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## **The Greening of Canada's College Curriculum. A Pan-Canadian Survey**

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### **Abstract**

Canada's colleges are adept at developing new skills training and educational programs to meet changing labour market needs. The challenge of responding to a greening economy, environmental sustainability and climate change and mitigation is different. In this, colleges face the prospect of systemic transformation of education and training programs, with limited market intelligence, and an increasing sense of urgency. This paper explores how colleges are leading and responding; with examples of new programs and program modifications, curriculum innovation, new strategies for teaching and learning, new types of partnership and a vigorous applied research agenda. Advancing Knibb's frameworks we identify three phases of development that characterize curriculum greening in Canada's colleges and institutes; some strategies for curriculum adaptation; propose a typology approach that can be used to help manage the curriculum transformation process, and suggest some systems level changes that would facilitate curriculum greening.

This paper provides an overview of pan-Canadian college efforts to meet the skills needs of a greening economy and climate change mitigation, and the evolving strategies for curriculum design, teaching, learning and applied research. It focusses on the 137 publicly funded providers of technical/technology training; the colleges, cégeps, (Quebec's Collège d'enseignement général et professionnel), institutes, and polytechnics, (herein after referred to as colleges), which serve over 3,000 communities, Canada wide. (Of note, TVET is not a term in common usage in Canada.) Established with a mandate to support economic development in each of their regions, most have distinct institutional cultures, areas of specialization, applied research programs, industry/business partnerships and international programs.

**Keywords:** *greening, Canada, college curriculum, green skills, green economy, green jobs, environment*

### **1 Introduction**

In examining current practices, this paper evaluates: the status of, and growth prospects for, Canada's greening economy and greener jobs; the demand for green skills and skills for sustainability and the definition, development and nature of those skills, across and between sectors.

Then it assesses: the ways in which federal and provincial policy, has shaped colleges' sustainability strategies and the preparation of an appropriately skilled work force; current strategies for the greening of college curriculum, and the challenges of, and approaches to, the

systematic design and evaluation of that curriculum, together with some frameworks to help facilitate that process. It concludes with a commentary on: the ways colleges can be more effective as agents of change in addressing the urgencies of a greening economy. The focus of this discussion is on leveraging academic programming and applied research in the interests of a greening economy; college green campus initiatives have generally been well documented. The paper proposes that new and different ways of thinking around curriculum design, development and modification are critical to the success of transitioning programs to a greener economy. It proposes a number of different strategies including approaches to curriculum adaptation, a green skills typology and some systems level changes that would facilitate change.

## **2 Factors influencing the greening of the economy and green skills development in Canada**

The status and growth potential of Canada's green economy and green jobs has been shaped by regional differences, challenges of intergovernmental relations, and a patchwork of policies, all of which have affected college capacity to respond as needed, where needed, to skills training.

First, there is no single, federal government agency tasked with either the leadership of, or accountability for, the greening of the economy. There are currently no national strategies for green jobs or green skills, although these may exist at the provincial level. For much of the last decade, leadership on climate change and mitigation has been assumed by the provinces, (e.g. British Columbia's carbon tax 2008; cap and trade in Quebec 2007), while at the tertiary level municipalities are making integrated sustainability planning a priority (Federation of Canadian Municipalities 2011).

Data collection and metrics related to the scope, scale and growth of the green economy, as well as Green House Gas Emissions (GHG), rests with no single level of government. Projections of pan-Canadian human resource needs for a greening economy are largely diffused across sectoral councils. Provincial and/or federal policy initiatives have periodically stimulated job creation in areas associated with the greening economy, such as research, development and commercialization in the clean technology industries; Feed in Tariff programs, (Ontario's Green Energy and Green Economy Act 2009, British Columbia's Clean Energy Act 2010); or subsidies for energy conservation and building retrofits (the federal Eco-Energy Retrofit Homes Program, and Manitoba's Power Smart), but these efforts have not always been sustained.

Second, a coordinated, pan-Canadian training response to green skills development isn't realistic. There are multiple training providers with accountability for technical/technology training. Regional differences are profound. Colleges, as with all education, fall within provincial/territorial jurisdiction, with significant differences in funding, operations, academic programming, and quality assurance processes.

Third, Canada's post-secondary educational institutions are managing complex issues, which, while not unique to Canada, are transformational. These include outcomes-based learning; a changing student demographic; increased public and employer scrutiny and government accountability; issues around credentialing, credit transfer and portability of credentials; quality assurance processes, and significant pressure on revenues. In this context, sustainability and the greening of curriculum are not always an institutional priority, unless the goal is aligned successfully with some of these other, pressing concerns. Moreover, gains from sustainability initiatives are not necessarily easy to account for, especially in the short-term.

Finally, as in many jurisdictions, definitions of green skills, green jobs, the green economy and sustainability continue to be debated. The differences in understanding and value have not helped to either, raise awareness of, legitimize, or promote consistency in green skills development, or measure its usefulness and affect. There are, as yet, no common definitions of green skills or skills for sustainability, used with consistency across elementary, secondary and post-secondary institutions and the rest of government and business.

This complex and fluctuating landscape leads to challenges in the development of pan-Canadian college initiatives around clean technology including for example, development of common curriculum; inter-institutional and inter-provincial credit transfer initiatives; cross-sectoral dialogue on human resource development needs, and the mapping of non-traditional career pathways in a greening economy.

### **3 The status of and growth prospects for the green economy in Canada**

#### **3.1 The greening of the Canadian economy**

The Canadian economy 'varies considerably by province and region reflecting differences in natural resource endowments, geography, labour force, educational institutions and other factors' (Sustainable Prosperity 2012, 2). Assessment of the scope and growth of Canada's greening economy is as much a challenge of definition, as it is of accessible, relevant, current, and useful metrics and data. Most definitions fail to 'capture the full nature of what a green economy should be in the Canadian context' (Wood 2013). Often, it has been defined narrowly, sometimes as a subset of the existing economy, usually with a focus on environmental goods and services, (ECO Canada 2010, 3), but rarely factoring in the incremental changes that contribute to greening across all industries. Definitions fail to adequately account for clean air and carbon emissions; 'dirty' industries transitioning to greener practices, (Alexander & McDonald 2013, 1); natural capital productivity, such as carbon storage; or the economic contribution of 'biodiversity protection and land and water conservation', (Kuszewski & Crowther 2012, 5). Nor are the indirect benefits of moving towards a greener economy (better jobs, quality of life, changes in consumer habits and healthy communities) easily accounted for.

More inclusive definitions advocate a systems approach, one that acknowledges the 'complex set of interrelations between the environment and the economy,' (Alexander & McDonald

2013, 3), and address social well-being and social equity as well as the capacity for resource efficiency and low carbon (United Nations Economic Program 2011).

This challenge of definition has not been helpful to colleges in their efforts to identify, prioritize the development of, justify and position new and modified, greener programs.

### **3.2 Green jobs and the greening of jobs**

In 2008, the Canadian research programme ‘Work in a Warming World’ reflected on why, ‘despite our growing concern about environmental sustainability, existing research on the complex interactions between climate change, work and employment in Canada has yet to be collated, analyzed and synthesized’(2015). Later, Winter and Moore (2013) noted: ‘There is little information on green employment in Canada. As many studies point out, green jobs do not typically fit into standard industry or occupational definitions’ (11).

Early labour market analysis of the green economy focused mostly on renewable and clean energy, environmental sector jobs and the minimizing of environmental impacts. Data on jobs in construction, business, forestry, mining, transportation, and other areas that might be considered ‘brown’, or ‘transitioning’ to green, was, and is, more difficult to quantify, and is often siloed. Often, data collection has been sporadic with long intervals between studies. A cross-sectoral analysis of green employment is missing; more needs to be known about distinctions between entry-level, versus middle-skill jobs. More usefully, distinctions are now being made between ‘green’ careers and jobs where a percentage of work activity might be considered ‘green’, and a new class of ‘sustainability practitioners’ has been defined as those ‘who spend at least 50% of their time performing activities related to environmental, economic or social sustainability’ (ECO Canada 2013).

From a training/education perspective, there are obvious challenges. Students and parents want to know the realities of emergent, green(er) careers and prospects for job mobility and advancement. College programs need to be carefully positioned so that the skill development is anticipatory, but not so far ahead that students do not have the right skills match for the workplace. Colleges must be able to build a business case for new programs. Curriculum development is dependent on environmental scans, labour market intelligence and pattern recognition to create/modify programs, yet colleges have limited, up-dated resources available to them in assessing skills need. It could be said that the greening of college curriculum has been driven as much by a conviction that it is the right thing to do, than by an evidence-based rationale.

### **3.3 The role of industry and sector councils in identifying green skills**

In Canada, green skills identification has been mostly sector or industry specific. There has not been the kind of cross-sectoral collaboration that has occurred in jurisdictions such as the United Kingdom, across the European Union and in Australia, that has resulted in definitions

of broad-based skills for a low carbon economy, collaborative green skills development strategies, systematic approaches to skills modification and career mapping.

Canadian sectors have each developed distinct approaches to the identification of green skills and/or National Occupational Standards/NOS. NOS are the ‘competencies required to perform successfully in a particular occupation’ including ‘core knowledge, transferable competencies and technical skills’ (ECO Canada 2015). Significantly, the NOS reflect a maturity of job performance, (i.e. five years of work experience), not necessarily the skill sets required of the entry-level, college graduate. In addition, the NOS are usually renewed on a five year cycle; a development process that is not able to respond easily to rapid change in skill sets, or incremental changes and skills modification.

Three sector approaches are briefly examined here in order to illustrate the variants of approach. They represent areas in which colleges are considered primary providers for entry-level training, and cover three diverse areas: environment, electricity and construction. In each case, there is a somewhat different relationship between the sector and the training providers and they illustrate some of the challenges in developing a uniform approach to curriculum greening.

## **Environment**

The sector council for environmental careers, ECO Canada, based its National Occupational Standards on established environmental skills, both specialized technical and soft skills that can also transfer usefully to other occupational areas in a greening economy. In common with other jurisdictions, the sector’s influential 2010 labour market research study, *Defining the Green Economy*, concluded that a green economy impacts the labour force not so much through the creation of new jobs, but mainly through the adaptation or reallocation of jobs (ECO Canada 2010, 19). Existing workers have ‘to learn new skills and/or broaden their pre-existing skill sets’ (ibid, 19). As well, jobs where a component part of the activity might be considered ‘green’ applies to a much broader section of the workforce. Both require a rigorous approach to the review and modification of college curriculum and are potentially more challenging to negotiate, than developing new programs for specialized green jobs.

As the first generation of green skills were identified under the environmental banner, there has been a tendency to classify them as contributing primarily to the production of environmental goods and services. It has taken several years for a more inclusive, cross-sectoral approach to emerge. In a subsequent 2012 ECO Canada study, *The Green Jobs Map*, researchers analyzed current green job descriptions, reflecting labour market needs captured ‘as found’ in job listings. The study noted that ‘the growing influence of the green economy ... corresponded with greater integration of environmental information into strategic decision-making and business planning’ (ECO Canada 2012, 4). Skills developed through environmental work in ‘regulatory driven contexts, such as expertise in human health and safety, environmental protection, and environmental remediation’, were now being applied more broadly across other sectors (ibid 4). ECO Canada has collaborated with colleges in order to promote the

integration of these relevant skills across environmental and natural resource management programs, but more work is needed on skills transfer to other sectors.

## **Electricity**

The Electricity Human Resources Council identified specialized, green technical skills for new/emergent occupational areas and jobs in renewable energy. A 2008 study, *Powering up the future*, projected specific long-term skills shortages in the solar industry, primarily in installation, as well as the greening of 'technical areas, systems design and integration, sales, project management and engineering (2). A subsequent 2014 pan-Canadian study, released after a significant gap, and entitled *Renewing Futures a National Human Resource Strategy for Renewable Energy (RF)*, identified seven new sub-sectors: wind, solar, bioenergy, geothermal, hydro (small and large), marine: tidal and wave; integration and storage (4), as well as a steady increase in jobs in operations. The study also warned of an impending, substantial, shortage of qualified workers, threatening the high growth potential of the industry. While urging a national Human Resource strategy and the collaboration of industry, government and educators, the importance of post-secondary education in skills training was made clear, as was the need for on-going collaboration. Of 95 training programs of relevance to renewable energy, 52 were offered at the technician/technologist level in engineering, by colleges and universities and 39 of those were college programs. These were described as 'the core of Canada's current capacity to add depth and breadth to the RE workforce' and 'the central focus for strategic actions' (ibid 12).

## **Construction**

In the past it was argued that while there was a critical need to 'green' the construction industry, especially in the area of materials selection, this change process did not necessarily require that skilled trades workers would require, or benefit from, 'up-skilling'. The assumption was that engineering and design professionals would make most key decisions (O'Grady 2010, 169). That perspective is changing. In *Closing the Gap Green Skills Training for Trades*, Hazel Farley of the Canada Green Building Council defines the 'green gap' as 'missing foundational knowledge that is necessary for all individuals involved in constructing today's buildings' (2015). Moreover, there is increased recognition of the need for 'in-depth training' of 'specialty trade occupations such as plumbers, electricians, carpenters, and HVAC mechanics', in order to 'become familiar with new green technologies and techniques' (ibid). An alternate, not-for-profit group, the Construction Resource Initiatives Council, also has been working on engaging stakeholders in greening the supply chain for the construction industry, focusing on a change strategy, as well as the skill development required to tackle a non-linear and complex field which crosses jurisdictions: 'Landfills are municipal. The province is the regulator. And, materials are an international trade matter. The supply chain is ultimately international, with local and regional intricacies' (Gratton in Milijasevic 2015).

These cases illustrate the challenge for colleges in responding to distinct industry and sector skills needs, different rates of change as well as regional and jurisdictional differences,

through different education/training models and approaches, across multiple programs. Sometimes it is difficult for colleges to bridge the gap between the skills needs identified by sector councils and industry bodies for early-to-mid career, and expressed in National Occupational Standards, against those required for entry-level positions and college curriculum. More could be done to bridge this skills gap.

## **4 The capacity of Canadian colleges and institutes to meet emerging, in-demand green skills**

### **4.1 The greening of Canada's colleges**

Historically, Canada was an early leader in the promotion of Education for Sustainable Development (ESD). Pan Canadian initiatives, such as the incorporation of sustainable development in primary and secondary education policy across Canada's provinces and territories began as early as 1991 under the leadership of Learning for a Sustainable Future.

At the tertiary level, institutions also began to embrace sustainability in their operations and culture with both universities, (The Halifax Declaration 1991), and colleges, (The Pan-Canadian Protocol for Sustainability 2007), developing voluntary protocols.

With the 2005 launch of the UNESCO Decade for Sustainable Development, many colleges began the more systematic integration of sustainability across the curriculum, aligning with the global, 'green campus' movement as well as responding to sector needs. The result has been an evolving matrix of inter-related initiatives, not necessarily a coordinated, college-wide movement. Every college is at a slightly different place on this sustainability continuum with growth occurring in all, or some, of these dimensions. Table 1 illustrates some of these differences and inter-dependencies. In each case, it could be said that colleges are responding to different stimuli, which have promoted and accelerated certain initiatives over others. For example, in Ontario, the 2009 Green Energy Act was the impetus for new programs in renewable energy; the UNESCO Decade for Sustainable Development influenced the teaching of more generic principles of sustainability, and the green campus movement has been supported by the co-ordinating work of Colleges and Institutes Canada, as well as that of the USA-based Association for the Advancement of Sustainability in Higher Education.

Table 1: The greening of Canada’s colleges: scope of activity (Knibb 2012)

Learning for sustainable development	Green skills development	Green campus movement	Applied research
<p>Learning for sustainability; understanding the ‘why’ of sustainability</p> <p>Environmental, ecological and sustainability literacy (general education or breadth courses)</p> <p>Infusion of skills for sustainability (generic or employability skills) across the curriculum</p> <p>Changing teaching/ learning strategies such as place-based learning, service learning and action research</p>	<p>New and modified green/greener programs and learning outcomes</p> <p>New industry/sector partnerships</p> <p>New industry and academic standards</p> <p>Changing approaches to program design (e.g. stackable credentials, multiple entry/exit points, career mapping)</p> <p>Changing strategies for teaching, learning and assessment (e.g. use of external experts, applied learning, field practice, co-op)</p>	<p>Campus as ‘green’ learning laboratory; modelling of best practices; applied research</p> <p>Sustainability embedded in college vision, mission, strategic and operation plans and policies</p> <p>Greening of campus operations (e.g. buildings, transportation, landscaping, food services, student residences, resource conservation)</p> <p>Student engagement in, and leadership for, sustainability</p> <p>Community engagement and partnerships</p> <p>Use of sustainability self-reporting metrics to measure institutional progress (e.g. Sierra Youth Coalition’s <i>Campus Sustainability Assessment Framework</i> (CSAF), or AASHE’s <i>Sustainability Rating and Tracking System</i> (STARS))</p>	<p>Increased access to federal/provincial research funding for mitigating environmental impacts</p> <p>Centres of specialization/ excellence, many with a focus on clean technology and environment</p> <p>Increased opportunities for student engagement in applied research</p> <p>Evolving, research-driven curricula</p> <p>Project partnerships between colleges and universities, sectors and industries, and small-to medium sized businesses (SMEs)</p> <p>Technology transfer</p>

Today, the conversations around sustainability are occurring in multiple arenas, including those of special interest groups, in a pan-Canadian context facilitated by Colleges and Institutes Canada (CICan), and in a north-south dialogue through the Association for the Advancement of Sustainability in Higher Education. Increasingly, colleges are being drawn into the global conversation through project partnerships and applied research.

#### 4.2 Curriculum greening

College green skills development has, according to Knibb, (unpublished paper, 2013), followed a number of distinct, but overlapping development phases, ones not atypical of those occurring in other jurisdictions:



*First phase: circa 2005-2011*

In this first phase, college-level green skills development was most often in the form of isolated, voluntary actions, sometimes in response to one-time, often short-term, stimulus funding (e.g. Ontario's 2009 Green Jobs Skills Strategy provided \$5 million over two years); a faculty member with a good idea; an alignment with a regional economic activity or priority; a sector/industry partnership (e.g. Electricity Human Resources Canada's Wind Turbine Maintenance curriculum), or the outcome of a college sustainability plan.

Much has been learned from this first generation of new, 'green' specialized programs, particularly in the area of renewable energy. Often, it was assumed a new and distinct program was needed. Some were at too basic a level, too broad-based for the job requirement, or developed for a student profile that was not the best fit for the credential. Sometimes designed without benefit of external occupational or academic standards and/or regulation, the programs often lacked consistency in program nomenclature, (e.g. programs might be variously described as renewable, sustainable, alternate, green, or clean energy technology), and program outcomes, length and credentials varied significantly. Some referenced international standards, such as those of the North American Board of Certified Energy Practitioners (NABCEP), adding Canadian and/or provincial content to the skills mix. They produced generalists and specialists; and at best complemented industry certifications. Some caught the student imagination, and others struggled with recruitment. Often, there were limited numbers of skilled faculty, resourcing was an issue, and curriculum may have suffered from the 'laundry list' approach to skills development (Wiek, Withycombe & Redman 2011, 204). It was not unusual for not-for-profit organizations to be ahead of the colleges, through the provision of short courses and specialized training. Some sought collaborative arrangements in order to formalize that training.

Of necessity, colleges and institutes developed innovative strategies for teaching and learning, built community/industry partnerships, and integrated field experience and applied projects. As with the sector councils, colleges were feeling their way without benefit of a green skills classification, or reliable labour market intelligence. Despite these start-up challenges, students graduated, found jobs and sometimes went on to further education.

New, blended programs also began to be developed, such as green business, green or sustainable building, and sustainable agriculture. While developed from an established discipline, they set themselves apart with a distinct learning culture and values; links with community, project-based learning and often, they attracted a very different student profile, including university graduates.

Colleges also began to present a 'greener' public profile. Existing programs in environmental science and natural resource management became part of the 'green' inventory and a tool in student recruitment. Most important, consideration was given to the greening of all academic programs, not necessarily new 'green' programs.

### *Second phase: 2011 to present*

The second generation of specialist, green technical/technology programs have benefitted from a more systematic approach to design. Curriculum developers can reference a growing body of knowledge and new, Canadian, industry-driven occupational standards, particularly in renewable energy. (A major stimulus to standards development was the passing of green or clean energy acts in some provinces.) Programs may be positioned differently, and build directly on skills sets and credentials, sharing common foundation curriculum such as electrical, mechanical or power engineering. Job prospects for graduates are greater, as is academic and work place mobility.

The most significant developments are modifications within established programs, sometimes through program-level learning outcomes, but operationalized at the course-level by infusing concepts of sustainability such as social justice, diversity and indigenous culture across the curriculum. These are changes that reach and influence all students, on an assumption that practices in all occupational areas will need to change in order to promote workplace sustainability. These changes have not been easy to design, implement or evaluate. A primary focus is how best to engage faculty and students in what is sometimes perceived as values-based curriculum, and the most effective strategies for teaching, learning and assessment.

### *Third phase: 2012 to present*

Historically, colleges did not have access to research funding and applied research activity was limited, but it could be argued that this is a key characteristic of the emergent third phase of college greening. The impetus for this development phase is access to new sources of funding, and it parallels and expands upon developments in phase II. An environmental scan of pan-Canadian college activity, (2012-13), identified 654 areas of research specialization and 489 specialized research centres and labs, engaging nearly 30,000 students. Small and medium sized enterprises accounted for 78% of the business/industry partnerships with a growing number of social innovation projects. Environmental science and technologies, natural resources, and energy and clean tech sectors were strongly represented, with projects in areas such as mine remediation, clean water, and organic food production (ACCC 2014).

Since 2002, colleges have also accessed Natural Sciences and Engineering Research Council, (NSERC) funding through a federal program supporting public-private partnerships. Aiming to increase innovation at the community and/or regional level, it enables Canadian colleges to work with small-to-medium sized businesses (SMEs) on applied research, commercialization, technology transfer, adaptation and adoption of new technologies (ACCC 2013). Subsequently, numerous clean technology projects have developed under the program in areas such as land reclamation, agriculture and green roof technology.

The potential impact of this work is profound. Research-driven curriculum may ultimately leverage the most significant and lasting of any changes in the greening of college programs.

## 5 Strategies for the greening of curriculum and approaches to systematic design

A challenge in the process of greening program curriculum is finding clarity and consistency of expression in articulating new types of vocational learning outcomes, as well as building efficiencies in the design process. Knibb (2012, 2013) identifies at least three primary strategies, of increasing complexity:

### 5.1 Additive strategies for curriculum greening

The most simple and direct approach to curriculum greening has been modification through an additive approach. Strategies include:

- Mandatory or voluntary college-wide, sustainability Vocational Learning Outcome(s) (VLOs) that can be aligned to any program. For example, Nova Scotia Community College has five Sustainability Learning Outcomes. They include students' ability to: develop skills necessary to implement sustainable solutions; the capacity to make connections between their chosen program of study/career path and sustainability; to view themselves as part of inter-connected world systems; to synthesize understanding of social, economic, and environmental systems and discuss practical solutions to sustainability issues and understand how sustainable thinking and decision-making contributes to the process of solution-building for social, environmental, and economic crises (NSCC 2015).
- New, program specific, or course-level VLO(s) sometimes developed in collaboration with industry stakeholders;
- Mandatory, or voluntary college-wide, or program-specific general education courses or electives with a focus on education for sustainability (e.g. Introduction to Sustainable Development, Environmental Sustainability, Global Warming Concepts);
- Learning for sustainability with action-oriented, trans-disciplinary courses such as Yukon College's Decision Making for Climate Change, that provides an overview of climate change science and policy, and the tools for integrating climate change considerations into policy and planning;
- Establishing targets, (e.g. specific numbers of new courses with a sustainability focus);
- Vocationally-oriented, 'bolt-on' course(s) as a means of quickly up-dating a program (e.g. Canada's Green Building Council offers a number of courses in LEED (Leadership in Energy and Environmental Design) in partnership with Canadian colleges);
- 'Top-up' of existing programs with certificates or modules, ('up-skilling'), such as the Green Professionals Building Skills Training; five upgrade modules for the skilled trades, based on a 2010 American program of the same name.

## 5.2 Systematic approaches to integrating sustainability across the curriculum

More challenging from a design perspective, is the infusion of green/sustainability skills in ways that alter program structure, or more profoundly, the culture of a program. These more systematic changes could include:

- Infusing sustainability concepts and themes across the college culture (e.g. Centennial College's Signature Learning Experience: Global Citizenship & Equity, the outcomes of which can be attained through a student portfolio; or Yukon College's 'core competency' in knowledge of Yukon First Nations, which is now required of all students);
- Review of all program/course level Vocational Learning Outcomes and modification, as and where, required as part of a cyclical program of program review and quality assurance;
- Developing new 'green' specializations around an established academic foundation in order to facilitate career mobility through 'stackable credentials' (e.g. Wind Turbine Technician/Industrial Electrician Coop Diploma Apprenticeship, St Lawrence College, Ontario);
- A focus on 'skills for sustainability' as essential employability skills, embedded in all programs;
- Development of a bank of green, technical, cross-sectoral, vocational learning outcomes that can be adapted to any program at various levels (e.g. waste reduction, energy conservation and green procurement);
- Changing strategies for teaching, learning and assessment.

In all cases, a significant challenge has been the extent to which these strategies are, or can be, evaluated effectively as curriculum models, in relation to the needs of the workplace and economy, and with regard to the short and long-term impacts on student mobility and success.

## 5.3 A green skills typology

Developed by Knibb, (2012, 2013), as a response to the challenges of integrating different skill types and modifying others, this typology (see Table 2) can be used in the re-framing of program curriculum. It was designed as a development tool in order to help faculty manage their thinking around greening the curriculum, gradations of change and skills progression. For example, it makes distinctions between the type and nature of technical skills and helps to illustrate where commonalities across program families might be found, thereby finding efficiencies. It amplifies and make distinct, the important 'skills for sustainability', but at the same time aligns them with the existing convention of required learning of generic or soft skills, to make their integration easier. All skill types can be expressed at different levels of learning.

Table 2: **Green skills typology for technical and technology-based, college programs (Knibb 2015)**

Skill types	Description and application to the work place
Specialist technical skills	<p>These skills most commonly apply to what are sometimes called ‘deep’ green jobs. They may be:</p> <ul style="list-style-type: none"> <li>▪ Job specific, or distinct to an emergent, occupational area</li> <li>▪ ‘New’, but more commonly are adapted from existing occupational areas, or represent a fusion of existing, but often very different skills for a new application (e.g. installation of roof-top PV panels)</li> <li>▪ Few in number, relative to other skills categories</li> <li>▪ Focussed on the production of goods and services</li> <li>▪ Time-sensitive, (requiring rapid development), or time-limited, (e.g. installation of a particular product that may have a limited shelf-life)</li> </ul> <p>Some may be positioned at the granular level, requiring only ‘surface learning’ (such as the capacity to follow, accurately, manufacturer’s instructions for installation). Others may be complex requiring site assessment and design skills.</p> <p><u>Examples:</u> photo-voltaic systems design; installation of photo-voltaic panels, decommissioning of wind turbines.</p>
Broad-based technical skills	<ul style="list-style-type: none"> <li>▪ These skills apply to a broad range of technical/technology programs.</li> <li>▪ Includes new(er) or modified green, (or environmental), skills common across multiple jobs, occupational areas, industries, or sectors and/or program ‘families’ (programs within the same cluster, possibly at different levels of learning).</li> <li>▪ Several models for these have been developed at a jurisdictional level (e.g. UK’s <i>Skills for a Low Carbon and Resource Efficient Economy</i>).</li> <li>▪ Identification of these skills might help promote greater consistency of approach, as well as commonalities across education/training programs.</li> <li>▪ Once identified, these skills can be adapted to different workplace contexts.</li> </ul> <p><u>Examples:</u> life cycle assessment; impact minimization processes; reporting for sustainability; carbon accounting; energy conservation; waste reduction and management.</p>
Transitioning skills	<ul style="list-style-type: none"> <li>▪ Represent the adaptation of existing vocational skills to include more sustainable practices and processes.</li> <li>▪ Most common skills types for ‘light’ green jobs where a percentage of the work may need to adapt to new practices.</li> <li>▪ Modifications may be incremental.</li> <li>▪ Represents a large skill cluster of particular significance in</li> </ul>

	<p>re-positioning <u>all</u> academic programs around change in work processes.</p> <p><u>Examples:</u></p> <ul style="list-style-type: none"> <li>▪ Business (green procurement; stakeholder engagement);</li> <li>▪ Construction (materials selection; building decommissioning and materials reuse; appropriate disposal);</li> <li>▪ Culinary arts (selection and use of energy efficient appliances; waste reduction; sourcing of local food).</li> </ul>
<p>Skills for sustainability (transversal skills)</p>	<ul style="list-style-type: none"> <li>▪ Future-oriented skills for sustainability, (e.g. thinking, process and change agent skills; ‘habits of mind’), that can help build desirable graduate attributes such as resilience and adaptability in an unpredictable and changing work world and climate.</li> <li>▪ Considered to be key skills for the 21st Century workplace and ‘career capital’.</li> <li>▪ They ‘prepare people to cope with, manage and shape social, economic and ecological conditions characterized by change, uncertainty, risk and complexity’ (Sterling, 2012, 9).</li> <li>▪ They complement, and can be integrated into, existing frameworks for generic skills, essential employability skills, or so-called ‘soft’ skills.</li> <li>▪ Do not require frequent up-dating.</li> <li>▪ May be challenging to teach to, and assess.</li> <li>▪ Must be embedded in curriculum not taught ‘stand-alone.’</li> <li>▪ Require ‘deep’ learning.</li> </ul> <p><u>Examples:</u> systems thinking, capacity to solve complex problems, civic responsibility, accountability for the consequences of one’s actions, ethical/moral decision-making, the capacity to work in intergenerational, culturally diverse environments.</p>

There has also been a concerted effort by colleges to promote teaching, learning and assessment strategies that help students move from learning about sustainability to learning for sustainability. To do so, means for example, a shift from lecture-based delivery to problem-oriented, real-world, (often community-based), applied projects. Strategies might include team-teaching across disciplines, mentoring/coaching, use of external experts from the local community, business and government, use of ecological principles to integrate curriculum elements, place-based learning, (outside the classroom), and authentic assessment. A focus on the evaluation on the effectiveness of these methods in teaching to sustainability would be a critical contribution to furthering our understanding of best practices for applied arts and technology programs.

## 6 Green skills development: challenges and solutions for Canada's colleges

The greening of the economy requires a new kind of responsiveness from training providers and other stakeholders and new approaches to skills analysis and program design. The fusion of new and existing occupational skills sets across sectors, changes in the type and nature of work, different expectations of work place performance, and the capacity to respond to environmental and social challenges require different approaches. Knibb documented some of these as an outcome of an investigation into strategies on the greening of post-secondary curriculum (unpublished paper 2013). They might include for example:

- Recognizing emergent, cross-sectoral, skill sets and opportunities for occupational 'fusion' (e.g. energy management and sustainable building technology);
- Facilitating multi-skilling and employee mobility through increased cross-sectoral dialogue and collaboration with sector councils, trade unions, and government;
- The timely collection and dissemination of reliable, relevant and accessible data on projected skills needs, regionally as well as nationally;
- Capacity to deliver, and 'speed to market' from training providers, as well as from those agencies charged with standards development, accreditation or regulation;
- Recognition that 'one size does not fit all', and that regional distinctions, particularly those relating to labour shortages, skills needs and training in the North, and in First Nations and Inuit communities, must be accounted for;
- Targeting training to the right audience at the right level (e.g. many clean technology jobs are considered 'middle-skill' requiring more than a high-school diploma, but less than a university degree);
- Consideration of worker mobility and, increasingly, international mobility, especially in renewable energy;
- 'Next generation partnerships' in order to better resource quality skills training and program resources;
- Orientation of high school students to the career possibilities of a greening economy including career lattices, the value of STEM subjects, and workplace experience;
- New approaches to workforce development, and dissemination of information to better enable career counselling;
- Strategies for effective evaluation of skills training, particularly in the area of skills for sustainability, including longitudinal studies.

In moving forward, it's clear that given the scope, scale and possible required speed of change and development, Canada's colleges would benefit from a number of strategies that would help promote a more systematic approach to green skills development and the capacity to respond to 'urgencies' in meeting skills needs. There is a need for more structures, sup-

ports and stimuli, as well as greater efforts at alignment of activity across all levels of governance and policy-making. Based on an inter-jurisdictional investigation by Knibb (unpublished paper 2013), these might include:

#### *Jurisdictional level*

- Alignment between, and a commitment to, long-term policy directives at provincial and federal levels to stimulate and support the greening of industries and green skill development;
- A ‘whole of government’, systematic and inclusive approach to policy and green skills development (e.g., the province of Manitoba’s Education for Sustainability Leadership Council will guide a ‘whole-system approach’ towards education for sustainability).
- Stable, long-term, funding to support research and innovation and technology-industry partnerships;
- Inter-jurisdictional collaboration around credentials and portability of qualifications.

#### *Sector level*

- Current, relevant, and accessible, labour market intelligence;
- Reliable, current and proven occupational and/or academic standards to promote program-to-program consistency and quality assurance in fields that are still emergent;
- Career mapping;
- Better understanding of the merits of skills for sustainability and their value in the workplace;
- Increased cross-sectoral dialogue around critical, broad-based technical skills;
- Rigorous evaluation of green workplace skills and their relevance.

#### *College systems level*

- A systematic, (scalable and transferable), but not necessarily prescriptive, approach to green skill development that promotes consistency across ‘like’ programs, but which can accommodate regional and institutional differences;
- New approaches to training for existing jobs transitioning to green (de-carbonizing);
- New models for program design that promote student access and mobility (i.e. multiple points of entry);
- Flexible models of academic program development, implementation and renewal that better respond to the needs of emergent occupations and/or rapid skill change including ‘up-skilling’ and retraining;



- Creative and collaborative approaches to resourcing new program design (e.g. industry partnerships, regional consortia, centres of specialization/excellence, shared curriculum, innovative financing).

#### *Institutional level*

- Development of faculty expertise – not only specialized content, but appropriate teaching, learning and assessment strategies;
- An holistic approach to curriculum development and mapping of green skills across programs;
- Continuous, and critical assessment of green/sustainability-related curriculum initiatives;
- Integration of applied research as a means of driving curriculum greening;
- Long-term commitments to the sustainability agenda.

## **7 Summary and Conclusion**

Despite limited labour market intelligence in many sectors, colleges are moving forward with ambitious sustainability initiatives. The analysis of current practices suggests that there are commonalities of approach, within a culture that also supports and celebrates institutional distinctions and regional differences. Their collective strengths include:

- Developing distinct cultures of sustainability that respond to regional, student, and community needs and institutional strengths;
- Green campus initiatives and modelling of sustainability practices across all campus operations (campus as learning laboratory);
- ‘Second generation’ programs of study in renewable energy and clean technology, and the design of ‘next generation’ cross-sectoral programs that offer new skill combinations;
- Partnerships with local, small-to-medium businesses and stimulous to the local economy;
- Centres of specialization, applied research and technology transfer;
- Working with First Nations youth to build better, more sustainable communities, and promoting understanding of First Nations’ culture across the student population;
- More systematic approaches to the infusion of green skills; the greening and modification of existing skills and skills for sustainability across all college curricula, reaching all students.

Canadian colleges have the responsiveness, flexibility, adaptability and the will to be at the forefront of green skills training. What is also needed is an enriched infrastructure and long-term funding commitments that will help build and accelerate that capacity for change.

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