO Canada (2007) predicts the following:

> Employment in all industries is expected to grow at an annual average rate of 1.4% from 2006 to 2011, while the demand for environmental employment is expected to increase by 1.6%. This is an annual increase of 0.2% for environmental employment compared with the growth of total industrial employment. (Labour Market Transition p. 2)

Further, ECO Canada comments:

> Environmental employment is concentrated in industries with above average employment growth, which likely explains why the overall growth in the demand for environmental employees exceeds the increase in employment for all industries. (Labour Market Transition p. 2)

In another study ECO Canada (2007) reports that of 6,096 organizations who responded to a 2006 survey, "approximately one in ten firms in Canada (10.1 % on a weighted basis) employed one or more environmental employees in their establishments." (p. 6)

This same study provided detailed information on the number of environmental employees by major industry group, as follows (p. 7):

Environmental Employees by Major Industry Group 2007	
Industry Group	**Number of Environmental Employees**
Administration and Support, Waste Management and Remediation	80,290
Professional, Scientific and Technical Services	69,825
Education, Health and Social Assistance	55,845
Public Administration	52,372
Wholesale/Retail Trade	46,106
Manufacturing	42,836
Construction	41,273
Arts, Recreation, Accommodation and Food Services	36,679
Agriculture, Forestry, Fishing and Hunting	34,438
Other Services (except Public Administration)	24,354
Utilities, Transportation and Warehousing	23,217

Information, Finance, Insurance, Real Estate and Management of Companies	13,542
Mining and Oil and Gas Extraction	9,6319
Total	**530,414**

In its 2007 study on labour shortages in the environmental sector, ECO Canada identified 11 priority environmental industry occupations in short supply out of a total of 529 available. They are listed below (p. 3):

Priority Environmental Industry Occupations

- Architecture and science managers
- Geologists
- Geochemists and Geophysicists
- Biologists and Related Scientists
- Forestry Professionals
- Agricultural Representatives, Consultants, and Specialists
- Civil Engineers
- Urban and Land Use Planners
- Biological Technologists, and Technicians
- Civil Engineering Technologists, and Technicians
- Inspectors in Public and Environmental Health and Occupational Health and Safety
- Natural and Applied Science Policy Researchers, Consultants, and Program Officers

2.2 Global Environmental Labour Market

The United Nations Environment Program (UNEP), in conjunction with the International Labour Organization (ILO), the International Organization of Employers (IOE) and the International Trade Union Confederation (ITUC) commissioned a Green Jobs report (2008) in which they predict that "the global market for environmental products and services is expected to double from $1,370 billion per year at present to $2,740 billion by 2020. Half of this market is based in energy efficiency and the balance in sustainable transport, water supply, sanitation and waste management." (p. 13) The report claims that globally there are millions of green jobs already in existence, for example, more than 2.3 million green jobs have been created in recent years in renewable energy. (p. 5).

3. Labour Market Classifications

Both ECO Canada and CCHREI (2004) use the following subsector model of environmental employment, following on from their definition cited earlier (p. 7)

Environmental Protection Subsectors:

1. Air Quality
2. Water Quality
3. Land Quality
4. Waste Management
5. Restoration and Reclamation
6. Human & Environmental Health & Safety
7. Environmental Protection Management

Conservation & Preservation of Natural Resource Subsectcors:

1. Fisheries & Wildlife
2. Forestry
3. Agriculture
4. Mining
5. Energy
6. Parks & Natural Reserves
7. Natural Resources Management

Environmental Sustainability Subsectors:

1. Education
2. Research & Development
3. Policy & Legislation
4. Communications & Public Awareness
5. Sustainable Development Management

(Note that Appendix A, p. 1 – 6 in CCHREI (2004) provides detailed definitions of these sectors and subsectors.)

During the course of this research, lists of various environmental industries and environmental occupations were compiled to provide background for UBC's primary research with employers, thought leaders and students, particularly with respect to UBC's interest to understand the trends in sustainability "areas" considered important by these key audiences. They are included in Appendix A (Industries) and Appendix B (Occupations)..

It is notable that a considerable amount of the research into occupations and industries focused on energy, particularly renewable energy and energy efficiency and engineering.

4. Current Environmental Labour Market Composition and Recent Trends

The following summarizes some of the key current environmental labour market statistics in Canada and internationally (specifically U.S. and global).

4.1 Canada

The environmental sector in Canada consists of multidisciplinary industry groups. As reported by ECO Canada (2008), "the majority of environmental employees were in public services (22%), followed by environmental consulting (18%) and service industries (15%)". (p. 7) "Hiring over the past 12 months was more common in the public services industry (27%) and the environmental consulting industry (24%), as opposed to the natural resource (6%) and waste management industry (6%)" (p. 9) (Note that the survey sample of 1,126 organizations was overweighted to the first two sectors. Other sectors included architecture, engineering and related services, service industries, construction/manufacturing/utilities.)

Additionally, the same study reports that "more companies hired people with the following environmental expertise:

- Environmental protection management (57% of organizations)
- Communication and public awareness (52%)
- Water quality (47%)
- Waste management (47%)
- Environmental education (47%)" (p. 10)

In addition to analyzing prior hiring trends, ECO Canada also investigated future hiring trends over the next two years: "among the organizations that expected growth over the next two years, water quality (29%), waste management (24%) and land quality (17%) were most often identified as the areas of expertise required", as identified in the figure below (p. 49):

Top areas of hiring

Note: Multiple responses allowed. Survey respondents were asked to identify three areas. N=729.

ECO Canada also polls its student visitors to its website on various topics. Its Sept. 19 – Nov. 22, 2008 poll asked students to "select the most exciting field of environmental study today". Polling results reveal a high degree of interest in the more generic area of "sustainable development" (sample size not available):

ECO Canada Student Poll September 19 – November 22, 2008.	
"What is the most exciting field of environmental study today?"	
Sustainable development	43%
Restoration and reclamation	26%
Natural resource planning and management	15%
Education and training	3%
Policy, legislation and regulation	3%
Public awareness	1%
Risk assessment, health and safety	1%
Prevention and control	1%
Other	1%

(ECO Canada: Student Poll, 2008)

4.2 Pacific Northwest (clean energy labour market trends only)

The Sustainable Oregon Workforce Initiative conducted a gap analysis study of Oregon clean energy workforce needs, "An Analysis of Clean Energy Workforce Needs and Programs in Oregon", in 2008. The report references a survey conducted by Athena Institute, which canvassed companies operating across Washington, Oregon, BC, Idaho, and Alberta. The study concluded that respondents had a highly educated workforce, with 62% of respondents hiring employees with a trade degree or more. "36% of respondents report[ed] that all of their employees have at least a four year degree or more. 72% of the firms have employees with graduate degrees, 33% employ workers with doctorates". (p. 15). Further, "companies reported difficulty filling specialty positions. Engineers, in particular are in high demand within this sector. But there were a number of organizations who had challenges with marketing and general management and administration positions as well." (p. 15)

Some specific sectors reported university-level training gaps, including geothermal developers who reported a need for geologists with specific geothermal resource expertise (p, 18); the wave energy industry which reported a lack of a robust naval architecture and marine engineering industry particularly in Oregon (p. 20); and in the area of conservation technologies and energy efficiency, the report noted that "the Building Sciences workforce needs engineers (mechanical, controls, electrical) that understand the energy efficiency aspects of the systems. Traditional curriculum in engineering schools doesn't address the energy efficiency issues. Another identified need is for people with project management skills who understand energy efficiency technologies" (p. 21).

The Oregon report (2008) goes on to state that "engineers are in high demand within all of the clean energy sectors. Companies are reporting challenges finding energy engineers, and anticipated needs are growing. Energy engineers serve as building energy modelers, energy auditors, energy systems managers, energy systems designers, etc. Employers are looking for engineers who understand the broad field of energy engineering; traditional engineering curricula like electrical and mechanical engineering do not address energy engineering issues in whole." (p. 39) The clean energy industry in Oregon has "identified short term industry needs includ[ing] workers

with manufacturing and assembly skills, energy engineers, wind technicians, solar installers, geologists with geothermal resource evaluation skills and meteorologists with wind resource evaluation skills." (p. 45)

Further information on clean energy labour market gaps identified in the Athena Institute Clean Tech Study and reported in the Oregon report include (p. 49 – 50):

Positions where there is difficulty finding qualified people locally
Specialty technology areas
• Engineers, e.g. with fuel cell system expertise, energy efficiency engineers who are also able to effectively communicate with and motivate businesses to implement energy efficiency programs
• Commissioning and design simulation
• Licensed architects with sustainable design experience
• Sustainability consultants
• Water/wastewater treatment plant operators
Why it is difficult to hire those positions, some examples
• Lack of experience
• New field of engineering
• Lack of cleantech/sustainability backgrounds

4.3 United States

Global Insight (2008) estimates that as of 2006 there were just more than 750,000 green jobs in the US economy. "More than half of [the] existing jobs were in engineering, legal, research and consulting, revealing the importance of these indirect jobs to the Green Economy." (p. 5) This sector has also grown faster than direct Green Jobs since 1990, "expanding 52% compared with 38% growth in direct jobs." (p. 16) [Note: direct jobs are numbered 2 – 7 in the chart below.]

Green Jobs by Major Category – US Total	
1. Engineering, Legal, Research and Consulting	418,715
2. Renewable Power Generation	127,246
3. Agriculture and Forestry	57,546
4. Construction and Systems Installation	8,741
5. Manufacturing	60,699
6. Equipment Dealers and Wholesalers	6,205
7. Government Administration	71,900
Total	**751,051**

However, to prove the complexities in defining and calculating environmental employment, another report, *Renewable Energy and Energy Efficiency: Economic Drivers for the 21st Century* (Bezdek, 2007), declared that in 2006 renewable energy and energy efficiency technologies generated 8.5 million new jobs in the US, in marked contrast to the earlier figure of 750,000 green jobs. (p. 7) Their claim that these technologies are driving significant economic growth in the US is likely indisputable.

Bezdek (2007) defines renewable energy technologies primarily as hydroelectricity, biomass, geothermal, wind, photovoltaics and solar thermal. Energy efficiency includes insulation sales, energy service company industry sales and recycling and reuse industry. The study predicts sectoral growth under different scenarios, such as the base case with no special measures which anticipates1,305,000 jobs in renewable energy and 14,953,000 in energy efficiency; under the moderate scenario they predict 3,138,000 jobs and 17,825,000 jobs in renewable energy and energy efficiency respectively. (p. 7)

Specifically Bezdek (2007) predict that "the vast majority of the jobs created by the renewable energy sector are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc." (p. 24)

In the case of the energy efficiency sector, they claim that "the total number of jobs created directly and indirectly […] in 2006 exceeded 8 million, and more than 90 % of those jobs were in private industry. More than 50% of the jobs were in the manufacturing sector, and the second largest number of jobs was in recycling, followed by the construction industry. Nearly 80% of the energy efficiency government jobs were in state and local government." (p. 29)

In sum, "in 2006 there were 452,000 direct and indirect jobs in renewable energy and 8,046,000 direct and indirect jobs in energy efficiency." (p. 31)

As for the green building sector, as reported by Blaszczyk (2008) "according to the US Green Building Council, the number of accredited professionals in [the US] has grown from 527 in 2001 to more than 43,000 today. […] The green building industry has opened doors for other professionals as well, including construction managers, landscape architects, materials engineers and more."

It is interesting to assess environmental labour market demand by analyzing US job postings, two of which are reported below:

GreenBiz.com Post a Job: Current Jobs December 30, 2008	
Job Posting Category	**Number of Job Postings**
Engineering	68
Program/Project Management	62
Green Building	51
Executive/Senior Management	33
Business Development and Sales	27
Government	25
Administration/Management	19
Biotech/Science	15
Art/media/design	13
Education	10
Legal/Environmental Law	10
Accounting/Finance	9
Fundraising	7
Marketing/PR/Advertising	5
Research/Writer/Editor	4
Web/Technology/IT	4

Other	36

Top Job Sectors Stopdodo.com December 30, 2008	
Job Posting Category	**Number of Postings**
Conservation/Naturalist	201
Renewable Energy	115
Climate/GHG & Carbon Consulting	112
Energy Efficiency	77
Fauna & Wildlife	56
Omithology (Birds)	50
Biodiversity	44
Forestry & FSC	45
Sustainability	72
Marine Ecology (also see Marine)	43
Administration	43
Marine Biology	43
Communication, Marketing & PR	42
Wind Farm	42
Environmental Engineering	39
Management and Executives	40
Environmental Management	38
Flora (Botany)	34
Campaigning	32 (added in 2009)

4.4 Global

Renewable Energy

UNEP (2008) reports that "Globally some 300,000 people are employed in wind power and maybe 170,000 in solar. Over 600,000 are employed in solar thermal – most of these in China. [Note: the report does not define solar and solar thermal. The distinction could be that solar thermal energy harnesses solar energy for thermal energy (heat) versus solar photovoltaics, which converts solar energy directly into electricity.] Nearly 1.2 million are employed in biomass energy in four countries – Brazil, US, Germany and China. Overall 2.3 million are employed in renewable energy sector, a conservative figure. […] The German renewable sector, […] employs 250,000 people and is expected to provide more jobs than the country's auto industry by 2020." UNEP points out that half of the reported jobs in the renewable energy sector are in emerging and developing economies.

Energy Efficiency

The UNEP Report on *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World* (2008) notes that "Energy efficiency, particularly in buildings and construction […] is one of the areas with the highest potential to reduce greenhouse gas emissions and to create jobs in the process. Some 4 million direct green jobs based on improving energy efficiency already exist across the economy in the US and in certain European countries. Buildings currently account for less than one million of this total but could represent a future source of many more green jobs." (p. 8)

Transportation

The same report analyzes employment in the transportation sector: "Some 1.3 million people work in public transport in the European Union and the U.S. alone. Public transport is a growth sector in a low-carbon world, particularly in the mega-cities of the developing world. Bus rapid transit systems are being put in place in more and more cities around the world. […] There are also substantial green employment opportunities in retrofitting diesel buses to reduce air pollutants, and in substituting cleaner compressed natural gas (CNG) or hybrid-electric buses." (p. 9)

Basic Industries and Recycling

UNEP (2008) states that "greening basic industries is difficult and fewer than 300,000 jobs in iron, steel and aluminum can be considered to have any "shade" of green. The best option of reducing the impact of these industries is through recycling. Secondary steel production, based on recycled scrap, requires 40 – 75% less energy than primary production. […] It is estimated that more than 200,000 jobs across the world are involved in secondary steel production. […] Recycling provides 12 million jobs in three countries in which data could be found (Brazil, China, U.S.)." (The report cautions that many existing recycling jobs cannot be considered green because they cause both pollution and health hazards and are not examples of decent work.) (p. 10)

Agriculture

According to UNEP (2008), it is not possible to quantify green jobs in the agriculture sector – however the report finds that "there is considerable potential in this area as evidenced by sustainable practices on productive family farms, organic production and successful adaptation to climate change." (p. 11) Further, they found that "a study of 1,144 organic farms in the UK and Ireland showed that they employed one third more full-time equivalent workers per farm than conventional farms. […] If 20% of farmland became organic in both countries there would be an additional 73,200 jobs in the UK and 9,200 in Ireland." (p. 12)

Forests

UNEP did not provide statistics on the degree to which the forest sector has created green jobs, but claimed that "given the current hope pinned on forests as carbon sinks and considering their role as providers of renewable raw material, pools of biodiversity, regulators of water flows and other environmental services, it is clear that green jobs in forests will play an increasingly important role in the future." (p. 12)

Finally, the job search engine "Monster Worldwide data shows a steady increase in the number of environmental job postings since 2005, particularly for engineers, protection technicians and specialists. […] The next decade will see an increase in green job opportunities in law, conservation and urban planning",according to Blaszczyk (2008), one of their job analysts.

5. Environmental Employment Forecasts and Trends

The foregoing section primarily profiled recent environmental labour market statistics up to present day. This section is a compilation of future labour market trends in environmental employment.

5.1 Canada

According to Canada's environmental labour market forecasters, ECO Canada (2008), most environmental organizations expect growth, particularly "environmental consulting (86%), architecture, engineering and related services (79%) and service industries (75%) have a higher percentage of organizations anticipating growth over the next two years. […] Among the organizations that expected growth over the next two years, water quality (29%), waste management (24%) and land quality (17%) were most often identified as the areas of expertise required." (p. 10)

The same study asked employers to indicate the skills where their employees required further training and they responded:

- Environmental management systems and operations/risk assessment (62%)
- Environmental assessment, restoration and remediation (55%)
- Environmental education and training (55%) (p. 10)

In a 2002 presentation on important and emerging eco-careers, Kevin Doyle, then the National Director for Program Development at ECO Canada, provided the following list in his slides:

1. Pollution prevention/waste reduction specialist
2. Conservation biologist/ecosystems manager
3. Environmental information technology/GIS
4. "Dual track" environmental manager
5. Global climate change researcher
6. Renewable energy and energy management
7. "Smart growth" urban planner
8. Policy integration specialist
9. Community organizer
10. Fundraiser, "rainmaker", dealmaker
11. Environmental economist
12. Environmental health specialist (Slide 10)

Engineering Forecast

Monster.com job analyst Woog (2009) provided an engineering hiring outlook for 2009, in which he commented that there is predicted growth in green engineering, "officially defined by the [American] Environmental Protection Agency as "the design, commercialization and use of processes and products feasible and economical while minimizing generation of pollution at the source and risk to human health and the environment", [including] hybrid vehicles, windmills and less obvious sectors like smokestack industries whose plants need modernizing." As he states in his article "many green projects call for multidisciplinary approaches across electrical and mechanical engineering."

5.2 United States

A report on "How the Northwest Can Create Green Jobs, Deliver Energy Security, and Thrive in the Global Clean-Tech Marketplace" by Climate Solutions and Clean Edge (2008) lays out the following "Medium Growth Job Estimates for Oregon and Washington" (p. 22) (The report predicts an accelerated and a medium growth rate for each of the following sectors, based on unique calculations and assumptions tailored to each sector and found on pp. 23, 30, 37, 43 and 50):

Medium Growth Jobs Estimates for Oregon and Washington Certain Sectors		
Sector	**Current**	**2025**
Solar PV Manufacturing	800	14,182
Wind Power Development	2,217	4,507
Green Building Design	3,826	12,937
Bio-Energy	3,207	6,946
Smart-Grid	1,280	2,669

Global Insight's October 2008 paper on *Current and Potential Green Jobs in the U.S. Economy* makes a few key points:

- "Many potential manufacturing jobs in the solar industry are high tech jobs in the Semiconductor and Related Devices subsector." (p. 13)

- "Reducing current annual energy consumption levels of residential and commercial buildings by 35% over the next 30 years will result in incremental energy savings of more than 32,000 million kilowatt-hours each year. Achieving these annual energy efficiency goals will require nearly 81,000 green jobs, approximately 36,000 in the residential sector and 45,000 in commercial. (p. 15)

- "The potential growth in Green Jobs is significant in that it could be the fastest growing segment of the U.S. economy over the next several decades. […] The current count of 750,000 amounts to less than one-half of a percent of total current jobs. The generation of 4.2 million new Green Jobs […] could provide as much as 10% of new jobs growth over the next 30 years." (based on assumptions). (p. 17) See the table below for their projections:

Potential New Green Jobs 2038 – US Total			
	2018	**2028**	**2038**
Renewable Power Generation	407,200	802,000	1,236,800
Residential & Commercial Retrofitting	81,000	81,000	81,000
Renewable Transportation Fuels	1,205,700	1,437,700	1,492,000
Engineering, Legal, Research & Consulting	846,900	1,160,300	1,404,900
Total	**2,540,800**	**3,481,000**	**4,214,700**

5.3 Global

UNEP reports (2008) that on a global level "the five sectors likely to generate the biggest transition in terms of economic returns, environmental sustainability and job creation are:

- Clean energy and clean technologies including recycling
- Rural energy, including renewables and sustainable biomass
- Sustainable agriculture, including organic agriculture
- Ecosystem infrastructure (also referred to as environmental infrastructure and natural infrastructure and referring to the goods and services provided by the Earth's ecosystems, e.g. coral reefs provide fishery, tourism and flood protection services)
- Reduced emissions from deforestation and forest degradation
- Sustainable cities including planning, transportation and green building."

Their 2008 report provides the following chart listing the long term growth potential of green jobs:

GREEN JOBS LONG TERM GROWTH POTENTIAL		
		Long-term green job potential
Energy	Renewable energy	Excellent
	Carbon capture and sequestration	Unknown
Industry	Steel	Fair
	Aluminum	Fair
	Cement	Fair
	Pulp and Paper	Good
	Recycling	Excellent
Transportation	Fuel-efficient cars	Good
	Public transport	Excellent
	Rail	Excellent
	Aviation	Limited
Buildings	Green buildings	Excellent
	Retrofitting	Excellent
	Lighting	Excellent
	Efficient equipment and appliances	Excellent
Agriculture	Small-scale sustainable farming	Excellent
	Organic farming	Good to excellent
	Environmental services	Unknown
Forestry	Reforestation and afforestation	Good
	Agroforestry	Good to excellent
	Sustainable forestry management	Excellent

Source: Green Jobs –Towards Decent Work in a Sustainable, Low-Carbon World, UNEP, 2008. p. 14.
(Note: highlights added to identify the good to excellent prospects for job growth.)

With respect to green jobs in renewable energy, UNEP predicts that by 2030 on a global level there will be 12 million jobs in Biofuels, 2.1 million jobs in Wind, and 6.3 million jobs in Solar PV. (p. 13). They report that "investment in renewable energy is booming, surging from $10 billion in 1998 to at least $66 billion in 2007, equivalent to 18% of all energy investment. It is expected to reach $343 billion in 2020 and to almost double

again by 2030 to $630 billion. It may be noted that in the past even optimistic predictions concerning the development of renewables have consistently been exceeded. Projected investments would translate into at least 20 million additional jobs in the sector, making it a much larger source of employment than today's fossil industry." (p. 14)

As for energy efficiency, UNEP (2008) predicts that "a worldwide transition to energy-efficient buildings would create millions of jobs, as well as "greening" existing employment for many of the estimated 111 million people already working in the construction sector. Investment in improved energy efficiency in buildings could generate an additional 2 – 3.5 million green jobs in Europe and the U.S. alone, with the potential much higher in developing countries."

6. Curriculum Recommendations

One report focused on analyzing trends and gaps in clean energy workforce needs in Oregon (Hayes, Rafkind and Byrd, 2008). The following recommendations are pulled from this report as possibly relevant to UBC's projects:

- "In addition to developing targeted clean energy specific training programs, sustainable energy elements should be added into the core curriculum for conventional academic and technical programs such as engineering, electrician, plumbing, buildings sciences, meteorology and geology." (p. 42)
- Consider a full four year Bachelors degree in Renewable Energy Systems. (p. 45)

Employer interviews as part of this study included the following suggestions:

"Specific training programs, workforce programs or other policies [clean energy employers] they would like to see to meet their human resource requirements [include the following]:

- More courses in renewable energy
- Solar installer programs
- Byproducts management associates degree
- Training in biofuels operations planning inspections
- Environmental planning
- Sustainability planning
- LEED technical and project management
- Sustainable Design Advisor program
- More internship programs" (pp. 51 – 52)

(Note that the foregoing terms were not defined.)

7. Conclusion

As the UNEP (2008) report states, the greening of enterprises and the redefinition of many jobs in the coming decades will have a profound impact on the global labour market. With the "total size of the global labour force […] of over 3 billion, the

significance of green jobs can only be appreciated by taking a broader look at the transformation to a green economy. The most sweeping and pervasive change from the greening of an economy will be the redefinition of many jobs across the board." (p. 15) As UNEP says, "people in jobs at all levels will see the content of those jobs change, with new performance and skills requirements." (p. 15). These numbers are difficult to quantify, but this report has attempted to pull together the most recent environmental labour market research to this end.

Some of the key trends are to be found in the shift to a low-carbon economy, specifically the renewable energy and energy efficiency industries, including energy management. Major job opportunities are expected in environmental engineering and recycling and waste management. Many other environmental industries are expected to grow in the coming years, as chronicled in this report. However, the lack of consistency in methodology and classifications makes it difficult to draw conclusions beyond this first level of analysis. Further, while a number of references were made to generic sustainability professions, quantifiable labour market research did not emerge in the literature scan to permit detailed analysis. Indeed, research into the green job opportunities in the future labour market is just beginning to come on-stream, hence the recent publication dates of the majority of the references (2007 and 2008). However, there are enough data points to begin to plot an academic response to growing employer and student demand for education and knowledge development for the expanding green economy labour market. Those academic institutions which proactively upgrade their curriculum to reflect the new realities of the 21st century economy will be amongst the leaders forging a new path to a more sustainable society, while ensuring their course and program offerings are more relevant to the employer and employee of the future.

References

Apollo Alliance and Urban Habitat. (2007). *Community Jobs in the Green Economy.* U.S.A.: Author.

B.C.Government. (2008). *What your BC Government is doing for Green Economy. Retrieved Dec. 23, 2008, from* http://www.gov.bc.ca/yourbc/green_economy/ge_workers.html?src=/workers/ge_workers.html

Bezdek, R. (2007). *Renewable Energy and Energy Efficiency: Economic Drivers for the 21st Century.* U.S.A.

Blaszczyk, C. (2008). *Get into the Green: Details on 5 Environmental Career Options.* Retrieved Dec. 28, 2008, from: http://career-advice.monster.com/job-industry-profiles/entry-level-jobs/Get-into-the-Green-2008/article.aspx

Blaszczyk, C. (2008). *Green and Growing: Environmental Jobs.* Retrieved Dec. 30, 2008. from http://career-advice.monster.com/job-industry-profiles/entry-level-jobs/Green-and-Growing-2008/article.aspx

Canadian Council for Human Resources in the Environment Industry. (2004). *Expansion, Update, and Maintenance of the National Occupational Standards for Environmental Employment (2003).* Canada: Author.

Climate Solutions & Clean Edge (October, 2008). *Carbon-Free Prosperity 2025: How the Northwest Can Create, Green Jobs, Deliver Energy Security, and Thrive in the Global Clean-Tech Marketplace.* U.S.A: Author.

Doyle, K. (2002). *Environmental Career Trends: 2002.* [Powerpoint]. Canada.

ECO Canada. (2007). *Labour Market Transition: A Remedy for Labour Shortages in the Environment.* Calgary, Alberta: Author.

ECO Canada. (2007). *Profile of Canadian Environmental Employment 2007.* (2007). Calgary, Alberta: Author.

ECO Canada. (2008). *College Graduation Trends for Environment-related Programs 2002 – 2005.* Calgary, Alberta.

ECO Canada. (2008). *ECO Student's Poll: What is the most exciting field of environmental study today?* Retrieved Dec. 23, 2008, from http://www.eco.ca/_educator/viewContent.aspx?display=pollresults2

ECO Canada. (2008). *Environmental Labour Insights 2008: Employer Perspectives Draft Report.* Calgary, Alberta: Author.

ECO Canada. (2008). *Occupational Profiles.* Retrieved Dec. 23, 2008, from https://www.eco.ca/_educator/default.aspx?display=occupationprofiles

Employment Development Department, Government of California. (n.d.) *Digest of Green Reports and Studies*. Retrieved Dec. 28, 2008, from http://www.labormarketinfo.edd.ca.gov/?pageid=1032

EnvironmentalPrograms.Net. (2008). *Interview with Kevin Doyle: Trends in Environmental Jobs and Employment.* Retrieved Dec. 30, 2008, from http://www.environmentalprograms.net/guidance/env-jobs/

Fisher, P. (April 4, 2008). *BC Government Paper: Definition of Green Jobs and Targets for Green Jobs Growth in B.C. Draft.* Victoria, BC.

Global Insight. (October 2008). *Current and Potential Green Jobs in the U.S. Economy.* Lexington, MA: Author.

GreenBiz.com (n.d.). *Post a Job Categories.* Retrieved Dec. 30, 2008, from http://jobs.greenbiz.com/

Hayes, C. and Rafkind, D. and Byrd, B. (2008). *Analysis of Clean Energy Workforce Needs and Programs in Oregon.* Oregon, U.S.A.

Stopdodo. (n.d.). *Top Job Sectors.* Retrieved December 30 and Jan. 18, 2009, from http://www.stopdodo.com/cv_search/cv_details.asp?c=664

United Nations Environment Program. (September 2008). *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World.* Nairobi, Kenya: Author.

United Nations Environment Program. (22 October 2008) *Global Green New Deal – Environmentally-Focused Investment Historic Opportunity for 21st Century Prosperity and Job Generation.* Retrieved Dec. 28, 2008, from http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=548&ArticleID=5957&l=en

University of Toronto Centre for Environment – Environmental Careers. (2008) *Environmental Careers.* Retrieved Dec. 30, 2008, from http://www.environment.utoronto.ca/EnvironmentalCareers.aspx.

Woog, D. (2009). *Engineering Hiring and Salary Outlook 2009.* Retrieved Jan. 14, 2009, from http://career-advice.monster.com/job-search/Company-Industry-Research/Engineeering-Hiring-Salary-2009/article.aspx

Appendix A

Environmental Industries Cited

The following is a list of various environmental industries cited in the publications listed under References. No attempt has been made to integrate the various lists. This list is not exhaustive, but is derived from publications included in the literature scan.

Renewable Energy Generation
- Solar
- Wind – wind assessment and mapping consultants; wind resource assessor (aka wind power forecasting); wind turbine installation and maintenance; most jobs at wind plants are in turbine installation and maintenance
- Geothermal
- Hydro and marine
    - Small-scale hydro
    - Wave/tidal
    - Biomass, biofuels

Energy Storage
- Fuel cells
- Advanced batteries
- Hybrid systems

Energy Infrastructure
- Management
- Transmission

Energy Efficiency
- Lighting
- Buildings
- Glass

Transportation
- Vehicle
    - More fuel-efficient vehicles
    - Hybrid electric, electric, and fuel-cell vehicles
    - Car sharing and public transport
- Logistics
- Structures
- Fuels

Waste & Wastewater
- Water treatment
- Water conservation
- Wastewater treatment

Air & Environment
- Cleanup/Safety
- Emissions Control
- Monitoring/compliance
- Trading & offsets

Materials
- Nano
- Bio

- Chemical

Manufacturing/industrial

- Advanced packaging
- Monitoring and control
    - Pollution control
- Smart production
    - Energy and materials efficiency
    - Clean production techniques (toxics avoidance)
    - Cradle to cradle (closed loop systems)
    - Recycled materials

Agriculture and Forestry

- Natural pesticides
- Land management
- Aquaculture
- Corn farming
- Soybean farming
- Forestry and reforestation services
- Forest management services
- Agroforestry

Recycling & Waste Management

- Recyling
- Waste Treatment

Green Buildings

- Lighting, energy-efficient appliances and office equipment
- Solar heating and cooling, solar panels
- Retrofitting

Disease Prevention
Housing and Community Development
Fund-raising and Foundation work
Meteorology
Chemistry

Engineering, Legal, Research & Consulting:
Environmental law
Environmental policy
Environmental journalism
Environmental protection
Environmental risk assessment and modeling
Environmental impact assessment and auditing
Pollution control engineering
Building construction consultant
Heating and ventilation engineering
Electrical or electronic engineering
Energy conservation engineering
Agricultural and biological research
Biotechnical research
Natural resource research
Energy research
Environmental research
Materials management consultant

Productivity improvement consultant
Environmental remediation
Energy conservation consultant
Environmental consultant
Earth science services
Geological and geophysical consultant
Environmental cleanup services
Natural resource preservation service

Government Administration
Environmental health program administration
Environmental agencies
Air pollution control agency
Environmental protection agency
Environmental quality and control agency

Manufacturing
Wet corn milling
Corn milling by-products
Gluten feed and meal
Soybean and vegetable oil mills
Lecithin, soybean
Soybean flour, grits, oil, cake, meal, or powder
Soybean protein concentrates and isolates
Hydrogen
Ethyl alcohol, ethanol
Solar heaters and collectors
Turbines and turbine generator set units
Gas turbine generator set units
Hydraulic turbine generator set units
Steam turbine generator set units
Turbines and turbine generator sets and parts
Gas turbines, mechanical drive
Hydraulic turbines
Steam engines and turbines
Turbo-generators
Wheels, water
Windmills for pumping water
Windmills, electric generation
Light emitting diodes
Solar cells and photovoltaic devices
Fuel cells
Hydrogen ion equipment
Environmental controls and testing equipment
Solarimeters

Construction & Systems Installation
Solar energy contractor
Energy management controls
Environmental system control installation
Pollution control equipment installation

Appendix B

Environmental Occupations Cited

The following is a compilation of various environmental occupations cited in the publications listed under References. It is in alphabetical order and may overlap in some instances.

Air-quality auditor / engineer / specialist/ technician / technologist
Building material developer
Biochemist and biophysicist
Bioenergy

- Biotechnologist
- Biomass plant operator
- Plant engineer
- Biodiesel process engineer
- Engineer – biomass systems integration
- Assistant plant operator
- Station attendant
- Maintenance mechanic
- Production operator
- Operating engineer
- Plant and laboratory technician

Climatologist
Conservation biologist
Conservation officer
Ecologist – wetland ecologist
Ecotourism operator
Ecotoxicologist
Emergency manager
Energy analyst
Energy auditor
Energy engineer
Environmental chemist
Environmental communications officer
Environmental compliance officer
Environmental economist
Environmental educator (elementary, secondary, post-secondary teachers; parks; nature centers; hands-on science museums or centers; outdoor education)
Environmental enforcement officer
Environmental engineers (including grid integration positions; usually in water, waste-water or air-quality management)
Environmental edpidemiologist
Environmental geologist
Environmental geophysicist
Environmental health officer
Environmental lawyer
Environmental manager
Environmental monitoring technician

Environmental planner
Environmental policy analyst
Environmental psychologist
Environmental risk assesor; impact assessor
Environmental reporter
Environmental science and protection technicians, including health
Environmental scientist and specialist
- Atmospheric physics, climatology and meteorology
- Environmental service technician

Environmental technical salesperson
Environmental technician/technologist
Environmental training specialist
Forest and conservation worker
Fuel cell test technician
Flood defense
Geophysicist
Geothermal analyst
Geothermal geologist
Geo-thermal heat pump designer
GIS analyst
Glaciologist
Green building
- Building energy analyst
- Design simulation professional
- Energy engineer/building scientist
- Energy modeler
- Green building analyst
- Green commissioning mechanical engineer
- Home energy and green rating professional
- LEED AP
- LEED certification coordinator
- Sustainable building engineer

Hazardous materials specialist
Hazardous waste technician
Hydrologist, hydrogeologist
Industrial waste inspector
Industrial production manager
Landfill engineer
Landscape architect
Lobbyist
Naturalist
Occupational hygienist
Oceanographer
Packaging scientist
Park interpreter
Park warden
Pollution control technologist
Process engineer
Project developers
Reclamation specialist

Recycling coordinator
Smart grid technologies

- Advanced metering infrastructures hardware project manager
- Electronic test technician
- Energy systems controls engineer
- Field service engineering technician
- Manufacturing supervisor
- Power electronics engineer
- Program manager
- Senior software engineer
- Test automation engineer
- Utility program manager

Solar PV manufacturing

- Solar panel and geothermal heat pump installer
- Crop and slab engineer
- Crystal growing engineer
- Laser operations technician
- Logistics manager
- Module manufacturing engineer
- Production planner/scheduler
- Quality insurance manager
- Silicon crystal growers
- Wire technology engineer

Soil conservationist
Soil scientist
Sustainable architect
Sustainable interior designer
Toxicologist
Urban and regional planner
Waste management specialist
Wastewater collection and treatment operator
Water and wastewater plant engineer
Water quality technician/technologist
Water treatment and distribution operator
Wildlife biologist
Wildlife technician/technologist
Wind power development

- Wind energy developer
- Wind energy technician
- Wind field technician
- Wind plant monitoring technician
- Wind data analyst
- Site supervisor
- Senior risk management analyst
- Senior buyer
- Wind energy forecasting and resource assessment
- Site prospector
- Wind plant administrator
- Senior property agent