Greenification of SMEs:

Green Skills Competency Framework

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The Diversity Institute conducts and coordinates multi-disciplinary, multi-stakeholder research to address the needs of diverse Canadians, the changing nature of skills and competencies, and the policies, processes and tools that advance economic inclusion and success. Our action-oriented, evidence-based approach is advancing knowledge of the complex barriers faced by under-represented groups, leading practices to effect change, and producing concrete results. The Diversity Institute is a research lead for the Future Skills Centre.

The Future Skills Centre (FSC) is a forward-thinking centre for research and collaboration dedicated to driving innovation in skills development so that everyone in Canada can be prepared for the future of work. We partner with policymakers, researchers, practitioners, employers and labour, and post-secondary institutions to solve pressing labour market challenges and ensure that everyone can benefit from relevant lifelong learning opportunities. We are founded by a consortium whose members are Toronto Metropolitan University, Blueprint, and The Conference Board of Canada, and are funded by the Government of Canada's Future Skills Program.

The Environmental Change Institute (ECI) at the University of Oxford is an internationally recognised centre for interdisciplinary research on environmental change. ECI brings together expertise across climate, energy, ecosystems, food systems, and governance, fostering collaboration between academia, policy, and practice. A particular strength lies in its pioneering work on energy demand and the transition to a zero-carbon economy, including initiatives that support small and medium-sized enterprises (SMEs) through research, tools, and policy engagement. ECI is also a leader in advancing green skills, with projects focusing on the construction sector and beyond, exploring the development of technical, employability, and sustainability skills essential for SMEs to thrive in a net zero future.

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Executive Summary

The Green Skills Competency Framework is a tool designed to support small and medium-sized enterprises (SMEs) and their workforce transition to a sustainable economy. This competency framework is a roadmap for developing essential green skills from a base level of environmental literacy, through skills to support green innovation, to a level of deep green skills. The goal of the Green Skills Competency Framework is to address the competencies needed at all three levels.

*The goal of the Green Skills Competency Framework is to **support Canadian small and medium-sized enterprises (SMEs) and their workforces in the transition to a net-zero economy** by providing a structured roadmap to develop green skills.*

Transition to net zero

Driven by the United Nations' Sustainable Development Goals (SDGs), the global economy continues its shift toward environmental sustainability. Canada has committed to achieving a net-zero economy by 2050 and has supported this transition through strategic policy measures and investments. A net-zero transition is important for ensuring business continuity and enterprise resilience to climate-related shocks throughout the value chain. Working toward net zero is not just a regulatory requirement for enterprises; greening operations (e.g., reducing energy expenditures in logistics, and transport) can generate business value and provide market competitiveness as consumer preferences trend toward sustainability. Decarbonization initiatives offer opportunities

SMEs produce ~50% of GHG emissions within the value chain.

for businesses to upskill their workers, fund a variety of green projects, and engage with rural communities and equity-deserving groups.

Actualizing Canada's net-zero goal requires organizational transition plans for Canadian business that centre on green skills development. Green skills are the knowledge, values, and technical abilities required to support a sustainable business operation. Plans need to outline concrete steps and actions with climate science and ensure accountability. A key aspect of this transition is to identify and reduce greenhouse gas (GHG) emissions, support workers in understanding emissions production across the value chain, achieve regulatory compliance, and provide the necessary skills to implement and innovate emissions reductions strategies. While considerable developments have been made in green technologies and processes within certain sectors, research suggests the implementation of skills-development programs for the green transition has not received the same attention. Small and medium-sized enterprises have limited guidance, yet produce around one-half of all GHGs within the value chain, emphasizing the importance of a targeted skills-development-led transition pathway for SMEs.

SMEs in the transition to net zero

Canadian SMEs employ over one-half of all private-sector workers and make up nearly all of the Canadian business landscape. Despite their importance in the net-zero transition, SMEs face unique barriers preventing access to knowledge, structures, and resources required to develop and implement effective transition plans. To date, many existing programs and competency frameworks, particularly those in Canada, target specific sectors or assume the capabilities of larger corporations. There is a growing global recognition of this gap, prompting responses such as the United Nations Global Compact, which features programs tailored to SMEs. Within Canada, the Future Skills Centre has partnered with the Ontario Chamber of Commerce, the Diversity Institute, and Magnet to develop the Skills Bridge program, a learning management system providing curated training content to address the upskilling demand by Canadian SMEs.

Demand for green skills

The global transition to net zero and the need for SME-tailored guidance aligns with the increasing demand for green skills across the Canadian economy. Research conducted by the Future Skills Centre, Diversity Institute, and Smart Prosperity Institute indicate the growing green skills demand will result in job creation, transition, and transformation in response. Further Future Skills Centre and Diversity Institute research shows green skills are crucial in the net-zero transition for SMEs, which often involve technical science and engineering competencies. More broadly, research points to the need for foundational green literacy across all Canadians for a green transition.

The Green Skills Competency Framework

This report introduces the Green Skills Competency Framework to address the growing demand for green skills in Canadian SMEs, while being applicable to all businesses in their transition planning efforts. The framework is a clear progression for developing cross-functional "greenification" skills that promote environmental sustainability throughout distinct stages. Additionally, it incorporates the Canadian context and diversity considerations while covering a wide range of competencies from basic environmental awareness to advanced sustainability strategy implementation.

Methods

The Green Skills Competency Framework was developed following an extensive literature review of existing frameworks and consultation from SMEs and partner institutions such as PricewaterhouseCoopers (PwC) Canada and the University of Oxford. An analysis of existing frameworks reveals a need for foundational green literacy to support the emphasis on soft skills and broad strategic goals. Frameworks do not focus on upskilling workers and miss out on both technical green skills and the SMEs business context, which face expertise and resource constraints. The Green Skills Competency Framework designed to be applicable to SMEs, including a three-level competency structure for clear progression and alignment with established frameworks.

Framework design

The Green Skills Pyramid structures the Green Skills Competency Framework—a three-level hierarchy of competencies required for environmental sustainability and the green transition. The levels consist of: 1) foundational skills and basic green literacy for building fundamental environmental knowledge; 2) transformational skills for facilitating environmental change within organizations; and 3) deep green skills for developing specialized expertise needed to address transition goals. The framework's core competencies are adapted from the Employment and Social Development

Canada's net-zero goal by 2050 relies on concrete, accountable organizational transition plans focused on green skills.

Canada's Skills for Success framework and promotes environmental literacy through several soft skills required for facilitating a successful green transition. Individual framework competencies are further distilled into three levels: (Foundational), Skilled (Intermediate), and Experienced (Advanced) which describe the progression of expertise as an individual gains foundational knowledge of the competency, is able to apply their expertise in an organizational context, and can demonstrate advanced skill and leadership qualities. The framework and report have undergone several stages of revision with partners at PwC Canada and the University of Oxford.

Preliminary conclusions and implications

The Green Skills Competency Framework represents an important advancement toward providing Canadian SMEs with the necessary guidance to contribute to a sustainable, net-zero economy. Our work addresses critical gaps in SME-applicable green transition frameworks, acknowledging their importance in decarbonizing the interconnected global supply chain and the barriers they face in limited expertise, personnel, and resources. The focus on green skills aims to enhance the competitiveness of Canadian SMEs in global markets while contributing to Canada's net-zero commitments. Importantly, the scope of this framework extends beyond organizational change. As the framework is adopted by more Canadian businesses, it will become a guiding tool for developing policy, form educational curricula, and create new job opportunities for Canadians. The framework continues to be refined through Diversity Institute and Future Skills Centre partnerships.

Context

The Green Skills Competency Framework for Canadian small and medium-sized enterprises (SMEs) builds on existing research on the various technical skills needed for a net-zero economy. Reaching net zero relies on the digitization and innovation for sustainability across firm value chains and soft skills expertise in sustainability, natural resource management beliefs, and attendant social value shifts that minimize environmental impacts.[1] This report focuses on the technical green skills and sustainability competencies in SMEs that are elevated by tacit sustainability and environmental knowledge and perspectives.

Transition to net-zero

A net-zero economy refers to an economic system in which the total amount of greenhouse gas emissions (GHGs) is either eliminated or fully offset.[2] Technology-driven emissions reduction strategies require skilled workers to support the decarbonization of large-scale manufacturing and production processes, transitioning SME operations into clean energy, and implementing energy-efficient equipment. Offsetting methods including methane capture and carbon storage neutralize remaining emissions not eliminated through systems optimization. Net-zero approaches promote industrial and governmental efforts to produce environmentally beneficial goods and services.[3] However, organizations need to have a workforce with the skills to respond to the climate change predicted by scientists and ensure accountability and compliance in their sustainability efforts.[4]

Relative to SMEs, large firms often have greater resources, skills, and specialized trainings to support their net-zero transitions. Large firms—about 97% of S&P 500 companies—account their emissions to GHG Protocol, working to identify greenhouse gas emissions across three scopes: Scope 1: direct emissions from company-owned assets (e.g., vehicles, equipment); Scope 2: indirect emissions from purchased electricity; and Scope 3: other indirect emissions from organizational activities, including the use of product and services.[5] Scope 3 accounts for an average of 75% of a company's total GHG emissions, underscoring the need for organizations to integrate sustainability through the value chain.[6] Decarbonization initiatives offer businesses of all sizes

opportunities to innovate and enhance efficiency and reduce costs. Across sectors, CO_2-equivalent emissions reduction rates match with percent in cost savings for automotive (5 to 10%), energy and materials production (10 to 15%), travel and logistics (5 to 10%), and health care sectors (30 to 35%).[7] These opportunities incentivize firms to gain market advantage through participation in the green economy; however, for SMEs to participate meaningfully, skills-based support is required.

In concert, the Government of Canada is using regulatory and financial metrics to facilitate a transformation toward a net-zero economy. Since Canada's first national climate plan in 2016—the Pan-Canadian Framework on Clean Growth and Climate Change—several policies have followed. These include the A Healthy Environment and a Healthy Economy plan (2020)[8] and the 2030 Emissions Reduction Plan: Clean Air, Strong Economy (2022),[9] both of which utilize incrementing legislative requirements, grant funding, and worker education programs to support emissions reductions by 40 to 45% below 2005 levels by 2030. The goal is to transition Canada to a net-zero emissions society by 2050, per the Canadian Net-Zero Emissions Accountability Act,[10] and capitalize on Canadian industry decarbonization to grow the economy to 400,000 new jobs from 165,000 where green skills are critical.[11] Analyses by the Royal Bank of Canada highlight that about three million Canadian jobs (about 15% of the total labour force) will be disrupted by 2030 as the country transitions toward a net-zero economy. Canada's response in Bill C-50, the Sustainable Jobs Act, addresses the national skilled labour shortage, worker upskilling, and the alignment of current policies and efforts across various sectors and government levels.[12]

Regulatory compliance extends beyond Canada, as many SMEs enterprise operations often extend globally. For example, the Office of the Superintendent of Financial Institutions (OSFI)'s Guideline B-15 outlines climate-related risk management expectations for federally regulated financial institutions (FRFIs) globally.[13] Businesses are required to understand climate risks in relation to their global business strategy and have climate-related governance and risk management practices. Additionally, OSFI's B-15 expects FRFIs to make climate-related financial declarations, including the disclosure of climate-related governance bodies, climate strategies, risk management processes, and GHG emissions metrics.

Operationalizing Canada's commitment to reducing greenhouse gas emissions and maximizing the number of green jobs requires a skilled workforce.[14] The challenge lies in developing a skilled technical workforce capable of creating and deploying low carbon technologies, while also ensuring soft skills—such as strategy, management, sector outreach, communications, and social innovation—are implemented. Both require different policy responses, which have not been explicitly addressed. Canada has invested more than $120 billion into achieving

net zero, targeting green jobs in infrastructure and industrial sectors and community projects to attract private sector investments into climate solutions.[15, 16] The interim Sustainable Jobs Plan[17, 18] supports the creation and green transition of existing jobs through $25 million annually to union sustainability and green upskilling programs;[19] a funding and resource allocation of $960 million over three years to pilot programing on upskilling, rural and remote community-led approaches to sector engagement and innovation;[20] $250 million for industry-led upskilling efforts;[21] and $272 million over five years to engage persons with disabilities in the labour market.[22] Collectively, these programs aim to support a talented and diverse workforce across key Canadian industries.[23]

SMEs in the transition to net zero

SMEs play a critical role in Canada's economic landscape, making up 99.6% of employer businesses and employing 63.6% of private sector workers.[24] SMEs are estimated to account for 200 million tonnes of CO_2 equivalent emissions, or 30% of total emissions in Canada.[25] In addition, Scope 1 and 2 emissions of SMEs are intrinsically linked to Scope 3 emissions of larger enterprises; SMEs are estimated to have a 50% share of emissions across the supply chain.[26] For example, a large grocery chain aiming to achieve net-zero will not only have to look at emissions generated by their corporate vehicles and purchased electricity, but will also need to evaluate emissions throughout the value chain, including farmers, product refinement and packaging, and transportation intermediaries; often, these are services provided by SMEs.

Canada's net-zero transition mechanisms prefer large corporations and green tech startups, whereas support for SMEs lags.[27] For Canadian SMEs, emissions reduction first requires a focus on green skills development among workers. An informed, environmentally literate workforce that understands the business implications of a net-zero transition can then target business support activities, including procurement, technology development, HR management, and firm infrastructure. Subsequently, workers can feel prepared to help their SME navigate climate risks for primary business activities where emissions are generated,[28] including inbound logistics, operations, outbound logistics, marketing and sales, and service.

Many SMEs have taken up climate planning. BDC's 2023 survey of SMEs found that nearly 68% of firms have or intend to act on sustainability[29]; of these, 55% reported elevated business reputation,[30] competitor differentiation, customer approval, branding benefits, and preferential status with consumers and business-to-business relationships. Net-zero strategies–such as maximizing HVAC efficiency, electrifying vehicle fleets, and optimizing production processes–yield tangible cost reductions in support firm activities averaging 16 months for a return on investment.[31] Some

organizations may avoid decarbonization simply because they lack the green skills needed to approach decarbonization, whereas others may encounter issues overcoming initial institutional inertia, view being first as a disadvantage, or ignore industrial effects on the environment altogether; however, non-participating SMEs risk exclusion and missed economic opportunities across the value chain.

As large companies transition toward decarbonization in inputs and production, they create a market case for SMEs to follow suit; however, large corporations often have specialized roles, workers, and training programs to facilitate this transition whereas support for SMEs are comparatively less.[32, 33] For example, Morgan Stanley reports about 85% of individual investors are interested in impact and sustainability,[34] and sustainable funds exhibit lower risk profiles and comparable economic gains;[35] the Harvard Business Review reports about 70% of consumers declare ethical behaviours and sustainability influence their purchasing.[36] The data suggests a shift away from the narrative prominent in the 2010s, and revived after the 47th U.S. presidency, that positioned profit and socio-environmental good as mutually exclusive.[37, 38] While PwC reports about 33% of firms do not link sustainability to overall strategy,[39] rising environmental externalities to corporations are expected to increase sustainability participation. While efforts target large organizations, SMEs play key roles in supply chains; targeted interventions to SMEs ensure large firms can decarbonize and SMEs can participate in a sustainable market.[40]

Equity, diversity, and inclusion (EDI) are essential components in the transition to sustainable practices and achieving net zero. Integrating EDI practices into an organization's infrastructure, skills training, and overall net-zero strategy catalyses sustainability innovation in firm operations. Canadian Chamber of Commerce reports that Canada's dedication to diversity in the net-zero workforce transition has led to higher participation rates of diverse groups in industry.[41] The Diversity Institute has led extensive research indicating that racial, ethnic, and gender diversity and parity in the workforce drives broad financial and innovation gains,[42] reinforcing data that links diversity with increased profit, future-readiness, and resilience.[43] In North America, women are more likely to prioritize and practise social and environmental sustainability compared to men.[44] In Canada, women-led SMEs lead in sustainability, with 61% of women-led startups minimizing their businesses' environmental impact.[45] Organizations with diverse leadership report greater innovation and associated revenues.[46] Since achieving net zero requires transformation across technologies, processes, and business offerings, diversity is key to drive sustainable innovation. Thus, a key focus for industry leaders, educators, diversity organizations, and governments in achieving environmental goals is understanding the representation of diverse groups in different roles and experience levels, as recently promulgated with associated

funding and regulatory mechanisms in Canada's Bill C-50.[47] This involves identifying why under-representation happens and addressing workplace challenges—such as organizational culture, accessibility, and working conditions—to foster inclusion.[48]

In Canada, 40% of self-employed Canadians are women; about one-fifth of SMEs are owned by women,[49] and 92.7% of women-owned businesses have fewer than 20 employees.[50] Women-led businesses effect change throughout the value chain, influencing other organizations' operations to improve system sustainability. Women are crucial to the SME landscape, driving innovation, job creation, and economic growth across the country; however, because women are more likely to lead micro-firms, they often have fewer resources to tackle climate-related issues, and existing resources may not be tailored to their needs.

The Green Skills Competency Framework outlined in this report addresses this issue. The framework is designed to support SMEs—especially ones led by entrepreneurs from equity-deserving groups—as they navigate the path forward to a net-zero economy, including identifying where to start with decarbonization and addressing barriers. Joint research conducted by the Diversity Institute and the Smart Prosperity Institute suggests that all paths can lead to net zero, either through a lower-carbon-intensity pathway with high rates of fuel switching in favour of end-use electrification, a higher-carbon-intensity pathway that relies more on carbon capture or direct air capture technologies, or a middle-ground approach combining both strategies with a greater reliance on carbon offsets.[51] The research reveals that net zero cannot be achieved through technological advancements alone. Like the digital transformation, the transition to net zero requires the implementation of new policies, processes, and behaviour change across all sectors.[52] Sustainable entrepreneurship demands a broad range of skills, meaning training and support programs must go beyond technology to foster innovation in all areas. To facilitate this transition, SMEs need more access to information, mentorship, and resources to effectively implement sustainable practices and achieve their net-zero goals.

Demand for green skills

Green skills are defined by the United Nations Industrial Development Organization (UNIDO) as "the knowledge, abilities, values, and attitudes needed to live in, develop, and support a sustainable and resource-efficient society."[53] Green skills reduce the environmental impact of economic activities promoting the transition to a green economy. Green employment focuses on roles that manage resources sustainably, reduce environmental effects, and preserve ecological balance through planning, implementing, and overseeing environmental programs, products, or services, as well as promoting environmental knowledge and awareness.[54] Green employment roles often encompass a broader or holistic approach to sustainable development, including considerations not

only to the environment, but social good and economic sustainability. Green skills include many holistic sustainability competencies but emphasizes technological and innovation-driven capabilities needed by current practitioners as well as new positions within existing value chains.

A green skills portfolio encapsulates technical expertise in engineering and science, architecture, and design, as well as operational and business skills to make the most out of the value chain. They draw on core environmental knowledge to understand the problem, leverage technical proficiencies to develop solutions, and use communication and other transferable skills to optimize each step and process toward a sustainable outcome. As we have seen with digitization, "greenification" skills intersect sectors and job functions, meaning all workers need basic green literacy.[55, 56] Investing in these skills reduces costs and risks related to climate change, drives innovation, and strengthens brand reputation. Canadian Chamber of Commerce reports worker misconceptions about their applicability to upskill and transfer to green economies, as technical knowledge can be re-applied to sustainable development by employing a green lens.[57] LinkedIn's "Global Green Skills Report 2023" indicates that the increased demand for green jobs (22.4% more job postings) far exceeds the availability of candidates with green skills (increase of 12.3%),[58] underscoring economic opportunities and momentum in green skills across transportation, finance, and energy sectors.

Research strongly suggests that green skills education for SMEs across Canada is essential for the path to net zero.[59, 60, 61, 62, 63] However, SMEs face challenges related to knowledge and resources for "greenification." For example, some businesses are unaware of new regulations, so they may struggle to change familiar practices. This is common in SMEs run by women or young entrepreneurs, who often have limited access to skills and resources for new opportunities.[64] It is important to address these challenges because the adoption of cross-sector skills is vital for the transition to a net-zero economy across firm sizes.[65]

The transition to a net-zero economy will affect workers in diverse ways. For instance, some workers in green companies need training for new skills, while others, such as electricians, may find that their existing skills are in higher demand.[66] Additionally, many existing jobs will require workers to upskill and reskill.[67] In marketing sectors, ECO Canada estimates one in five workers holds an environmental role, with 20,400 net job openings projected across Canada by 2033. Of these, about 63% will be in Ontario (12,910), 15% in British Columbia (3,150), and 13% in Alberta (2,750).[68] In Ontario alone, 181,750 environmental job openings are expected by 2033, driven by expansion and replacement needs—equivalent to 36% of environmental employment in 2024.[69] With 25% of the current workforce set to retire in the next decade, employers must focus on attracting and developing talent to meet growing demand[70]; younger Canadians

entering the workforce generally feel more responsible for climate action.[71]

Environmental employment growth is expected to outpace the growth of the general employment market.[72] As such, it is important to acknowledge the wide variety of skills needed for a net-zero economy; the International Labour Organization identifies skill mismatches as a major obstacle to the greening of the economy.[73] In Canada, post-secondary institutions must rapidly adapt to equip the workforce with the skills and knowledge needed to support a sustainable economy, an effort spurred by the federal government's net-zero commitment and increased societal awareness of environmental topics and its associated impacts.[74]

An analysis conducted by the Future Skills Centre and the Conference Board of Canada found that most green jobs require post-secondary education; however, more than one-half only require a college diploma or less, creating opportunities across different education levels.[75] Canadian post-secondary institutions support green skills acquisition primarily in the classroom through specialized programs such as environmental engineering, environmental management, and specialized courses in environmental, social, and governance, corporate social responsibility, and social innovation. Institutions foster green skills acquisition greater than 50% through participation in student clubs and groups, co-op programs and capstone projects either in or with green industries, and through institutional commitments to sustainability: though there are significant gaps.[76] Low-carbon technology skills and training demand is increasing, highlighting the opportunity for reskilling and upskilling initiatives across sectors and organizations.[77] These programs can be tailored to fill the gap between current educational offerings and the specific green skills in demand, addressing the needs of individuals at various education levels with particular attention to the needs of individuals from equity-deserving groups.[78]

The Green Skills Competency Framework

To meet the growing need for green skills within SMEs, this report aims to develop a green skills competency framework. A competency is the demonstrated ability to effectively perform a task and achieve desired results. It stems from the application of knowledge, skills, and attributes and reflects consistent actions that lead to the intended outcomes.[79] Competencies are important because they emphasize both "what" and "how" a person performs, while skills primarily focus on "what" a person can do. Competencies are more context-dependent and outcome-oriented, focusing on overall effectiveness in a role rather than proficiency in specific tasks.[80] In other words, we use competencies as an overarching construct that takes in a variety of skills, abilities, and other attributes relevant to executing tasks and achieving goals.

Leveraging industry expertise and best practices to tackle distinct sustainability challenges, the Green Skills Competency Framework serves as a structured guide, addressing the market demand for a teaching approach that emphasizes practical experience and flexible learning models.[81] The goal is to apply the competency framework to shape training programs, support workforce development, and help businesses integrate sustainable practices into their operations, thus ensuring they are well-equipped for the future.

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Methods

This section outlines the steps used to develop the Green Skills Competency Framework. Our approach to develop this competency framework begins with a review of academic and industry research on green skills, SMEs, and their needs in transitioning to net zero. We then analyze existing frameworks to ensure our competency framework is aligned with established versions.[82, 83, 84]

There are a variety of competency frameworks, occupational databases, skills taxonomies, and typologies for identifying and classifying green skills.[85] Some of these focus on the green economy, while others cover the entire economy and identify green skills within it. The key difference between these frameworks is their level of analysis; they might focus on skills, skill clusters, or occupations, or they might rely on differing lenses to conceptualize green occupations or green industries. These frameworks also differ in the way they are used to analyze labour market data.

The following analysis of existing frameworks and guidelines reveals significant gaps in applicability towards Canadian SMEs. They often assume a level of organizational structure, resources, and expertise that many SMEs do not possess, particularly regarding access to green finance, staffing, and specialized green skills. Additionally, there is a lack of focus on the Canadian context with regard to country-specific policies, regulations, and frameworks. The Green Skills Competency Framework aims to address these gaps by providing a structured, accessible approach in preparing SMEs for the transition to net zero, from foundational to advanced green skills. Further detail into individual frameworks and guidelines, their intended audiences, key elements, and strengths and limitations can be found in Appendix A.

Review of existing frameworks

A review of existing frameworks reveals several common competency domains, including green literacy, soft skills, technical skills, and leadership. Green literacy emphasizes not only the foundational knowledge of environmental sustainability principles, but also supplementary knowledge needed to effectively implement a green transition, including knowledge of Canada's net-zero goals, existing resources for emissions accounting, and relevant legislation. Literacy competencies are prominently featured in frameworks from ECO Canada, Information and Communications Technology Council (ICTC), and Institute of Environmental Management and Assessment (IEMA).

Skills for success, including communication and interpersonal skills (often referred to as soft skills), are also highlighted across frameworks, underscoring the importance of the ability to think, collaborate, and lead in the adoption and management of the green transition. Frameworks from ECO Canada and IEMA integrate personal soft skills valuable for navigating new green technologies and processes such as problem solving, critical thinking, and resilience. Given the interconnected nature of a green transition, cross-functional collaboration and strong relationships across organizations' supply chains are essential. Accordingly, many frameworks also highlight competencies such as relationship development, networking, and leadership. The recognition of soft skills in most frameworks aligns with industry perspectives that soft skills are no less important than technical competencies when considering a green transition.[86]

Technical competencies are found in most frameworks. Common threads include technical skills for operational optimization, emissions quantification and analysis, and policy and regulatory expertise. Several frameworks concentrate on specialized, sector- or domain-specific competencies. For example, ECO Canada's emissions analyst framework focuses on the programming and mathematical skills for emissions analysis tasks. The Glasgow Financial Alliance for Net Zero (GFANZ)'s framework emphasizes modelling and knowledge of financial products to inform decision-making for financial activities, and the UN Global Compact disclosures guide focuses on nature-related disclosures. The strong presence of technical competencies across frameworks reflects their importance in developing the mechanisms that power the back-end work in the green transition.

Nearly all frameworks contain leadership and strategic elements. IEMA's skills map covers leadership skills at the Full Membership and Fellow Membership levels, including proactively identifying environmental risks and opportunities, enacting firm-wide strategies, and engaging stakeholders to adopt green practices. The GFANZ framework promotes engagement with clients and industry peers to distribute knowledge and lessons learned

from climate strategies, as well as advocacy with the public sector to further advance net-zero policy. The restructured Climate Action Competency Framework (CACF v2) by Resilience by Design Labs takes an inward-looking lens to leadership to incorporate capacity building, focusing on providing continuous professional development opportunities for staff. Most frameworks also tightly integrate strategic thinking and planning, highlighting the competencies needed to transform soft and technical skills into effective environmental strategies.

Structurally, frameworks often organize their content using thematic clusters or stages of progression. For example, the ICTC framework creates competency clusters by business activity, such as infrastructure design and construction, production of physical products, and involvement with transportation and logistics. Similarly, frameworks from ECO Canada and UNIDO cluster their competencies by skill groups, and GFANZ and Resilience by Design Lab organize their frameworks based on strategic objectives. The UN Global Compact SDG playbook is organized in accordance with related groups of SDGs. Other frameworks are progression-focused, with the structure of the IEMA framework following the professional progression of users as they advance through various stages of their career.

Framework scopes vary widely. ECO Canada's frameworks for sustainability managers and emissions analysts target skills for specific occupations. Some frameworks focus on sector-specific guidance, such as UNIDO's framework for the manufacturing and production sectors, and GFANZ's framework for financial institutions. Frameworks including those from ICTC and Canada Green Building Council (CAGBC) address specific-use cases—such as digital skills or competencies required to achieve status as a net-zero building—instead of targeting specific audiences. Notably, the competencies listed in the ICTC framework were developed mostly in response to survey results from Canadian SMEs, making it the only framework with strong relevance to the SME context. Other frameworks, such as those from IEMA, Resilience by Design Lab, and the UN Global Compact, have general applicability. Importantly, not all reviewed frameworks are competency frameworks. Some, like the ones from GFANZ and CAGBC are guidance frameworks for organizations looking to achieve specific environmental objectives.

Despite their strengths, the reviewed frameworks contain gaps, especially in the context of SME-applicability and green skills. Many frameworks implicitly assume a certain level of knowledge or skill within organizations, as well as a certain level of support for long-term green initiatives and dedicated green roles. This assumption excludes many Canadian SMEs, which typically operate with barriers to accessing green finance,[87] staffing,[88] and technical expertise.[89] For example, the rigorous guidelines listed by CAGBC's zero-carbon building standards are more suited to larger enterprises who are better positioned to

benefit from zero-carbon status and have the required support compared to smaller enterprises without technical resources. In addition, numerous frameworks tend to focus on high-level strategic objectives when implementing a green transition. Several frameworks integrate broadly accessible green skills, such as analytics or management skills; however, few frameworks sufficiently address deep green skills—specialized technical competencies essential for developing of emerging green technologies and processes, like biotechnology and green energy systems. Organizations that strengthen these advanced proficiencies can gain a significant competitive edge and position themselves as leaders in environmental fields. In addition, SMEs participating in Canada's clean or environmental technology sector have experienced faster rates of growth compared to the average growth of SMEs overall, underscoring the importance of advanced green skills in supporting SMEs' contributions to Canadian clean technology.[90] The Green Skills Competency Framework is developed with the challenges faced by Canadian SMEs in mind, and addresses the gaps in existing works by providing a skills-centric, progression-based framework for Canadian businesses.

Framework context

The transition to a greener economy requires two types of workforce transitions: workers moving into green jobs, and existing roles evolving to incorporate more green skills.[91] In the context of Canadian SMEs, we are interested in developing a competency framework that tackles the second type of workforce transitions.

A fundamental understanding of environmental systems, net-zero concepts, climate change mitigation, and the broader sustainability landscape is crucial for all workers. This includes understanding how human social and economic systems interconnect with environmental processes; recognizing the significance of net-zero in addressing climate change; identifying benefits for businesses—such as managing financial risks, seizing market opportunities, and ensuring regulatory compliance; and understanding the role of various sectors and government policies in Canada's transition.

Here is what makes this framework unique compared to the other sources we discussed:

> **SME-applicability:** This framework is designed to address the needs and challenges unique to SMEs in transitioning to net zero but remains generally applicable to all businesses. An emphasis is placed on the acquisition of foundational environmental and sustainable knowledge and easily accessible green skills. Deep green skills are also integrated in the framework, considering the growth of Canadian SMEs in clean technology.

> **Three-level competency structure:** The framework is structured around three levels of proficiency: Knowledgeable (Foundational), Skilled (Intermediate), and Experienced (Advanced). This allows for a clear progression of skill development, from basic understanding to applied actions in SMEs, to sector-level innovation led by SMEs.

> **Alignment with existing frameworks:** The framework was developed by analyzing and aligning with established competency frameworks. This ensures compatibility and recognition of the defined competencies within the broader Canadian skills landscape.

> **Practical application:** The framework is actively being used to develop training courses for SMEs focused on transition planning and implementation for a net-zero economy. This demonstrates its practical relevance and applicability in supporting SMEs in their green transition.

Design of the Green Skills Competency Framework

Competencies are characterized by the behaviours of an individual and regarded as minimum standards of performance.[92, 93] In this section, we outline the Green Skills Competency Framework's approach, components, and categories.

The Green Skills Competency Framework

Our proposed Green Skills Competency Framework uses skills categories from the Green Skills Pyramid (Figure 1), which is based on the hierarchy of competencies needed for environmental sustainability and green transition.

Our framework targets a *transition* to a greener economy and supports the many existing jobs in SMEs as they incorporate green skills. SMEs employ a greater market share of employment equity groups, including providing opportunities for skills development to low-skilled workers. While job transitions are occurring across organizations of all sizes, from transnational corporations to SMEs, tailored supports are especially needed for SMEs. Job losses in carbon-intensive industrial activities within smaller enterprises disproportionately affect youth and employees of equity groups.[94, 95] Current environmental sector competency frameworks, such as the ICTC, focus on larger enterprise modalities.[96] Employees of SMEs often support multiple organization functions, exercising breadth in technical skills. Investing in continued education and skills development has proven effective in retaining staff belonging to equity-deserving groups as well as enabling employees to perform across a range of technical functions.[97]

Foundationally, individuals need to be competent in basic environmental systems and be aware of current and emerging sustainability concepts and issues.[98] In an ICTC survey on green economies, about 50% of employers place high importance on fundamental environmental knowledge competencies.[99] These skills provide the basis upon which specialized skills are built. It also includes skills and competencies that guide SMEs on where to support business and employee transitions toward sustainability.

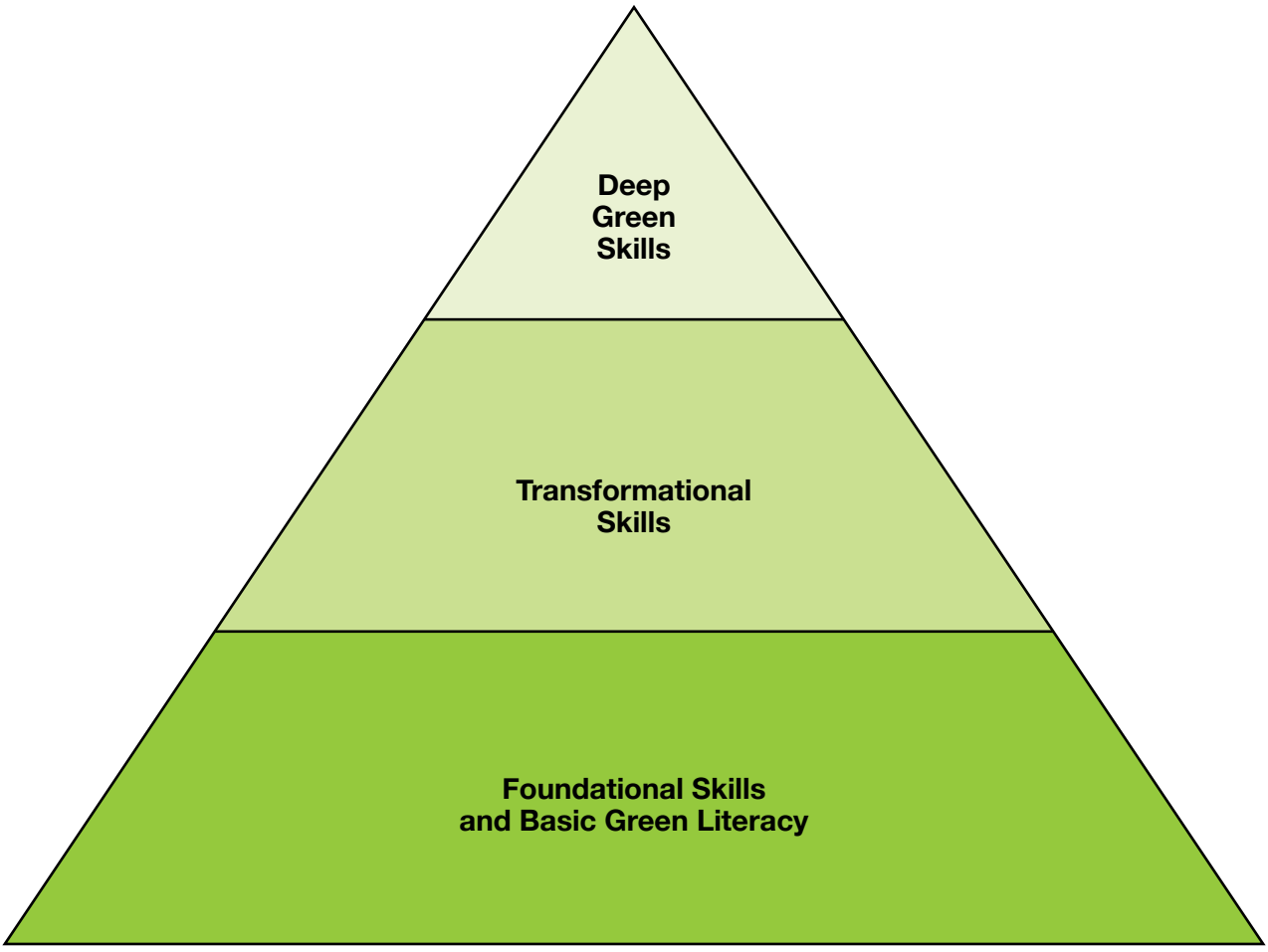
The middle layer consists of transformational skills that enable individuals to drive sustainable change across different business operations and organizational functions throughout the value chain. These skills involve a deeper understanding of how green transitioning and sustainability processes interconnect with business and organizational practices in both primary and supporting activities across the value chain, equipping individuals with the analytical tools and resources to plan, implement, and evaluate the efficacy of operational changes using standard sustainability key performance indicators and reporting frameworks. These skills allow SMEs to leverage existing resources to support transformation and innovation across the value chain including supplier management, production optimization, logistics and distribution, and product design.

At the top of the pyramid, the “deep green skills” represent specialized expertise in environmental issues. Many firms may not be in the green economy but participate in decarbonization from other sectors. These advanced competencies are necessary for developing innovative solutions, creating disruptive technologies, and leading major sustainability efforts, and depend on the specific products and services offered by an SME. Employers see increasing importance in competencies with digital tools, computation technologies, and scripting languages (e.g., JavaScript, C++, and Python) and artificial intelligence to analyze relevant data collected throughout the value chain.[100] Analytics proficiencies integrate with cross-sector expertise in life-cycle assessment, emissions calculations, waste management, e-mobilities and transportation, sustainable packaging and production, sustainable IT, land management and permitting, and optimized natural resource management and consumption, for instance, and use a data-driven approach to lead green practices in firm operations across the value chain.

The Green Skills Pyramid illustrates the significance of building skills in distinct levels starting from a broad understanding of environmental sustainability while also prompting for specialized expertise and innovation to address the complex environmental and sustainability issues.

Figure 1

Green Skills Pyramid



The framework's scope considers basic non-technical skills and cross-functional skills. Basic skills encompass both content and process abilities that enable workers to engage in continuous learning and knowledge acquisition. These foundational skills include active listening, reading, critical thinking, and monitoring. Despite being general skills, their importance is not to be understated. In a global survey of sustainability professionals, only 8% considered technical skills to be more important than soft or foundational skills.[101]

Cross-functional skills enable workers to perform tasks across multiple activities, including coordination, problem-solving, operations monitoring, decision-making, and management. A net-zero economy will not be created through capital-intensive, technological development alone.

Research by the Diversity Institute highlights the importance of soft skills by women-led SMEs working towards net zero, emphasizing value in relationship building, systems thinking, communication and collaboration.[102] These skills are increasingly vital in a decarbonized economy, as they facilitate adaptability and effective collaboration across different functions and roles.

Core competencies

Core competencies are the strengths and abilities that distinguish SMEs from their competitors. These include a mix of tacit and explicit knowledge, skills, technologies, and resources that allow a company to provide exceptional value to its customers.[103] From a green skills perspective, core competencies are the abilities and knowledge that support decarbonization, sustainability and ensure both market competitiveness and business value is retained. International guidelines for greenification of SMEs exist,[104] though they define SMEs differently and operate in a discrete regulatory context to Canadian industry. The Canadian Employment and Social Development Canada (ESDC) Skills for Success framework is adapted to elaborate on how competencies support greening SMEs.[105] The ESDC framework aims to equip individuals with the right skills to meet job demands, and we have adapted it to contribute to sustainable practices and environmental goals. This framework provides a structured approach to identifying key competencies that are crucial for achieving success. such as problem-solving, teamwork, and technical skills.

An adapted ESDC framework that considers tacit knowledge requisites for Green Skills requires the following:

Environmental literacy: Green initiatives often involve addressing complex environmental challenges. Foundational knowledge of environmental and economic system dependencies—positive and negative—are requisite foundations for upskilling to green careers.

Problem solving: Green initiatives involve addressing complex environmental challenges. Problem-solving skills are vital to develop innovative solutions for sector-wide decarbonization transformation, and balancing net-zero commitments with market competitiveness.

Collaboration: Many green projects involve collaborating with diverse teams and stakeholders. Collaboration skills across the value chain (i.e., logistics, business intermediaries) are important to collecting emissions data, and working to implement decarbonization goals in primary and supporting business activities.

Communication: Clear communication and distillation of the business value of investing in decarbonization complex environmental systems to SME leadership and stakeholders is key to supporting practice adoptions, community engagement, and collective action on environmental issues.

Creativity and innovation: Developing new green technologies and practices requires creative thinking and innovative approaches to reduce environmental impact and enhance sustainability.

Writing: Effective communication through writing is essential for drafting clear sustainability reports, creating impactful proposals, and conveying the benefits of green initiatives.

Numeracy: Strong numeracy skills are crucial for analyzing data related to business environmental impacts, evaluating resource efficiency, and managing budgets for green projects. Openness to other data sources (e.g., lived experiences, tacit cultural knowledge) ensures impacts are as intended.

Green competency categories

The present competency framework categorizes competencies into three levels. The three-level competency framework illustrates the learner's journey from basic knowledge (Level 1) to applying that knowledge in specific situations at an SME (Level 2), and ultimately to sector innovation (Level 3). This structure enables the in-depth evaluation of the learner's engagement and understanding,[106] and ensures jobs gain foundational knowledge of the environment, as this may not have been tacit knowledge to their original roles.

Foundational skills and basic green literacy (Level 1):
Basic environmental awareness, and an understanding of sustainability principles and policies that inform SME function and regulatory compliance.

Transformational skills (Level 2):
The ability to convert baseline sustainability knowledge into an effective, net-zero strategy for the SME, integrating technical solutions to assess the impacts of a net-zero transition on different business elements while promoting market competitiveness of the SME.

Deep green skills (Level 3):
Graduate-level areas of knowledge that promote sector transformation, requiring deep technical expertise of green technologies and infrastructures.

Individual competencies within the framework are further structured across three distinct levels—Knowledgeable (Foundational), Skilled (Intermediate), and Experienced (Advanced)—and represent a clear progression in expertise. At the Knowledgeable level, individuals acquire foundational knowledge. This includes basic green literacy and understanding how it relates to one's business, awareness of Canada-specific net-zero goals and policies, ensuring general net-zero policy compliance, understanding green transition strategies, and gaining an educational background in green skills. At the Skilled level, individuals apply their knowledge to effect practical changes within their company. This includes understanding how an individual's organization is impacted by the environment and the net-zero transition and developing specialized green solutions in support of the net-zero transition to improve market competitiveness. Experienced individuals lead in their sector, steering an SME-wide climate strategy; they adopt a critical lens to assess various green policies and technologies, and use specialized technical expertise to produce frontier research and innovative technologies that differentiate their SME as a transformative leader in net zero, ultimately guiding sector practices. Where levels 1 and 2 apply to most SMEs, level 3 competencies may be sector specific; for example, innovative biotechnologies in the agriculture and agrifood sector may not be applicable to SMEs in infrastructure sectors.

The proposed Green Skills Competency Framework, developed using the above methodology, is found in Table 1. Throughout the course of its development, the framework has undergone several stages of review with partner organizations including ECOco Canada, the University of Oxford, and PwC Canada.

Table 1

Green Skills Competency Framework

Competency	Level 1: Knowledgeable (Foundational Competencies)	Level 2: Skilled (Intermediate Competencies)	Level 3: Experienced (Advanced Competencies)
Level 1: Foundational skills and basic green literacy			
1.1 Understand climate change and the implications for SMEs	I can explain the concept of climate change and I understand that many environmental and human processes are linked.	I understand the importance of addressing climate change and have identified the business implications for my SME (e.g., energy in logistics and building energy use).	I have taken action to address the impacts of climate change in my SME and can explain how climate change affects business operations to leaders in my SME, other employees and enterprise customers and stakeholders.
1.2 Understand the net-zero concept and the reasons and benefits of transitioning to net-zero for SMEs	I can define net zero and its significance in responding to climate change.	I have an idea of what a net-zero strategy means for my SME and understand the difference between emissions mitigation and adaptation.	I have taken action to integrate a net-zero strategy into business operations, conveying the concept of net zero and its benefits to leaders in my SME, other employees, and enterprise customers and stakeholders.
1.3 Understand the financial risks of not decarbonizing	I understand the market considerations of deciding whether to adopt a net-zero strategy. I understand there are both short- and long-term economic, reputational, and operational risks.	I can quantify the financial impact of a net-zero strategy on my SME and can pinpoint short- and long-term transition risks.	I have worked to minimize the short- and long-term impacts of transitioning my SME to net zero and can articulate the opportunities it offers for my business—including financial gains—to leaders in my SME.

Competency	Level 1: Knowledgeable (Foundational Competencies)	Level 2: Skilled (Intermediate Competencies)	Level 3: Experienced (Advanced Competencies)
1.4 Understand the current environmental policies and guidelines for Canadian and Global enterprise	I understand the role of SMEs in Canada's overall greenhouse gas (GHG) emissions and recognize the business impacts for general compliance (net-zero by 2050, per Canada's 2030 Emissions Reduction Plan).	I understand the business implications for Canadian and global emissions policies for my SME and can make the business case for regulatory compliance.	I have implemented changes in my SME to ensure current regulations are followed and procedures to adapt operations for future regulatory compliance are in place.
1.5 Explore case studies and best practices to gain a clear understanding of where to start	I know about multiple real-world examples of successful net-zero implementations in SMEs and I am aware of the best practices to follow for a successful transition.	I understand the different types of net-zero case studies available (i.e., industry-specific) and have a plan for how similar processes would be implemented for my SME.	I have adapted case studies and use cases for decarbonization to fit my SMEs.
Level 2: Transformational skills			
2.1 Explore the sustainable value chain	I understand where I am in my client's value chain and my emissions scope requirements.	I have a plan to implement initiatives, such as sustainable procurement, to integrate sustainability into my SME.	I have implemented changes to improve the sustainability of my SME (e.g., reduced costs, improved brand reputation and market competitiveness, and risk mitigation of climate-related market stress), differentiating my SME.
2.2 Analyze opportunities and challenges in relation to the net-zero target	I recognize the Canadian government's net-zero goals, and the benefits of a net-zero target for my industry. I recognize common challenges that SMEs in my industry face in implementing net-zero strategies (e.g., limited resources, lack of expertise, competing priorities).	I can identify the key GHGs emitted by operations in my industry and utilize resources to circumvent resource and skill challenges for net-zero implementation in my SME.	I have the business case for various net-zero transition opportunities for my SME, utilizing a collection of resources to evaluate and implement solutions or workarounds (e.g., exploring alternative energy sources, emissions reduction with suppliers, logistics).

Competency	Level 1: Knowledgeable (Foundational Competencies)	Level 2: Skilled (Intermediate Competencies)	Level 3: Experienced (Advanced Competencies)
2.3 Establish a data infrastructure to map the current value chain	I understand the methodology to design data collection and data analyses, and I know how to use the data to monitor sustainability-related measures and outcomes in my sector.	I can assess which methods or measures are appropriate to capture sustainability activities for my SME (e.g. Scope 1 and 2 emissions, life cycle assessment, internal carbon pricing), and think through data structures to facilitate auditing requirements.	I have designed a data collection approach to support auditing requirements, and can use scripting languages, (e.g., Java, C++, Python), data infrastructure systems, and newer cloud technologies to continue iterating on the data infrastructure for future emissions reporting requirements for my SME.
2.4 Conduct carbon footprint accounting	I am aware of the differences between Scope 1 and 2 emissions and can list the sources of these emissions in my SME.	I can collect emissions data applicable to Scope 1 and 2, and am knowledgeable of available emissions accounting approaches (e.g., Canada's Greenhouse Gas Quantification Requirements) for my SME.	I have calculated Scope 1 to 3 emissions for my SME, combining data from multiple emissions activities with accurate emissions factor conversions toward assuring my SME's net emissions (e.g., as carbon dioxide equivalents).
2.5 Assess carbon footprint for buildings	I understand the different green building credentialing bodies that operate in Canada (i.e., Canada Green Building Council, ENERGY STAR, BOMA BEST) and the purpose of the different certifications offered under each body.	I can identify a certification(s) relevant to my SME and can compile data on building energy use and emissions metrics (e.g., utility data management, thermal imaging, HVAC literacy).	I am a certified assessor and have applied a green building certification (e.g., LEED) to my SME building(s), effectively integrating stakeholders and data from building operation systems and ensuring accurate reporting to maintain SME accreditation.
2.6 Conduct scenario analysis and assess financial impact	I understand the general importance of climate scenario analyses to evaluate organizational resilience to climate change and linking to business performance and business continuity.	I can navigate specific guidelines for climate scenario analysis (e.g., CDP Technical Note on Climate-Related Scenario Analysis, ISO 14091:2021) and extract the key elements for assessing climate risk in my SME.	I have utilized advanced analyses (e.g., geographic information systems) to understand risks of SME assets and supply chains relative to environmental, climate, and geopolitical hazards, and can suggest options to leadership in my SME to reduce risk.

Competency	Level 1: Knowledgeable (Foundational Competencies)	Level 2: Skilled (Intermediate Competencies)	Level 3: Experienced (Advanced Competencies)
2.7 Conduct business analysis	I understand the purpose and key components of a business analysis for a net-zero strategy in an SME, and I know how the data I have gathered on my SMEs current energy consumption, transportation emissions, and waste generation relates to business.	I understand the benefits of conducting a business analysis before embarking on a net-zero journey (e.g., cost savings, improved resource efficiency, enhanced brand reputation), and know of resources to support decarbonizing my SME (e.g., Clean Growth Hub, Net Zero Accelerator).	I have analyzed cost estimates, and sourced potential financing options and support programs to transition my SME to net zero.
2.8 Create a long-term green strategy	I understand different strategies for developing a business sustainability plan with a focus on aligning sector values with sustainability goals. I can ideate clear, achievable goals for long-term sustainability efforts.	I can combine elements from leading green-strategy frameworks for large corporations to my SME, and can lead assessment methods (e.g., questionnaires, requesting sustainability reports) to inform business strategy, resource allocation, and organization structure that align with business sustainability goals.	I have developed a firm-wide net-zero strategy and set of values to assess the sustainability performance of existing operations and implement them to improve the sustainability of my SME value chains. I can create a roadmap for long-term environmental efforts.
2.9 Engage in sustainable finance	I understand the sustainable investing principles of considering environmental, social, and governance factors alongside traditional financial metrics.	I can identify key environmental considerations in sustainable investing (e.g., climate change, resource use, pollution) and social factors relevant to sustainable investing for my SME (e.g., labour practices, diversity, community engagement).	I have led steps toward more sustainable investment strategies for my SME throughout the value chain (e.g., energy efficiency and resource use in operations, ethical and sustainable supply chains).
2.10 Participate in carbon markets	I understand external carbon markets for trading carbon credits, including the difference between compliance (e.g., cap-and-trade) and voluntary (e.g., project-based) carbon offsets.	I can navigate recognized compliance or voluntary registries (e.g., Verra, Compliance Instrument Tracking System Service) and assess the benefits of short- and long-term carbon market transactions for my SME.	I have developed the necessary reporting and financial models to optimize my SME's participation in carbon market mechanisms (e.g., emissions trades, offsets, credit registries), and can iterate to maximize the value of my SME's carbon reduction plan.

Competency	Level 1: Knowledgeable (Foundational Competencies)	Level 2: Skilled (Intermediate Competencies)	Level 3: Experienced (Advanced Competencies)
2.11 Address sustainability issues in primary business activities	I recognize fundamental sustainability issues and practices in my industry related to primary activities (e.g., energy consumption, waste generation, logistics, packaging, and sourcing).	I can identify inefficiencies and suggest practical improvements for sustainable and cost-effective primary activities in my SME, including optimizing resource use, reducing waste, and adopting eco-friendly packaging and transportation options.	I have led my SME to integrate sustainability across primary activities (e.g., long-term solutions like green supply chains, zero-waste production, and closed-loop resource systems).
2.12 Address sustainability issues in supporting business activities	I understand sustainability challenges in business support activities, such as the environmental impact of office operations, procurement, and financial activities.	I can identify opportunities to improve sustainability in economic areas of financial planning, legal compliance, and management practices.	I have led practical improvements in business support areas, including eco-friendly office policies, sustainable procurement practices (e.g., local sourcing, ISO 14001 compliant suppliers), human resource policies (e.g., emissions reductions in commuting), and facilities management (e.g., energy-efficient building operation).
2.13 Monitor, report, and verify emissions metrics	I recognize the importance of monitoring, reporting, and verifying emissions for accountability.	I can identify relevant metrics and key performance indicators for monitoring progress toward net-zero targets for my SME, and opportunities to integrate these performance metrics into my SME's decision-making processes.	I have led reporting for my SMEs to a global standard (e.g., Global Reporting Initiative, B Corp), and can articulate the position of my SME in reference to industry trends and Canada's sustainability and emission goals.

Competency	Level 1: Knowledgeable (Foundational Competencies)	Level 2: Skilled (Intermediate Competencies)	Level 3: Experienced (Advanced Competencies)
2.14 Infrastructure to monitor, manage, and optimize energy	I understand the types of data infrastructures in my sector to monitor, manage, and optimize energy usage and emissions production.	I understand where best practices and current technologies apply to my SME's energy monitoring, management, and optimization systems.	I have compiled and analyzed data from different high-resolution sensors (e.g., Information of Things-enabled smart meters, thermal cameras, power quality analyzers) to understand energy consumption across my SME's value chain and can forecast future energy reduction strategies.
Level 3: Deep green skills			
3.1 Environmental engineering	I understand the core environmental engineering topics needed to enable green tech development, including chemistry, biology, and systems analysis.	I can leverage specialized environmental education and experience with engineering tools for surveying, lab work, environmental monitoring, modelling, data analysis, and spatial analysis.	I have innovated above industry-standard green technologies (e.g., e-mobility systems, carbon capture, renewable energy systems and integration) throughout my SME's value chain.
3.2 Energy systems engineering	I have an educational background in engineering to understand the technologies (e.g., thermodynamics, fluid mechanics, power electronics, grid fundamentals) in decarbonized energy systems.	I have an educational background in engineering and experience in green energy systems engineering, where I apply energy system simulation and analysis tools (e.g., PSSE, MATLAB, Python) for prototyping different traditional and green energy solutions.	I have led frontier research in green energy systems and architectures for my SME, leveraging renewable energy, energy storage systems, and smart energy control elements.
3.3 Biotechnologies	I have knowledge of the innovations in biotechnologies, and a background in biology or chemistry.	I have formal education in biology or chemistry and experience in biotechnologies, where I am comfortable supporting project leaders in product development, testing, and implementation in firm operations.	I lead the conceptualization, testing and implementation of nature-based solutions in my SME, such as green infrastructure solutions (e.g., wetlands to filter production effluent), and biotechnologies (e.g., remediating lake algae for nutrient requirements use) in my SME operations.

Competency	Level 1: Knowledgeable (Foundational Competencies)	Level 2: Skilled (Intermediate Competencies)	Level 3: Experienced (Advanced Competencies)
3.4 Waste management	I have knowledge of waste production and management practices, including innovations for waste reduction throughout the value chain, diversion, and reuse.	I can evaluate and implement waste management in SME support activities, including procurement, technology development, HR management, and firm infrastructure.	I innovate to achieve waste reduction, circularity, and resource recovery in my SME's primary and support activities across waste streams, including water (e.g., industrial processing optimization), energy, and physical waste (e.g., recycling, waste-to-energy).
3.5 Computer science	I have an educational background in computer science and knowledge of data and analysis concerns related to environmental problems.	I can leverage technical skills in programming, machine learning, optimization algorithms, and systems design to analyze environmental data and develop green solutions.	I have created novel computing solutions to solve data issues for green problems (e.g., environmental data aggregation, supply chain optimization, and cloud-based, scalable green-tech systems) across my SME value chain.
3.6 Materials science	I understand how core materials science principles—such as atomic to macro structures, material properties, processing, thermodynamics, and kinetics—contribute to the advancement of environmental technologies and green building materials.	I can leverage technical processes (e.g., synthesis and processing, electrochemistry, characterization, and lifecycle analytics) to engineer low-carbon materials and advance the manufacture of green technology.	I innovate in materials discovery, piloting, and commercialization (e.g., addressing energy storage, building decarbonization, product composition) for my SME.
3.7 Architecture	I have an educational background in architecture and understand green building design concepts (e.g., passive design, life cycle costs, building materials, HVAC, and energy systems).	I can apply design and modelling tools (e.g., Revit, AutoCAD, Lumion) to green architecture principles and design structures with minimal environmental impact.	I have implemented next-generation green building materials and technologies (e.g., biocomposite insulation, photovoltaic glass), and can innovate in architectural design to support the development of carbon-neutral or carbon-negative structures.

Preliminary Conclusions and Implications

The development of the Green Skills Competency Framework for Canadian SMEs represents a step toward standardizing the skills needed for the transition to a net-zero economy. SMEs are critical to Canada's sustainability efforts; the following framework aims to provides a sequential approach to developing and upskilling competencies, ensuring existing jobs evolve to incorporate more green skills and diverse voices are retained in the workforce transition. Working toward a net-zero economy ultimately supports sector growth and positions Canadian SMEs to incorporate decarbonization policies and values into business operations, ensure local and global regulatory compliance, and strengthen their capacity to grow and innovate within their sectors. Continued collaboration, ongoing adaptation, and effective promotion of environmental and sustainability principles among SMEs generate enterprise value throughout the value chain, benefiting internal stakeholders (employees, managers) as well as external stakeholders (suppliers, distributors and logistics partners, community and social affiliates, and ultimately clients). The Diversity Institute has partnered with Oxford University to conduct research about best practices and green policies for SMEs to adopt sustainable development goals, which will be used to refine this framework. A skilled workforce capable of driving both environmental and economic progress in the years to come is essential to ensure Canadian SMEs remain competitive in the market.

The implications of this framework extend beyond SMEs to the broader Canadian economy. SMEs through to large corporations need green skills training to move beyond regulatory and emissions assurance compliance to reach Canada's net-zero goals and lead innovation, ultimately enhancing global market competitiveness and the industry share of Canadian businesses. As the framework continues to be implemented and refined, Canada will be capable of building a skilled workforce to ensure environmental and economic progress.

Appendix A: Existing Green Skills Frameworks and Adjacent Guidelines

Framework Name and Target Audience	Framework Elements	Strengths and Limitations
ECO Canada Sector Competency Profiles: Sustainability Manager[107] Target audience: Sustainability professionals	**Technical competencies:** Conduct research; manage team, project, and stakeholder relationships; manage budgets and costs; and oversee change management **Personal and professional competencies:** Solve problems; communicate; and collaborate **Legal, policy, and regulatory competencies:** Ensure regulatory compliance **Environmental competencies:** Implement environmental, social, and governance (ESG) practices; develop sustainability programs; provide sustainability education; and conduct sustainability reporting	**Strengths:** > Comprehensive framework coverage addressing strategic and operational elements at a management level > Defines a set of educational and professional credentials recommended for managing sustainability initiatives > Recommends specific frameworks for reporting ESG metrics > Includes more granular action items for each competency **Limitations:** > Requires experienced personnel to implement, which may not be realistic for SMEs with resource constraints > Non-hierarchical organization of competencies makes it challenging to discern clear learning pathways for skill development > Focus is only on management-level skills

Framework Name and Target Audience	Framework Elements	Strengths and Limitations
ECO Canada Sector Competency Profiles: Emissions Analyst[108] Target audience: Sustainability professionals	**Technical competencies:** Conduct data and statistical analysis; manage data and information; perform quality assurance; manage operations; and produce technical reports **Personal and professional competencies:** Communicate; collaborate; uphold ethical conduct; and maintain attention to detail **Legal, policy, and regulatory competencies:** Conduct emissions audits and ensure regulatory compliance **Environmental competencies:** Develop and understand environmental policy and model a long-term emissions strategy	**Strengths:** > Emphasizes highly technical skills relating to emissions analysis > Uses specific ISO guidelines for greenhouse gas (GHG) quantification and reporting and mentions training modules for upskilling > Focuses on practical actions that SMEs can take **Limitations:** > The depth of technical skills may not consider the investment of cost and time for SMEs with resource constraints > Heavy emphasis on documentation and administrative processes, which may prove to be a burden for SMEs
Information and Communications Technology Council Mapping the Junction of Digital-Green Skills for the Twin Transition: A Competency Framework[109] Target audience: Job seekers, employers, policy makers, and educational institutions	**Consulting and analyzing:** Collect environmental data; assess and analyze information; and report findings and data services **Designing and building:** Sustainably design, construct, and retrofit infrastructure across the built environment **Producing and manufacturing:** Sustainably produce and manufacture physical products and outputs **Managing, regulating, and accounting:** Manage, regulate, and account economic activities and human interfaces with the natural environment **Transporting and sustaining:** Interface with transport, distribution, logistics, and the supply chain	**Strengths:** > Fills a gap in existing frameworks by intersecting digital and green skills > Framework is based on employer surveys consisting mostly of SMEs, making the framework contemporary and highly relevant to Canadian SMEs **Limitations:** > Competencies do not reflect the digital green skills of all sectors and economies in Canada > Parts of Canada, including Quebec, Atlantic Canada, and the Territories, were under-represented in the survey used to develop the framework, thus leaving gaps in regional variations of competencies; further detail is yet to emerge > The strong digital focus may overshadow other technical green skills

Framework Name and Target Audience	Framework Elements	Strengths and Limitations
UNIDO Green Industrial Skills for a Sustainable Future[110] Target audience: Manufacturing and other productive sectors (e.g., construction, transportation, agriculture, etc.)	**Policy:** Create demand for green technologies; fund research and development; and facilitate education and training **Process:** Identify gaps in green skills capabilities; implement a systematic approach to monitor and evaluate outcomes; adapt to changing market conditions; and forecast future training needs in response to evolving labour markets	**Strengths:** > Promotes a top-down, systematic approach to green skills training, with a focus on creating an up-to-date, resilient green skills workforce instead of administering one-time training > Provides valuable insight for SMEs with resource constraints by assessing technical complexity of green initiatives **Limitations:** > Limited by scope to select sectors > Geared toward system-level green transition planning instead of green skills development > Guidelines are general and are not tailored to Canadian businesses and policies

Framework Name and Target Audience	Framework Elements	Strengths and Limitations
GFANZ Financial Institution Net-zero Transition Plans: Fundamentals, Recommendations, and Guidance[111] Target audience: Financial institutions (all sizes)	**Foundations:** Define net-zero objectives; set short- and long-term targets; establish strategic timelines; and prioritize financing strategies **Implementation strategy:** Facilitate emissions reduction through financial services; integrate emissions data into evaluations; and set net-zero policies for high-emission sectors **Engagement strategy:** Advise clients and portfolio companies on net-zero transition; share insights with industry stakeholders; and influence policy through advocacy **Metrics and targets:** Develop emissions-related metrics and targets with a focus on Scope 3 emissions from clients and financing activities **Governance:** Establish a board with climate-related expertise; advise on transition strategies; assess climate strategy progress; and provide training on transition plan	**Strengths:** > SMEs looking to transition can search for financial institutions following this framework to identify climate-aligned financing opportunities > Focuses on strategic planning and implementation of net-zero transitions > Includes numerous case studies for each stage of the framework > Provides an extensive list of activities and guidelines for each component of the framework **Limitations:** > Strategy is specifically tailored to financial institutions and is generally not applicable to SMEs > Many of the suggested strategies may not scale down so applicability to SMEs may be limited (e.g., it is realistic to assemble a board of experts for climate strategy in a financial institution, but not necessarily for an SME). > Less focus on hard green skills and greater emphasis on activities that firms can take to achieve the components of the framework

Framework Name and Target Audience	Framework Elements	Strengths and Limitations
IEMA Skills Map & Membership Standards[112] Target audience: Sustainability professionals	**Core knowledge competencies:** Understand sustainability fundamentals and grasp governance principles and issues **Technical knowledge competencies:** Understand sustainability principles and issues; navigate policy and legislation; and apply innovative and leading practices **Skills for sustainable leadership:** Think analytically; reframe and solve problems; communicate effectively; develop relationships; demonstrate resilience; manage risk; improve continuously; deliver sustainable solutions; and lead change	**Strengths:** > Outlines versions of its competencies at different career stages, from students to business leaders > Comprehensive coverage for sustainability, technical, and leadership knowledge **Limitations:** > Limited detail on technical green skills, focusing instead on knowledge acquisition and thinking from a sustainability perspective > Lack of case studies or expository explanations on how competencies can be achieved > Lack of focus on scalability and cost-efficiency, both important considerations for SMEs > Not specific to Canada, thus missing references to relevant Canadian policies and guidelines

Framework Name and Target Audience	Framework Elements	Strengths and Limitations
Canadian Green Building Council (CaGBC) Zero Carbon Building Standards[113, 114] Target audience: Building owners and operators looking to achieve certification as a Zero Carbon Building	**Carbon requirements:** Achieve zero carbon balance; offset and report embodied carbon; address refrigerant leaks; acquire renewable energy certificates and offsets; and eliminate onsite combustion **Energy:** Optimize energy efficiency; manage peak demand; and conduct air-tightness testing and reporting **Impact and Innovation:** Reduce peak electrical demand with renewable energy; implement intelligent building systems; implement building integrated photovoltaics; transition to non-combustion heating solutions; use refrigerants with a lower prescribed global warming potential; and stay under prescribed emissions thresholds during building construction and design	**Strengths:** > Provides practical guidance on building emissions reduction strategies, supplemented with case studies > Outlines several pathways to achieve goals in each topic area and provides quantifiable metrics that SMEs can follow **Limitations:** > Not technically a competency framework, thus missing the technical green skills needed to achieve the listed outcomes > Limited scope to building emissions, thus not applicable to other emissions-producing activities that may make up the majority of SMEs' carbon footprint[115]

Framework Name and Target Audience	Framework Elements	Strengths and Limitations
Resilience by Design Lab Climate Adaptation Competency Framework v2 (CACF v2)[116] Target audience: Front line workers responsible for developing climate policies and strategies	**Working together:** Collaborate; communicate; demonstrate cultural agility; facilitate engagement; resolve conflicts; and maintain professional practice **Climate action leadership:** Make climate-informed decisions; develop climate policy; and create climate strategies and plans **Capacity building:** Mainstream climate action; educate and train others; and pursue lifelong learning and development **Climate risk assessment:** Manage climate risks; analyze climate data; and conduct climate action research **Solution design:** Innovate and create solutions; apply critical thinking; leverage climate finance; and develop actionable solutions **Effecting change:** Adapt; manage organizational change; implement climate initiatives; and monitor and evaluate progress	**Strengths:** > Has similar levels of complexity to our proposed framework, providing users with a road map for translating literacy into leadership for each competency > Provides performance criteria, which delineates the intended outcomes of each competency **Limitations:** > Competencies are articulated at a high-level, offering limited guidance regarding the specific green skills needed for their implementation
United Nations Global Compact Network UK Sustainable Development Goals (SDG) Playbook for Small-Medium Enterprises[117] Target audience: SMEs seeking to align with UN SDGs	**Mapping impacts and identifying priorities:** Use UN Global Compact guidance to identify sustainability impacts across value chain; conduct materiality assessments; and prioritize resource allocation **Setting and achieving ambitious goals:** Promote gender equality; accelerate climate action; and provide and promote a living wage **Communicating and reporting:** Communicate business case for sustainability and conduct sustainability reporting **Partnerships for the goals:** Build value-chain partnerships; join sector initiatives; and engage in multi-stakeholder collaborations	**Strengths:** > Provides a simplified approach to achieving SDG integration, with special consideration to the limitations SMEs face and easily accessible resources to achieve the goals > The four steps provide a simple, clear roadmap for SMEs, compared to other more complex sustainability frameworks **Limitations:** > Does not address green skills, instead outlining high-level steps for hitting SDGs > Although the playbook is meant to be used by all SMEs, many of the referenced resources are UK-based, limiting applicability to Canadian SMEs

Framework Name and Target Audience	Framework Elements	Strengths and Limitations
United Nations Global Compact Network Canada A Beginner's Guide to Nature-Related Financial Disclosures[118] Target audience: Businesses looking to make nature-related disclosures	**Corporate aspirations:** Assess capacity to integrate guidance from the Taskforce on Nature-related Financial Disclosures (TNFD); identify existing nature-related goals in the organization; understand senior management's knowledge of nature and biodiversity; research what peers are doing; and consider a time horizon for reporting **Laying the groundwork:** Check for pre-existing work in the organization; identify internal data aggregation methods adaptable to TNFD; and identify potential supports at the C-Suite level **Materiality 101:** Familiarize with TNFD's LEAP guidance[119] and map sector-level impacts and dependencies with nature using the ENCORE tool[120] **Prioritization:** Focus on impacts with high materiality; assess the impact of physical footprint vs. supply chain; and select a single portfolio category to prioritize if applicable **Risks and opportunities:** Understand nature-related risks and opportunities using LEAP and select a single risk to focus on from ENCORE **Quantification and metrics:** Research one to two metrics for chosen impact or dependency; set a quantifiable target; and search for existing baseline data on chosen impact or dependency **Target-setting:** Identify relevant business drivers; determine appropriate disclosure level; set nature-related goals using SMART framework; and estimate costs and benefits of the disclosure commitment **Making the business case:** Define desired C-Suite commitment; benchmark company performance against peers; identify nature-related priorities and future outlook; propose disclosure solutions; and estimate commitment costs	**Strengths:** > Adopts the LEAP approach, which builds green skills such as systems thinking, materiality analysis, and environmental risk assessment > Lays out time-saving strategies for framework elements that are highly applicable and accessible for SMEs **Limitations:** > Focuses on only one aspect of a climate strategy: disclosures; however, Canadian SMEs have reported GHG disclosures as the lowest priority climate leadership action[121] > Assumes a certain organizational hierarchy containing a C-Suite and senior management levels which SMEs often do not have

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