



EXPLORING CANADA'S CLEANTECH SECTOR

EDC Economics

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Canada

 EDC
TAKE ON THE WORLD



As Canada's export credit agency, Export Development Canada (EDC) has been executing on our cleantech strategy for more than 10 years and through that experience has become one of the leading financiers and thought leaders in the cleantech ecosystem.

In the past decade, we've supported more than \$20 billion in cleantech exports for more than 300 Canadian companies, enabling them to go global and make their impact on the world.

"Compared to when we got started in cleantech in 2012, there's greater recognition today that the world is facing a climate crisis and that greater adoption of clean technologies is critical to reducing emissions and achieving a low-carbon and more sustainable future," says Lynn Côté, EDC's national lead for cleantech ecosystems and market intelligence.

"With our financing and risk protection solutions, expert trade knowledge and trusted international connections, we're committed to helping more Canadian businesses grow with confidence and reduce their carbon footprint to net zero emissions by 2050," Côté says.

With the global cleantech market projected to exceed \$2.5 trillion in 2022, Canada's innovative cleantech companies need to look abroad for opportunities to reach their potential.

In *Exploring Canada's cleantech sector*, EDC senior analyst Michael Borish takes a look at Canada's environmental and cleantech (ECT) sector, compares export volumes of Canada's cleantech goods versus services, highlights leading sustainable industries and offers insights into key areas of growth—and challenges—for Canadian exporters.

We hope you find this report helpful.

Executive summary	3
Global cleantech market	7
The Canadian cleantech market	16
Canadian trade in ECT	21
Strategy and support for cleantech exporters	27
Canadian successes and prospects for the future	29
Cleantech trends and opportunities	32
Conclusion	39





EXECUTIVE SUMMARY

Global cleantech activity is projected to exceed US\$2.5 trillion by 2022, or about 2.5% of anticipated global gross domestic product (GDP).

- In Canada, environmental and cleantech products (ECT) have contributed 3% to our GDP since 2012, with the cleantech portion contributing about 1.5% of total GDP from 2012-2020.
- Canada's ECT share of the global market is estimated at around 2% of the total with cleantech specifically accounting for 1%.

Global cleantech investment trends to monitor for 2022—and beyond—include:

- Whether levels of investment capital to mitigate climate change risks will continue to increase as governments around the world adapt to tighter monetary conditions, higher interest rates, higher levels of debt service, and withdrawal or repayment of fiscal stimulus used to offset the economic effects of COVID-19;
- How investment patterns will affect cleantech equity valuations, if a faster pace of unicorn creation (attesting to the capacity of the most successful startups to scale up) can be sustained, and how long-term environmental, social and governance (ESG) pressures will affect commercial valuations in cleantech; and
- The role of special purpose acquisition companies (SPACs) as a vehicle for listing mergers—SPACs have become unpopular in 2022 due to declining values. However, they reflect

consolidation among some startups in the race to scale up (in carbon capture, utilization and storage, green and other hydrogen projects, and other existing or potential cleantech sectors) as companies strive to meet 2050 targets. This includes potential reinvestment by oil and gas companies into decarbonization plans.

Recent investment patterns are triggering greater funding for:

- **Energy and power**, which accounted for more than half of 2021 funding, as work continues in renewables and long-term sustainability solutions (e.g., batteries, long-duration storage, solar-as-a-service);
- **Resources and environment**, reflecting stronger focus on the importance of all resources—air, carbon dioxide (CO₂), and waste and water as lead examples;
- **Cultivated and fermented proteins in agriculture and food**, which have taken over from plant-based alternatives, reflecting the view of early-stage markets that these production systems are more resource-efficient;
- **Solutions focused on soil quality** for enhanced and sustainable agriculture; and
- **Ambitious innovation in the hardest-to-abate industrial sectors** (e.g., aviation, cement and concrete, chemicals and plastics, heating/cooling).

More broadly, the industry is preoccupied with deep decarbonization initiatives and the need to achieve net zero emissions by 2050. This will potentially lead to:

- Stricter carbon accounting standards
- Improved and refined emissions measurement systems
- Closer scrutiny of large emitters' plans for decarbonization
- Funding restricted to decarbonization efforts
- Increased investor/shareholder scrutiny of disclosures
- Reduced greenwashing as part of the general effort to strengthen governance and the veracity of disclosures, as rating standards tighten, and reputation risk is more closely monitored

The Cleantech Group's 100 most highly innovative cleantech firms attracted more than US\$11 billion in funding in 2021, nearly doubling 2020's funding (US\$6 billion) and achieving levels well above the 2016-2019 average of US\$9 billion.

- The total cumulative value of funding since 2017 has exceeded US\$164 billion spread across 9,302 deals, or an average of US\$18 million per deal. (No 2021 data were available for enabling technologies.)
- By sector, cumulative investment among the cleantech firms since 2017 has primarily focused on (all in U.S. funds):
 - Transportation and logistics (3,104 deals) at \$74.6 billion
 - Agriculture and food (2,418 deals) at \$40.1 billion
 - Resources and environment (1,744 deals) at \$17.8 billion
 - Materials and chemicals (1,104 deals) at \$12.6 billion
 - Energy and power (932 deals) at \$18.7 billion



Canadian cleantech market

The environmental and cleantech (ECT) sector contribution to GDP approximated C\$69.2 billion in 2019, and then declined to \$67.5 billion in 2020.

- This was the first year-over-year (YOY) decline reported, but reflects a drop in general economic activity resulting from supply chain interruptions/delays and broader disruptions due to COVID-19.
- The ECT share remained roughly 3.1% of Canadian GDP (at current market prices).
- ECT contribution to GDP is about 59% of total recorded output in the ECT sector.

Ontario and Quebec contribute the most to Canadian value-added from ECT.

- As a share of the total contribution to 2012-2020 value-added, Ontario accounts for 34% of total ECT.
- Quebec is second at 30%, British Columbia third at 14%, and all others combined are 22%.

An estimated 322,972 jobs were attributable to ECT activity in 2020.

- ECT accounted for 1.75% of all jobs in Canada.
- ECT employment in 2020 was generally better compensated than other sectors by about 40%.

ECT product exports increased \$12.9 billion in 2020 from \$12.1 billion in 2019.

- The 2020 figure is the highest export amount recorded, and YOY growth has approximated a 0.75% compound annual growth rate (CAGR) since 2012.

- Growth in 2020 exports was driven by environmental products, namely clean electricity, as cleantech exports have been relatively flat since 2018.

Specific to cleantech:

- Cleantech accounted for more than half of total 2012-2020 ECT output (53%), but only 46% of the ECT contribution to GDP.
- The cleantech sector's contribution to GDP approximated \$32 billion (46%) in 2020, which was down from 2019, but higher than in other years.
- The 46% cleantech share of ECT contribution to GDP has been constant since 2011.

Cleantech accounts for nearly \$10 billion in exports, or about 75% of total ECT exports in 2020.

- Cleantech has accounted for 78% of total ECT exports since 2012, with the share slowly declining from the high of 82% in 2012 and 80% in 2014.

Most cleantech exports are complex manufactured goods (50%) or waste and scrap products (37%).

- This presents a conundrum for Canadian exporters, since manufacturing only accounts for about 18% of 2011-2020 cleantech output (13% of total ECT output), 12% of 2011-2020 cleantech value-added (7% of total ECT value-added), and 11% of 2011-2020 total ECT employment.
- While dominating export trade (partly due to weakness in services exports), manufacturers contributed a modest amount to output and GDP.

Canada has had a persistent net ECT trade deficit since 2012.

- The trade deficit declined in 2020 due to disruptions in auto manufacturing and other integrated (cross-border) industrial activities, but persists due to imports of complex manufactured goods in cleantech and biofuels in environmental products.
- The trade deficit is compounded by the inability in both environmental and cleantech categories to generate exports or trade surpluses in ECT services.
- As services account for most output and value-added in Canada's broader economy, Canadian businesses active in ECT will need to capture a greater share of the global cleantech services market.

Most ECT exports are to the U.S. market.

- Since 2018, there's been some success with trade diversification, as non-U.S. markets now account for about one-third of total ECT exports as opposed to 25% in 2017.
- However, three quarters of exports go to the U.S. market, reflecting a high degree of market concentration.



Outlook for the Canadian cleantech sector

Canada has many recognized success stories and a strong ecosystem for cleantech innovation that should help with future growth.

- One source ranks Canada fourth globally in terms of overall ecosystem and startup strength, trailing only the U.S., the United Kingdom (U.K.) and Israel.
- North America is recognized as the epicentre of cleantech innovation, based on comparative measures of innovation and investment funding.
- Greater collaboration between North American, European and some Asia-Pacific firms may increase in the coming years as supply chains and energy market relationships realign.

Nonetheless, the Canadian cleantech sector faces many challenges and will have difficulty meeting 2025 export targets.

- The Government of Canada set a target of \$20 billion in exports by 2025, which would mean more than doubling the 2020 export value of clean technology products in a period of five years.
- To achieve this, the strategy was based on 11.4% growth per year. According to actual performance and results, the required annual growth rate is now 15.7%.
- Conversely, applying the original 11.4% annual growth rate from 2021-2025 results in a 2025 export figure of \$16.6 billion, which falls well short of the original target of \$20 billion.

Additional macroeconomic, structural and geopolitical stresses will challenge capacity to fund Canada's cleantech innovation.

- Major challenges related to the tightening monetary environment are driving up interest rates and triggering a correction in equity markets. Fiscal pressures also portend rising interest expense and intensified competition for

future spending on defence, health care and other areas. This could mean less available financing for cleantech.

- The massive disruption caused by COVID-19 on supply chains and logistics in the distribution of goods around the world continues to affect trade and add to uncertainty, which also has a negative effect on trade and investment in cleantech goods.
- The war in Ukraine has caused a major reconfiguration of energy markets and consumption patterns, with Western Europe making significant changes to its commodity and market sources. Short-term increases in fossil fuel use are expected to lead to more aggressive medium-term investment in and purchases of renewables and lower-emitting sources in Europe to get back on track to achieve net zero targets for 2050.
- In some private equity and venture capital markets, there have been recent pullbacks from innovative startups. SPACs have lost significant value in recent quarters. This trend may make it more difficult for Canadian cleantech firms to attract needed funding for growth and development.



GLOBAL CLEANTECH MARKET

Cleantech market context

There are variations around the globe in how clean technology is defined¹. Export Development Canada (EDC) defines “cleantech” as any process, product, or service that reduces environmental impacts through:

- Environmental protection activities that prevent, reduce, or eliminate pollution or any other degradation of the environment;
- Resource management activities that result in the more efficient use of natural resources, thus safeguarding against their depletion; or

- The use of goods that have been adapted to be significantly less energy- or resource-intensive than the industry standard.

(This definition largely aligns with the definitions used by Statistics Canada for environmental and clean technologies, which are discussed below in the Canadian cleantech section of the report.)

More broadly, cleantech potential permeates all sectors of the economy as process and product efficiencies can be found and adverse environmental impacts can be reduced. This applies

to sectors as diverse as agriculture, resource extraction, light manufacturing, chemicals and transportation. More research and innovation are expected in heavy industry as global pressure increases for steel, cement/concrete and other energy-intensive industries to decarbonize. Statistics Canada includes dozens of products and processes in its measurement of the cleantech contribution to the economy and how this applies across activities. Table 1 showcases some of the key categories².

Table 1: Clean technologies and the survey of environmental goods and services

Code	Activity	Industry/sub-industry
ENVIRONMENTAL PROTECTION ACTIVITIES		
1a	Protection of air and climate	Air, environment and remediation
1b	Wastewater treatment and municipal sewage treatment	Water and wastewater
1c	Management of non-hazardous waste	Waste and recycling
1d	Protection and remediation of soil, sediment, sludge, groundwater, surface water and leachate	Air, environment and remediation; water and wastewater
1e	Other environmental protection activities	Air, environment and remediation
SUSTAINABLE RESOURCE ACTIVITIES–ENERGY		
2a	Alternative fuel production	Biofuels and bioenergy
2b	Renewable/non-emitting electricity and heat production	Renewable/non-emitting energy supply
2c	Smart grid and energy storage	Smart grid; energy storage
2d	Substitutes for fossil fuels and fossil fuel-based materials (bioproducts)	Biofuels and bioproducts
2e	Technologies to improve energy and resource efficiency/management	Energy efficiency
SUSTAINABLE RESOURCE ACTIVITIES–WATER		
3a	Reduction of water use, losses	Water and wastewater
3b	Water management	Water and wastewater
3c	Water recycling	Water and wastewater
SUSTAINABLE RESOURCE ACTIVITIES–AGRICULTURE, FORESTRY AND BIODIVERSITY		
4a	Agriculture	Precision agriculture, forestry, biodiversity
4b	Aquaculture	Precision agriculture, forestry, biodiversity
4c	Wild flora and fauna	Precision agriculture, forestry, biodiversity
4d	Forestry	Precision agriculture, forestry, biodiversity
SUSTAINABLE RESOURCE ACTIVITIES–MINERALS		
5a	Minerals and metals	Mining, processing, materials manufacturing and industry
ADAPTED GOODS		
6a	Energy-efficient equipment and appliances	Energy efficiency
6b	Sustainable mobility	Transportation
6c	Advanced materials	Materials, manufacturing and industry

Source: https://publications.gc.ca/collections/collection_2021/statcan/16-511-x2021001-eng.pdf

General estimates

Global cleantech activity is projected to exceed US\$2.5 trillion by 2022³, or about 2.5% of anticipated global GDP⁴. In Canada, environmental and cleantech products (ECT) have contributed 3% to our GDP since 2012⁵. With the cleantech portion of ECT accounting for about 46% of the ECT total GDP contribution, this means cleantech has contributed about 1.5% of total GDP from 2012-2020.

Cleantech investment and support for innovation and development have been increasing across the globe in recent years. But there have also been setbacks due to:

- COVID-19;
- Geopolitical tensions that have interfered with trade and investment and triggered a partial realignment of supply chains; and
- General disruptions resulting from these factors and the war in Ukraine.

Given the myriad definitions that exist and disruptions in the global economy, identifying a global figure for cleantech is a loose guesstimate at best. But assuming roughly 2.5% of global GDP, it would total \$3 trillion in 2020⁶, meaning Canada's cleantech share is approximately 1.0%⁷.

Recent and current trends

The considerable monetary and fiscal stimulus from governments in response to COVID-19 were partly focused on medium- and long-term infrastructure investment needs⁸. Multiple countries, along with development banks, have promoted “build back better” campaigns to reconcile the need for improved and expanded infrastructure with environmental and energy needs. In the private market, this has led to a surge in investment in energy and power, driven by support for technologies and business models such as batteries, long-duration storage, and solar-as-a-service.

Corporates are driving commercialization efforts and aligning strategy with climate goals, which means they're investing more than ever in innovators to support the transition to consumer-centric business models at the grid edge. Batteries, in particular, received major investment, driven by automotive original equipment manufacturers' (OEM) desire to reduce the cost of electric vehicles (EVs), lithium-ion battery manufacturing, and advanced battery technology, including silicon anodes and metal battery technology. Battery-related investment has also centred on the desire of manufacturers to be able to better manage supplies and reduce reliance on unstable markets where needed minerals and ores are sourced.

Combined with the push for EVs, smart housing, decarbonized industrial practices and more resource-efficient agriculture (e.g., reduced usage of water, insecticides and pesticides combined with greater energy efficiency), there's been sustained activity and investment focused on cleantech. But the pace of such investment and shift to greener policies have been partly stymied by the lack of infrastructure (e.g., charging stations for EVs), as well as persistent disruptions in supply chains for the manufacture of multiple products (e.g., EVs, consumer electronics) that would help accelerate the pace of environmental and cleantech reform.



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- Whether levels of investment capital to mitigate the climate crisis and challenges will continue to increase as governments around the world adapt to tighter monetary conditions, higher interest rates, higher levels of debt service, and withdrawal or repayment of fiscal stimulus used to offset the economic effects of COVID-19;
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as companies strive to achieve their 2050 targets. This includes potential reinvestment by oil and gas companies into decarbonization plans.

Investment patterns in 2021 triggered greater funding for:

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decarbonization initiatives and the need to achieve net zero emissions by 2050. This will potentially lead to:

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In this last case, the onus will be on companies and their shareholders, as well as the credit rating agencies that will rate company bond issuances. Market analysts will also be a part of the ratings ecosystem in their evaluation of company financial strength and how this relates to equity and other securities not rated by the conventional credit rating agencies. (More sector-specific trends and opportunities are discussed at the end of the report.)

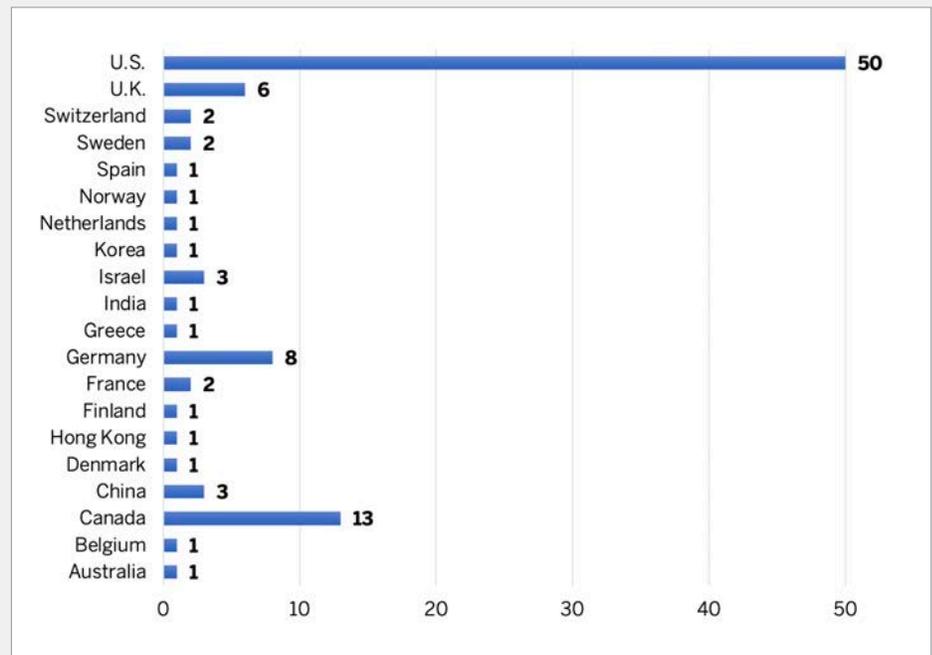
Markets and investment patterns

Regional geographic markets are diverse¹⁰, but investment (defined as paid-in capital into environmental and cleantech firms) and innovation in 2021 were concentrated in North America—described by the Cleantech Group as “the heart of the global startup scene”¹¹. Based on a global sample of nearly 11,000 innovative cleantech firms¹², 50 from the U.S. and another 13 from Canada were among the Top 100 companies by the end of 2021. These two countries accounted for nearly two-thirds of the most innovative companies able to attract investment in cleantech in 2021. This innovation is backed by the larger commitment to broad-based ecosystem development in the U.S. and Canada, which includes 298 of the Top 1,000 startup ecosystems in the world¹³.

Europe followed North America, with 30 companies among the Top 100. Europe also expanded their base, as Belgium, Denmark, Greece and Norway joined the ranks, along with Germany (eight companies), the U.K. (six), France, Sweden and Switzerland (two each), and Finland, Netherlands and Spain (one each). Europe also includes Israel, which had three successful companies on the list.

Asia-Pacific was a distant third, with only seven companies in the Top 100 attracting investment. These were mainly in China (three), Australia and India (one each). But like Europe, there’s been some broadening of the market, as Hong Kong and Korea added their names to the list.

2021 ranking of innovative and successfully funded cleantech firms by country

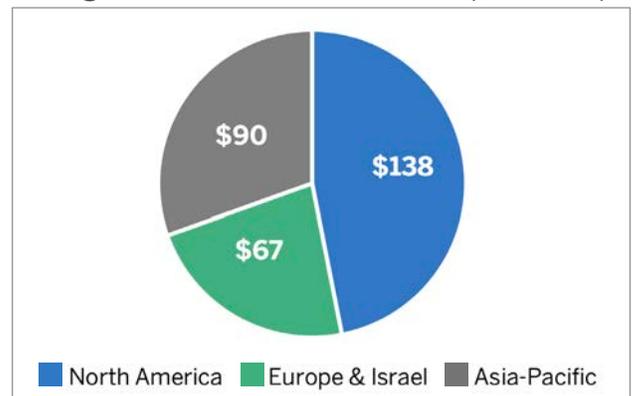


Source: Cleantech Group, 2022; EDC Economics

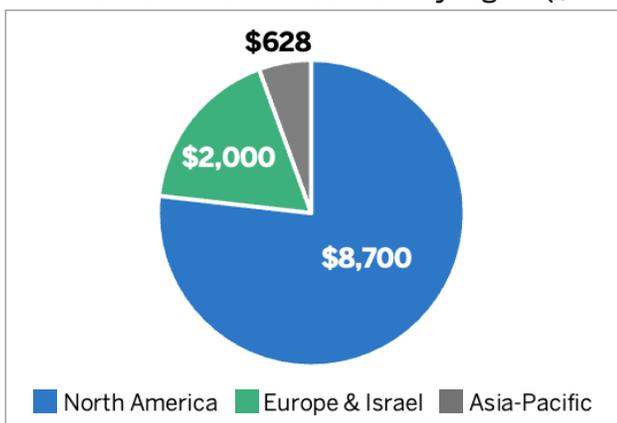


Regional distributions also showed skewness in investment value in the aggregate, as well as on a per firm or transaction basis. In total, cleantech attracted US\$11.3 billion in investment, with North America attracting US\$8.7 billion, or 77% of total. Average investment was US\$138 million, about 50% higher than the few transactions in Asia-Pacific and about twice as large as the average investment in Europe. Europe accounted for 18% of total investment (US\$2 billion), with average investments of about US\$67 million. Asia-Pacific attracted only US\$628 million in investments (6% of total), with an average of US\$90 million.

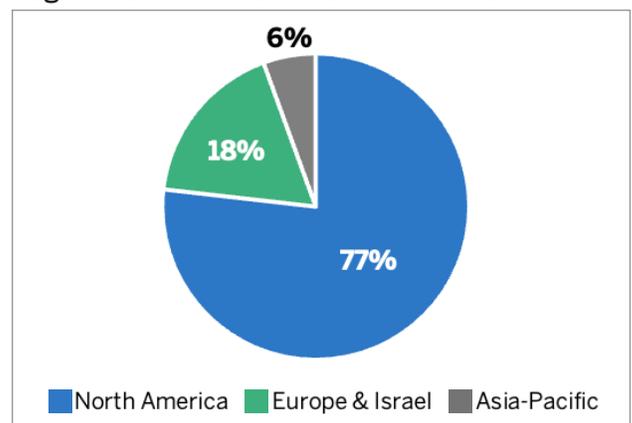
Average 2021 cleantech investment (\$ millions)



Total 2021 cleantech investment by region (\$ millions)



Regional share of 2021 cleantech investment



Source: Cleantech Group, 2022; EDC Economics

On a country basis, the U.S. remains the most highly represented among markets for cleantech innovation, followed by Canada and Germany. According to the Cleantech Group, the U.S. accounts for half (50 of 100) of the most innovative and successfully funded companies based

on its index that ranks the Top 100 from a sample of 10,950 cleantech firms from 94 countries¹⁴. Other countries cited for innovation (in order) are Canada (13), Germany (8), the United Kingdom (6), China (3) and Israel (3). Fourteen other countries are cited once or twice.

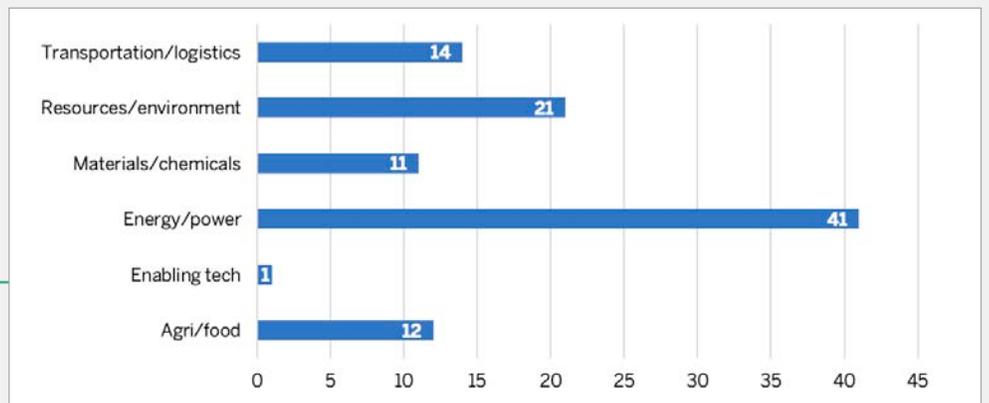
On a sector basis, favoured deals were primarily in energy and power, accounting for 41 of 100 and more than half of total investment. These deals were also the largest on average at US\$154 million per transaction.

Investment by sector in 2021 among the Top 100 was greatest in energy and power by a large margin at US\$6.3 billion



Source: Cleantech Group, 2022; EDC Economics

The greatest number of deals in 2021 among the Top 100 were in energy/power and resources/environment



Source: Cleantech Group, 2022; EDC Economics

The largest deals on average for the Top 100 in 2021 were in energy/power and agriculture/food



Source: Cleantech Group, 2022; EDC Economics

Emerging markets

Emerging markets aren't generally represented among the most innovative or funded cleantech ventures, even though the sample covered 94 countries. Apart from China (3), Hong Kong (1) and India (1), all of the other 95 companies showcased among the Top 100 above are Organisation for Economic Co-operation and Development (OECD) members and generally advanced economies. It is also noteworthy that some highly advanced and large economies are absent from the Top 100, including Japan and Italy.

For emerging markets, the challenge is partly due to less developed financial markets and associated ecosystems for venture capital and private equity, including links to university and government research. But this is

beginning to change with the development of incubators and accelerators, and growing interest in potential ventures from private equity firms, venture capital firms, and real sector firms (via corporate venture capital) investing in startups for potential market expansion. Major metropolitan areas in highly populated countries with comparatively large domestic economies are specifically showing progress in ecosystem development and funding for ventures. For instance, in one publication monitoring country and city environments for startups¹⁵, 14 emerging markets were included in the Top 50 countries ranked for startup environments¹⁶, while 12 emerging markets cities were in the Top 50 globally¹⁷. This emerging market representation hasn't changed much from the previous year, with the exception of

major ranking changes in Moscow/Kiev and Russia/Ukraine.

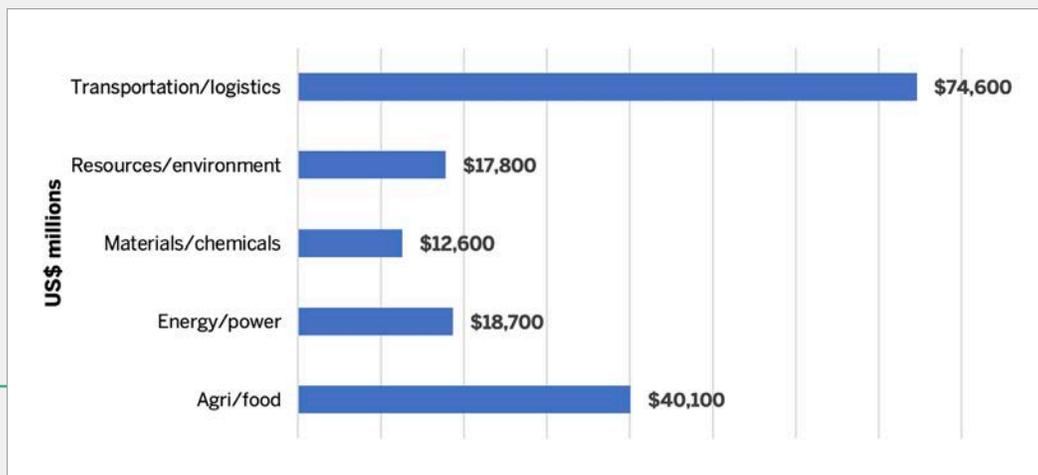
More broadly, as ecosystems in these countries and cities develop and expand to others not included in the Top 50, some of the beneficial effects of investment and innovation will spill over to cleantech. Shared research and exchange may also lead to additional investment through licensing fees, mergers and acquisitions, joint ventures, operating alliances without cross-ownership, and joint bids in public procurement. With tight labour market conditions affecting all regions of the world and geopolitical pressures encouraging greater regionalization of supply chains, there are also strategic reasons why opportunities abound in emerging markets.

Global cleantech investment patterns

Based on the annual index compiled by the Cleantech Group, the 100 most highly innovative firms attracted US\$11.3 billion in funding in 2021, nearly double the previous US\$6 billion in 2020. The decline in 2020 partly reflected disruption and realignment of investment goals due to COVID-19 and related geopolitical uncertainties. The 2021 figure partly reflected the lag effect of interrupted decision-making from 2020. At more than US\$11 billion, investment funding exceeded the 2016-2019 average of US\$9 billion.

Cumulative funding (2017-2021) exceeding \$164 billion* has been greatest in transportation/logistics and agriculture/food

* No 2021 figures available for enabling technologies

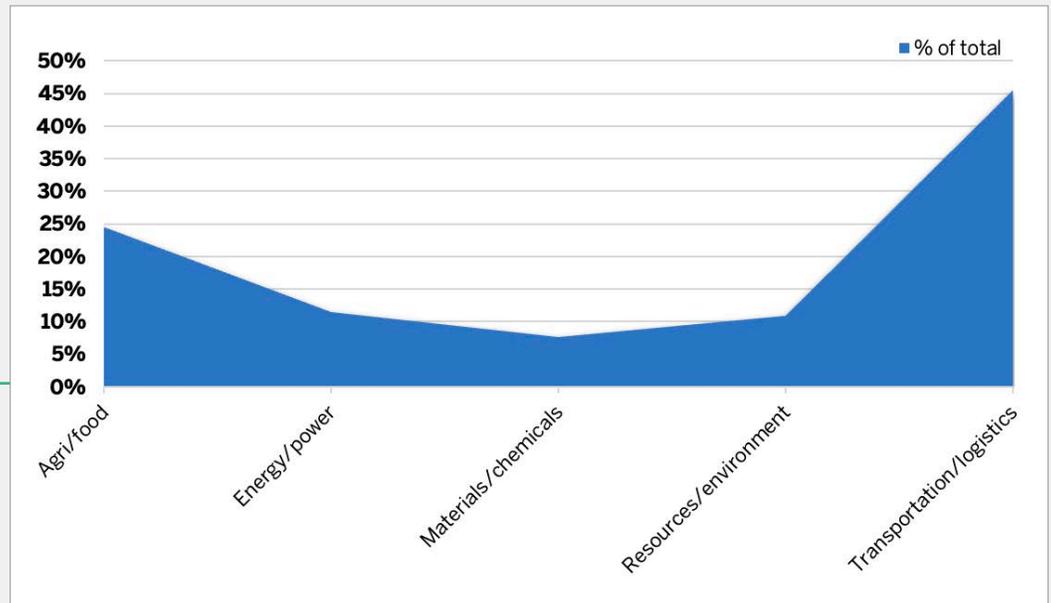


Source: Cleantech Group, 2022; EDC Economics

The total cumulative value of funding since 2017 has exceeded US\$164 billion spread across 9,302 deals, or an average of US\$18 million per deal. (No 2021 data were available for enabling technologies, which were reported to have about US\$7.3 billion in investment from 2016-2020.)

Transportation and logistics have been the primary sector target, with nearly US\$75 billion in cumulative investment in 3,104 deals, averaging about US\$24 million. Agriculture and food placed second at US\$40 billion across 2,418 deals. Together, these two sectors have accounted for 70% of cumulative investment funding since 2017. Energy and power and resources and environment have been in the US\$18-19 billion range, each at 11% of total. Materials and chemicals have the lowest level of investment at less than US\$13 billion, or 8% of total.

Transport and agriculture alone account for 70% of cumulative funding since 2017



Source: Cleantech Group, 2022; EDC Economics

As noted above, the market shifted focus in 2021 to energy and power, with more than half of the investments in the Top 100 companies migrating to firms active in the sector. But over the five-year period, this sector has only attracted US\$19 billion, or 11% of total. Therefore, with the significant energy sector challenges facing so many markets and the near-term intensification of fossil fuel production to meet these needs, major future flows are anticipated in this segment to reconcile power needs with environmental policy objectives.

Important as these investments are, they represent only a fraction of total investment or expenditure. With the global cleantech contribution to GDP at US\$2-3 trillion, these investments help to power GDP growth and innovation in the field. But they only tell part of the story. Value-added¹⁸ from these investments has a multiplier effect that contributes to other sectors of the economy, while also addressing some of the “hidden costs” or negative spillover effects that aren’t always captured in GDP data. As one measure in Canada, environmental and cleantech output has historically been more than 1.8 times the estimates of value-added.

As an example, ECT output was \$1.025 trillion from 2011-2020, while ECT value-added for the same period was \$559 billion. That means ECT output was equivalent to 1.83 times ECT value-added from 2011-2020. In simple terms, value-added is a form

of “net” output as products move from various intermediate stages of production and processing to finished goods or services. Output is more like a “gross” measure of total production values, while value-added is the difference between gross output and intermediate inputs that captures the value created (or the value added to these inputs) from labour and capital. Specific to cleantech and excluding environmental products, the ratio has been 2.1 times from 2011-2020¹⁹.



THE CANADIAN CLEANTECH MARKET



Contribution of environmental and clean technology products to Canadian GDP

According to Statistics Canada, the environmental and clean technology products sector (ECT) measures the contribution to the Canadian economy of goods and services that reduce environmental impacts through:

- Environmental protection activities that prevent, reduce or eliminate pollution or any other degradation of the environment;
- Resource management activities that result in the more efficient use of natural resources, thus safeguarding against their depletion; or
- Use of goods that have been adapted to be significantly less energy- or resource-intensive than the industry standard²⁰.

Clean technologies are defined as any good or service:

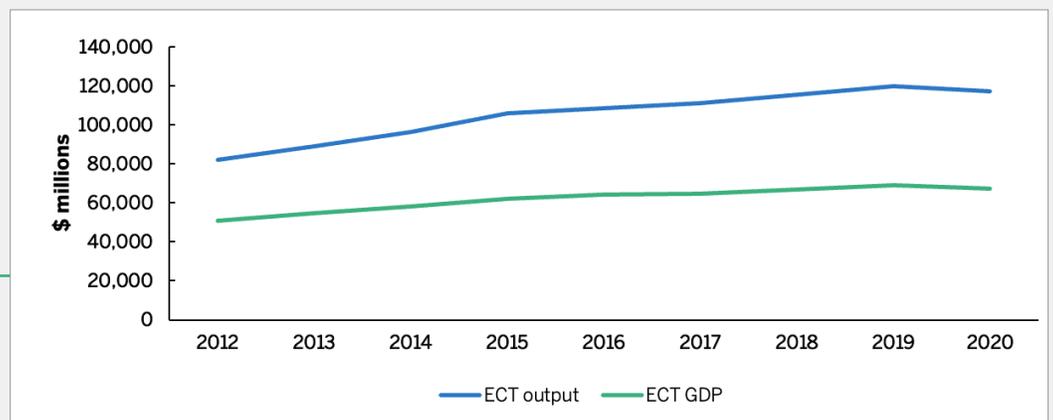
- Designed with the primary purpose of contributing to remediating or preventing any type of environmental damage; and
- Less polluting or more resource-efficient than equivalent normal products, which furnish a similar utility, even if their primary use isn't one of environmental protection²¹.

The Statistics Canada technical reference guide includes more than 300 technologies and services it monitors as part of the effort to measure the cleantech contribution to both GDP and environmental impact²².

Data available as of mid-2022²³ show the contribution to GDP of the ECT sector in Canada approximated \$69.2 billion in 2019, and then declined to \$67.5 billion in 2020²⁴. This was the first YOY decline reported, but reflects a drop in general economic activity resulting from supply chain interruptions/delays and broader disruptions brought on by COVID-19²⁵. The ECT share remained roughly 3.1% of Canadian GDP (at current market prices)²⁶.

ECT contribution to GDP is about 59% of total recorded output in the ECT sector²⁷. The compound annual growth rate (CAGR) from 2012-2020 for ECT output was 0.73%, and 0.78% for ECT contribution to GDP.

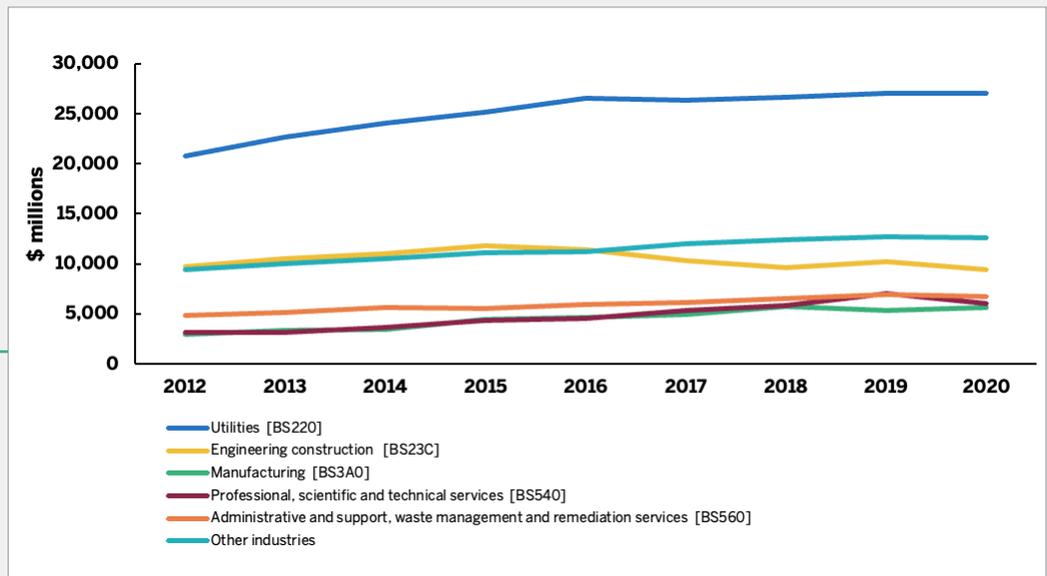
ECT contribution to GDP increased steadily until 2020



Source: Statistics Canada; EDC Economics

By industry, utilities have accounted for about 40% of ECT total from 2012-2020, followed by engineering construction (17%) and other industries (18%). Engineering construction has shown the highest CAGR, but barely 1% during the period. All other categories have shown lower compound annual growth rates, generally at less than 0.8%.

ECT contribution to GDP increased steadily until 2020



Source: Statistics Canada; EDC Economics

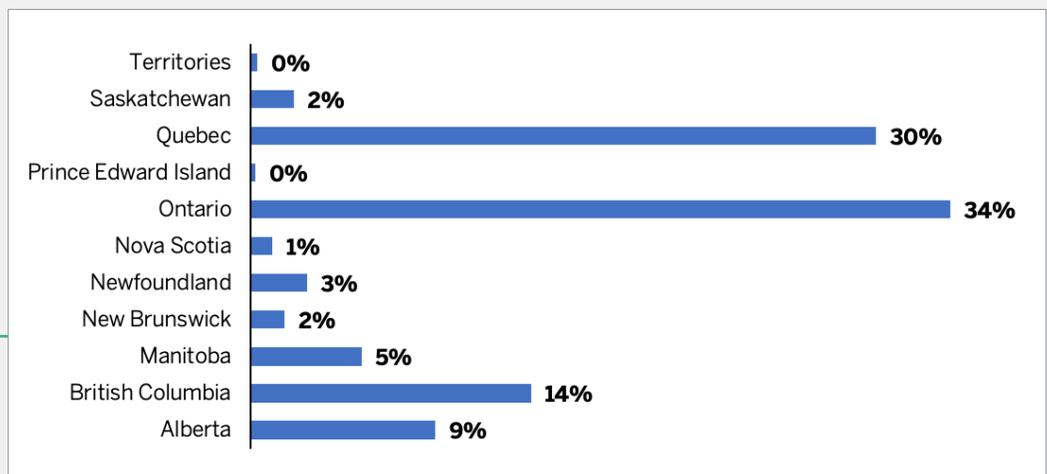
Specific to cleantech, Statistics Canada estimated that cleantech accounts for more than half of total 2012-2020 ECT output (53%), but only 46% of the ECT contribution to GDP. Therefore, environmental goods and services (e.g., clean electricity from renewable sources and nuclear power generation, biofuels and primary goods, waste management and remediation services) contribute more to GDP than cleantech goods and services.

The cleantech sector's contribution to GDP was about \$32 billion (46%) in 2020, which was down from 2019, but higher than in other years. The 46% cleantech share has been constant since 2011.

Provincial highlights for ECT

Ontario and Quebec contribute the most to Canadian value-added from ECT. As a share of the total contribution to 2012-2020 value-added, Ontario accounts for 34%. Quebec is second (30%) and British Columbia third (14%). All other provinces and territories combined account for 22%.

Provincial contribution to 2012-2020 value-added from environmental and clean technology products

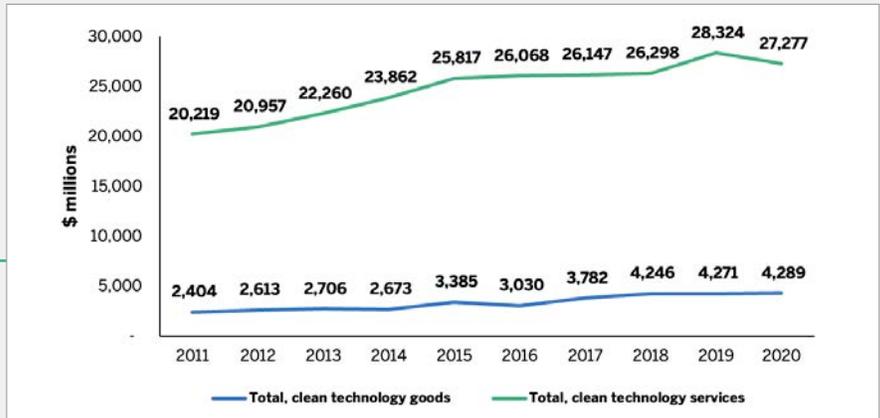


Source: Statistics Canada; EDC Economics

Specific GDP contribution from the cleantech sector: 2011-2020

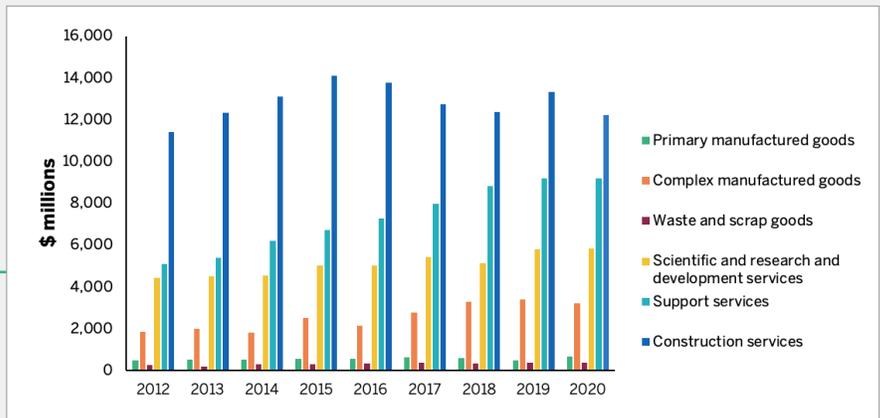
Growth patterns, specifically for the cleantech segment of ECT from 2011-2020, are presented below²⁸. The data show that services account for the majority (88%) of activity, led by construction (41% of total for the decade), followed by support services (29%) and R&D (19%). Goods played a small role (12%), with complex manufactured goods (8%) accounting for most of this. The highest CAGRs were in construction services (0.94%) and R&D (0.78%).

Services dominate the Canadian cleantech sector, while goods manufacturing is relatively low as a share



Source: Statistics Canada; EDC Economics

The three cleantech services categories account for 88% of total contribution to GDP since 2012

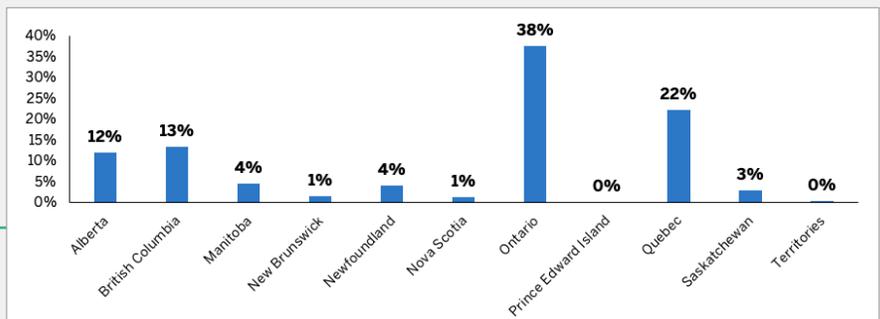


Source: Statistics Canada; EDC Economics

Provincial highlights

Specific to cleantech, Ontario (38%) and Quebec (22%) are the leaders, followed by British Columbia (13%) and Alberta (12%). The other provinces and territories collectively account for only 15% of 2012-2020 total, with none exceeding a 4% share.

Provincial contribution of clean technology products to 2012-2020 value-added

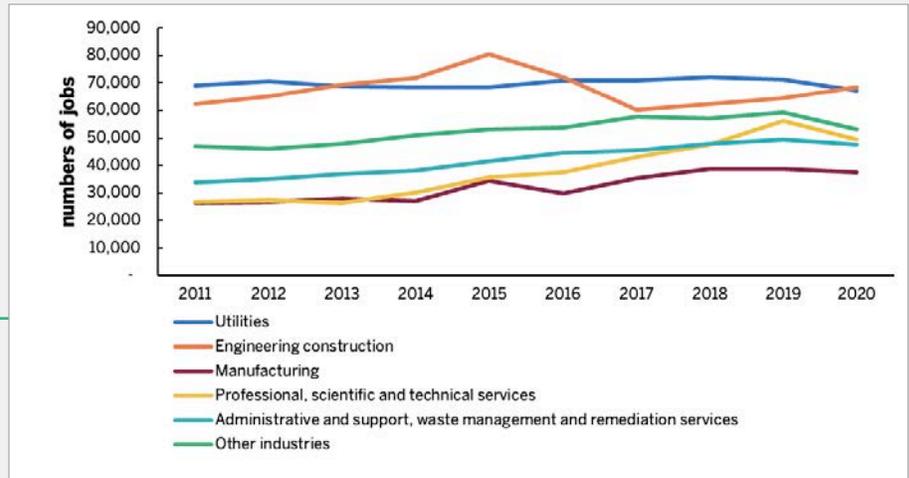


Source: Statistics Canada; EDC Economics

Environmental and cleantech employment and compensation

In terms of employment, Statistics Canada data show that an estimated 322,972 jobs were attributable to ECT activity in 2020, accounting for 1.75% of all jobs in Canada²⁹. The utilities (23%) and engineering construction (22%) segments accounted for nearly half the total from 2011-2020. But in 2020, their shares were lower, each at 21%, reflecting gradual increases in other activities, like professional, scientific and technical services (15%), waste management and remediation services (14%), and other industries (16%) that have grown faster, increased their relative shares, and together, now account for 45% of total ECT employment³⁰.

Most ECT categories showed employment growth from 2011 until 2020; despite 2020 declines, total 2011-2020 CAGR has been 0.8%



Source: Statistics Canada; EDC Economics

Utilities and engineering construction have accounted for nearly half of 2011-2020 ECT employment



Source: Statistics Canada; EDC Economics

Utilities jobs are predominately in electricity power generation, transmission and distribution. Engineering construction industry jobs are mainly in electric power engineering. Professional, scientific and technical services, administrative and support, and waste management and remediation service sectors are mainly concentrated in waste management and remediation services.

In terms of provincial employment patterns, Ontario (38%), Quebec (26%)

and British Columbia (12%) continued to employ the majority of ECT sector workers in 2020. These three provinces account for about three-quarters of total employment, similar to their share of the total Canadian population.

The national average annual compensation per ECT job, including benefits, increased to \$96,281 when based on calculations from Statistics Canada data³¹, although another Statistics Canada source reported the ECT annual average at

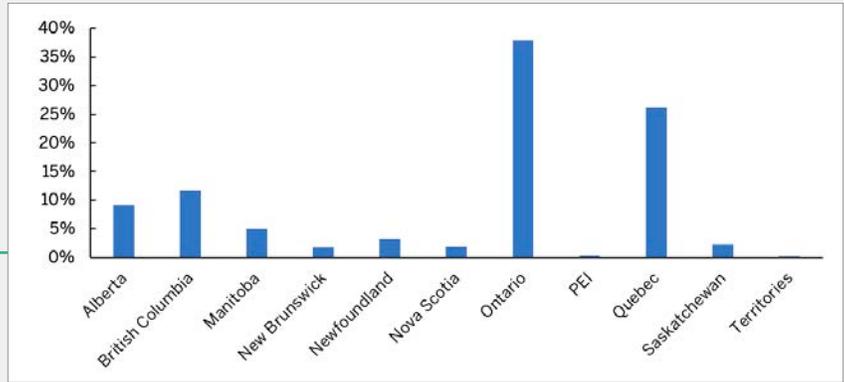
\$80,834³². The data calculation resulted in a 6.4% YOY increase in 2020 and a 3.5% YOY increase in 2019. Therefore, compensation picked up in the industry in 2020. The calculated \$96,281 in 2020 compares with an economy-wide average in 2020 of \$68,678³³. This means ECT employees are compensated at about 40% above the national average³⁴ and the trend has been rising in recent years.

Provincial highlights

Ontario accounts for the greatest share of ECT employment since 2012, with 38% of total jobs in the sector. Quebec is second with 26%, followed by British Columbia at 12%. All other provinces and territories account for less than 10% of ECT employment.

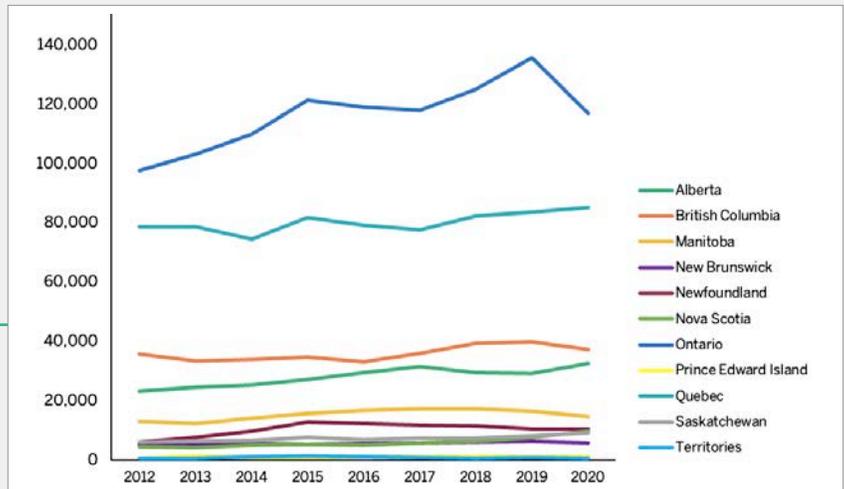
In general, CAGR of ECT employment has been 0.85%, with the territories (1.17%), British Columbia (0.96%), Quebec (0.93%), New Brunswick (0.92%) and Manitoba (0.90%) growing faster than the national ECT average.

Total employment, all ECT industries shows Ontario (38%), Quebec (26%) and BC (12%) account for 76% of total



Source: Statistics Canada; EDC Economics

Employment in ECT generally increased in all provinces and territories until 2020 when several declined, including a significant drop in Ontario



Source: Statistics Canada; EDC Economics





CANADIAN TRADE IN ECT



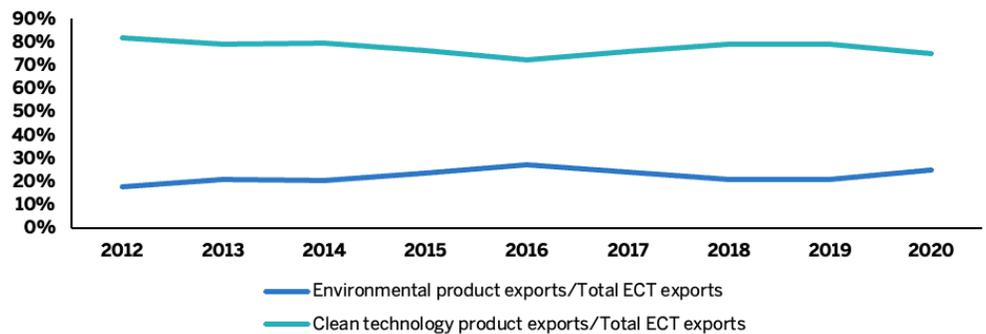
Exports

According to Statistics Canada, ECT product exports increased to \$12.9 billion in 2020³⁵ from \$12.1 billion in 2019. The 2020 figure is the highest export results recorded, and YOY growth has approximated 0.75% CAGR. The trend has been steady since 2016.

In 2020, environmental product exports were \$3.3 billion compared with \$9.7 billion in cleantech exports. This means cleantech exports currently account for about 75% of total ECT product exports.

Cleantech has accounted for 78% of total ECT exports since 2012, with the share slowly declining from the high of 82% in 2012 and 80% in 2014. Cleantech exports have CAGR of 0.82% from 2012-2020 compared with environmental products at 0.56%. But in 2020, environmental product exports increased 28.8% YOY on the strength of exports of clean electricity and electricity from renewable sources. Until recently, cleantech accounts for most exports and has shown higher CAGR in most product export categories.

Cleantech exports accounted for about 75% of total ECT exports in 2020, and 78% since 2012



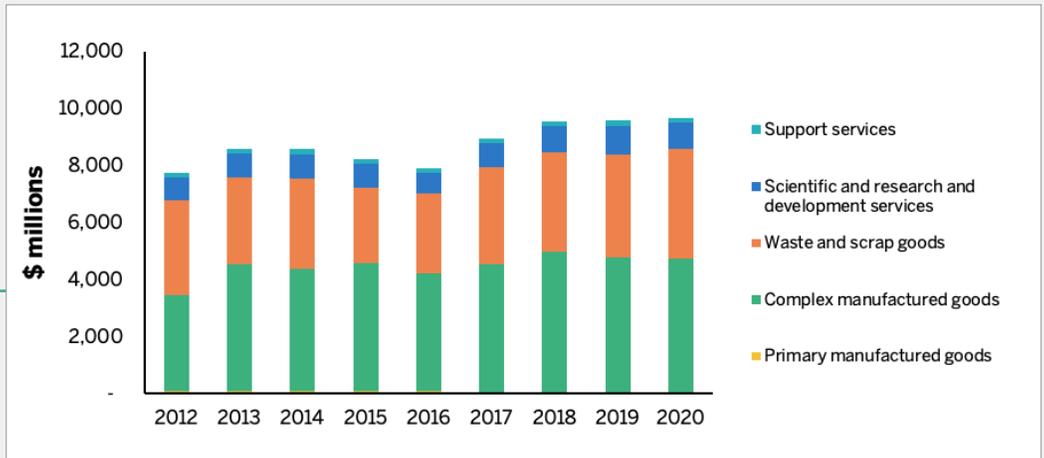
Source: Statistics Canada; EDC Economics

Most cleantech exports are complex manufactured goods (50%) or waste and scrap (37%)^{36, 37}. This presents a conundrum for Canadian exporters, since manufacturing only accounts for about 18% of 2011-2020 cleantech output (13% of total ECT output), 12% of 2011-2020 cleantech value-added (7% of total ECT value-added), and 11% of 2011-2020 total ECT employment.

While dominating the export trade, manufacturers contribute modestly to output and GDP. This partly reflects the predominance of influence in the domestic Canadian cleantech market towards services, with construction, related support, and scientific and R&D services playing a far larger role in the domestic cleantech market than the production of manufactured goods and waste and

scrap. It also reflects Canadian cleantech exporters' weakness in non-Canadian markets (e.g., U.S., Europe, Asia) in the export of cleantech services, which showed a decline in value in 2020³⁸. Most cleantech services are in construction, which should be relevant to other markets as investments are being made in infrastructure, commercial warehousing, and housing.

Manufactured goods account for most cleantech exports

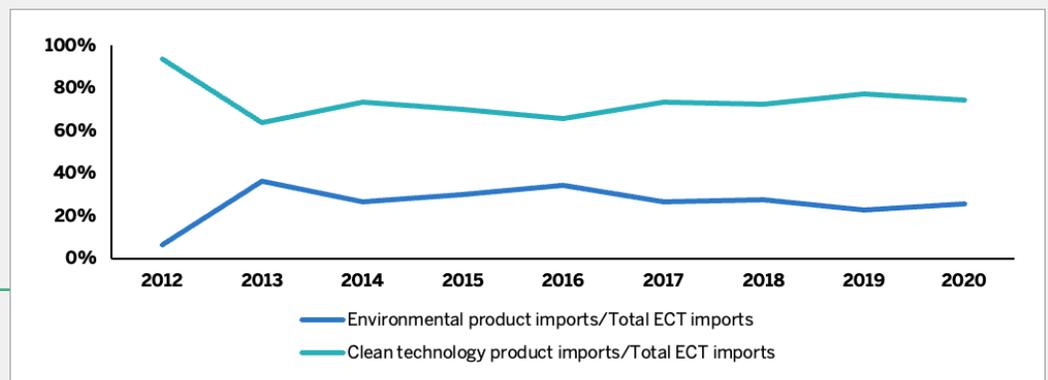


Source: Statistics Canada; EDC Economics

Imports

On the import side, ECT imports decreased slightly to \$18.5 billion in 2020³⁹ from \$19.2 billion in 2019. While biofuel imports increased and accounted for most of the change in environmental products imports, cleantech imports declined nearly \$1 billion. This decline was broad-based and spread across goods and services⁴⁰.

Cleantech imports have grown since 2017 as a share of total ECT imports, despite a decline in 2020



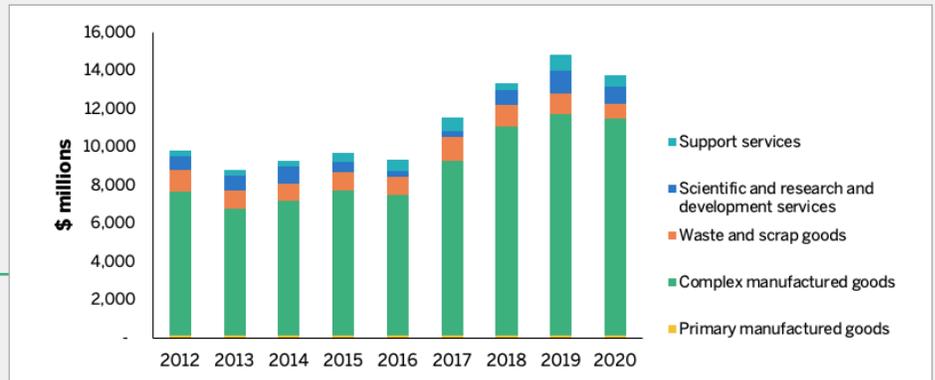
Source: Statistics Canada; EDC Economics

As with exports, most imports are clean technology products, mainly complex manufactured goods, which have been 58% of total ECT imports from 2012-2020 (and 79% of cleantech imports for the same period). This suggests supply chain

linkages, as complex manufactured goods account for most cleantech manufacturing in Canada. Therefore, these goods are imported as intermediate goods, and then exported either as closer-to-finished or finished goods. Cleantech imports

accounted for \$13.8 billion in value, or 73% of ECT imports in 2020. This was down slightly from 2019 when cleantech imports represented \$14.8 billion in value and 77% of total ECT imports.

Complex manufactured goods account for most cleantech imports by a large margin at 79% of the cleantech total on average



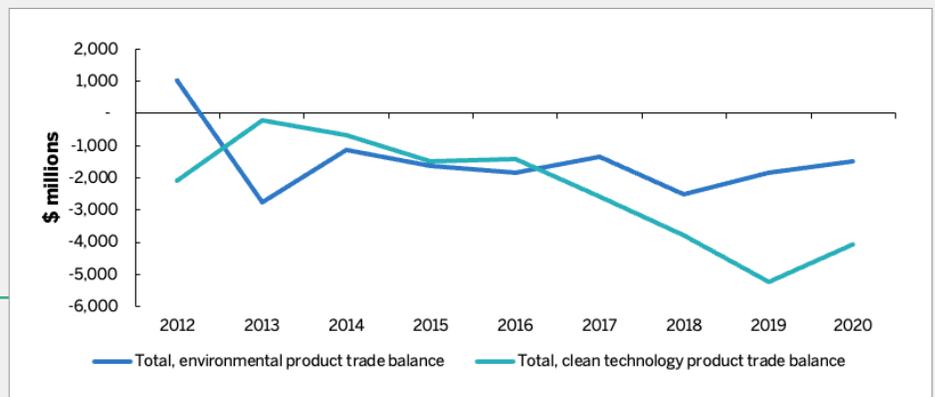
Source: Statistics Canada; EDC Economics

Net trade flows

These combined patterns have resulted in a net ECT trade deficit for Canada throughout the decade. This deficit increased steadily from 2015-2019, and then decreased in 2020. But the 2020 deficit of \$5.6 billion was still higher than in all years before 2018.

The main contributor to Canada's ECT trade deficit is its imports of complex manufactured goods. In 2020, the trade deficit in complex manufactured goods was \$6.6 billion—about \$1.1 billion greater than the total ECT trade deficit. Therefore, other categories such as waste and scrap goods (cleantech), as well as clean electricity and electricity from renewable sources (environmental products), show surpluses. But complex manufactured goods (cleantech) and biofuels (environmental products) show deep enough trade deficits for Canada's ECT sector to run up persistent aggregate trade deficits.

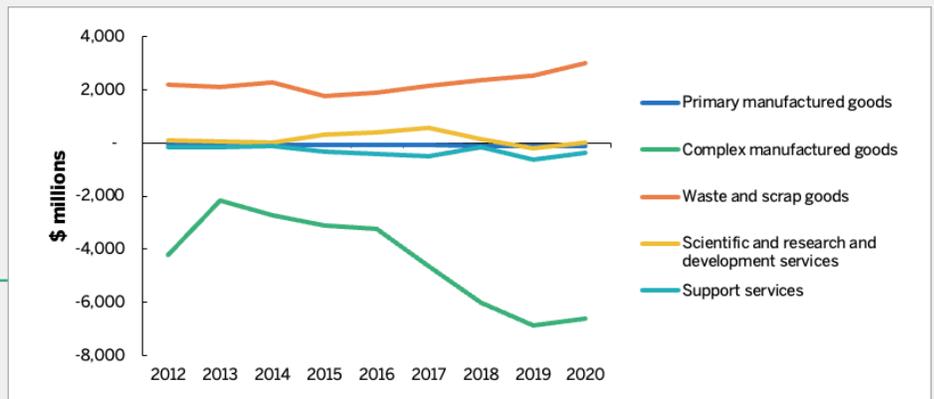
The ECT sector shows movement towards deficit reduction in both broad categories, but the cleantech deficit was still deeper in 2020 than all years except 2019



Source: Statistics Canada; EDC Economics

Due to the outsized role of complex manufacturing products in ECT trade statistics, cleantech is largely responsible for Canada’s ECT trade deficit. More positively, there has been growth in waste and scrap products, which have shown continued trade surpluses. These are likely related to advances in waste management and progress towards a “circular economy.”

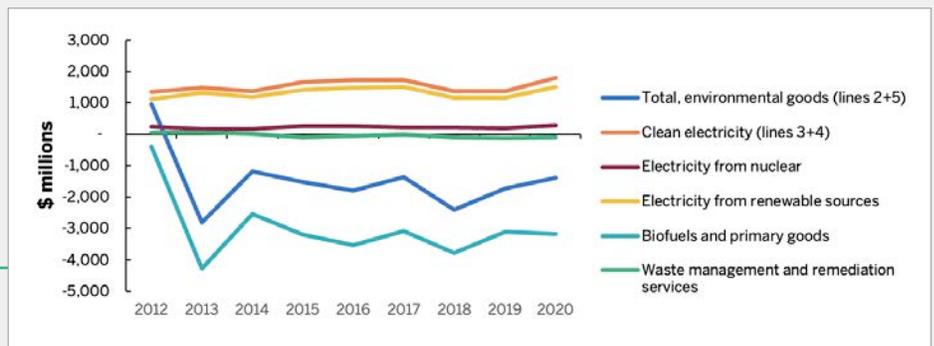
Most product categories are flat apart from continued YOY growth in waste and scrap and sizable deficits in complex manufactured goods



Source: Statistics Canada; EDC Economics

On the smaller environmental products side, clean electricity and electricity from renewable sources show stable surpluses have been maintained, mainly reflecting electricity exports to the United States and the benefits of cross-border integration of electricity grids. Meanwhile, the biofuels and primary goods deficit has been in the \$3-\$4 billion range since 2015, with little YOY change in the 2020 trade deficit.

Environmental products show more favourable trade patterns than cleantech products, but trade deficits prevail in both



Source: Statistics Canada; EDC Economics

Therefore, outside of complex manufacturing and biofuels, most ECT trade shows relatively stable patterns with double-digit growth in trade surpluses in some comparatively large categories, like waste and scrap goods (cleantech) and electricity exports (environmental products).

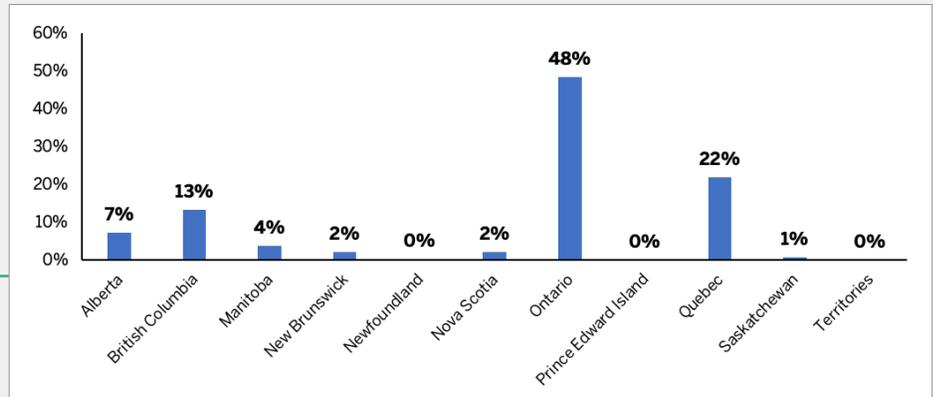
But in both categories, a key weakness appears to be the limited capacity to generate exports or trade surpluses in ECT services. All categories reporting figures⁴¹ were in deficit in 2020, apart from a very modest surplus in scientific and R&D services. As services account for most output and value-added in the

Canadian economy, it’s in these areas that Canadian businesses active in ECT will need to focus to capture a greater share of the global cleantech market. This weakness has been persistent, with net trade in ECT services accounting for a \$1.8 billion cumulative deficit from 2012-2020.

Provincial highlights related to exports

Ontario accounted for the greatest share of ECT exports from 2012-2020, with 48% of total ECT exports. Quebec is second with 22%, followed by British Columbia with 13%. All other provinces and territories accounted for less than 8% of ECT exports. These shares of total are generally unchanged from the 2012-2019 distribution apart from the slight 1% decline in Quebec's share of total.

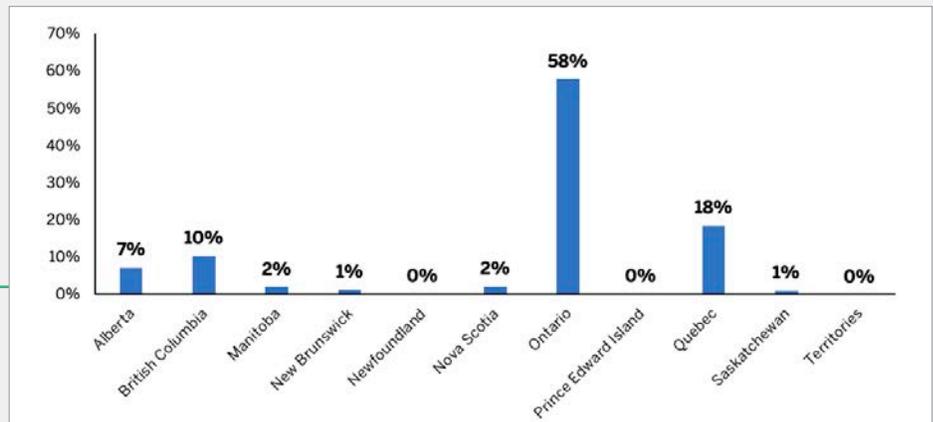
Ontario accounted for nearly half of total 2012-2020 ECT exports due to dominance in cleantech product exports



Source: Statistics Canada; EDC Economics

Specific to cleantech, Ontario is by far the largest exporter, accounting for 58% of total exports, followed by Quebec (18%) and British Columbia (10%). All other provinces and territories accounted for less than 8% of cleantech exports.

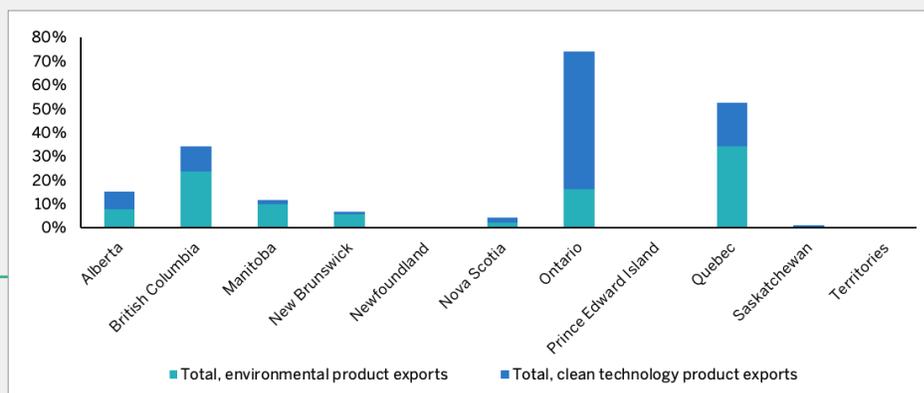
Ontario's prominence in cleantech exports continues to be greater than its overall ECT export profile



Source: Statistics Canada; EDC Economics

Ontario is the only province whose share of cleantech exports exceeds its share of environment product exports.

Ontario is the only province where cleantech exports are significantly greater than environmental product exports



Source: Statistics Canada; EDC Economics

In general, CAGR of ECT exports has been 0.75%, with PEI (1.52%), Saskatchewan (1.19%) and Quebec (0.91%) growing well above this average. Specific to cleantech, export growth has been 0.82%, with Saskatchewan (1.20%), New Brunswick (1.19%), British Columbia (1.18%), Nova Scotia (1.01%), Alberta (0.92%), Manitoba (0.91%) and Quebec (0.91%) growing well above the CAGR of cleantech exports in 2012-2020.

Geographic destination of ECT exports

Most ECT exports are to the U.S., accounting for about two-thirds of total⁴². There's conflicting information about trade. Data from Statistics Canada (Table 36-1006-31-01) show growth in export dollar value, albeit very modest growth in 2020 cleantech exports. But a separate report from Statistics Canada notes that Canadian ECT exports of goods and services fell \$381 million (4.0%) in 2020 to just more than \$7 billion⁴³. If this is true, the decline in exports to U.S. markets was estimated at \$470 million, which was only partly offset by increased exports to other international markets. But because the aggregate figures don't align with Statistics Canada data, the observation isn't validated.

The Statistics Canada report also notes that exports to non-U.S. markets were up 3.5% in 2020 to \$2.6 billion. Despite that, the increase to other markets of about \$87.5 million was well below the nearly \$470 million decrease to the U.S. market inferred by figures in the report⁴⁴. If the report is accurate, some of the decrease is related to disruption at industrial facilities due to COVID-19 and supply chain interruptions. For instance, shortages in semiconductor chips slowed down

auto manufacturing, which then reduced some of Canada's cleantech manufactures exported to the U.S. market.

With industrial integration in the auto and other sectors, Canada's exports are affected as well by its cleantech imports, which may have declined in 2020 as a result of disruptions⁴⁵. Statistics Canada data (Table 36-1006-31-01) show decreases in the dollar value of cleantech imports in 2020, but increases in imports of environmental products.

Earlier research by Statistics Canada noted that in 2017⁴⁶, exports were 75% to the U.S. market, followed by Europe (12%), Asia (10%), and others (3%). Therefore, there's been some success with trade diversification, as non-U.S. markets now account for about one-third of total ECT exports. Nonetheless, trade remains concentrated. Any absolute declines in the dollar value of exports to the U.S. would represent a risk to Canadian ECT exporters. The inferred data from the Statistics Canada report for 2020 show Canadian exports to non-U.S. markets offset less than one-fifth of the YOY decline in exports to the U.S.⁴⁷





STRATEGY AND SUPPORT FOR CLEANTECH EXPORTERS

Since 2017, the Government of Canada has provided funds for cleantech companies across a variety of themes and sectors. For example, in support of clean growth and emissions reductions, Budget 2022 included:

- \$2.2 billion over seven years, starting in 2022-2023, to expand and extend the Low Carbon Economy Fund
- \$250 million over four years to support pre-development activities of clean electricity projects of national significance, such as interprovincial electricity transmission projects and small modular reactors (SMRs)⁴⁸
- Up to \$8 billion in support of projects that enable Canada to reduce domestic greenhouse gas emissions through the Net Zero Accelerator initiative (e.g., decarbonization of large emitters, cleantech and industrial transformation, development of a Canadian batteries ecosystem)⁴⁹
- \$1.5 billion in investment funding over five years for the Clean Fuels Fund (approved in the 2021 budget) designed to “de-risk the capital investment

required to build new or expand existing clean fuel production facilities (including facility conversions)”⁵⁰

At least one source also noted discussion of a potential \$15 billion Canada Growth Fund, although nothing specific of this possible fund has occurred to date⁵¹.

Sustainable Development Technology Canada has been operating since 2001 to support technological innovation related to climate and other environmental risks. It received an additional \$750 million from the 2020 federal budget to support the Sustainable Development Tech Fund and a new Seed Fund linked to incubators and accelerators. This collective government funding and support have benefited—and will continue to benefit—cleantech exporters.

More broadly, the Government of Canada set a target of \$20 billion in exports by 2025⁵². This would more than double the 2020 export value of clean technology products in a period of five years, to at least \$20 billion in 2025 from \$9.7 billion in 2020⁵³. To achieve this, the strategy

was based on 11.4% growth per year⁵⁴. But with the slowdown in 2020 (which may carry over to 2021-2022 due to persistent supply chain interruptions and parts shortages, like semiconductors), the required annual average growth rate is now 15.7%. Conversely, applying the Innovation, Science Economic Development Canada’s (ISED) 11.4% annual growth rate from 2021-2025 results in a 2025 export figure of \$16.6 billion, which falls well short of the \$20 billion target.

Several challenges and opportunities for exporters were described in EDC’s Cleantech Report 2021⁵⁵. Challenges include:

- Global competition;
- Access to finance;
- The relatively small capacity of most cleantech enterprises;
- Intellectual property (IP) protection; and
- Difficulties companies have faced in forming joint ventures for scale.

All of these challenges have been exacerbated by exogenous shocks associated with economic and supply chain disruption resulting from COVID-19, as well as labour market tightness, which has intensified competition for scarce and skilled labour. Other challenges for Canadian cleantech firms include cybersecurity risk issues and intellectual property theft.

More recently, the Canadian Manufacturers and Exporters (CME) association conducted a survey of a small share of their members. Their results showed Canadian manufacturers are investing about \$1 billion a year in emissions-reducing technologies, as opposed to the estimated \$6 billion required to achieve net zero⁵⁶. Much of the problem likely relates to enterprise scale, as most small- and mid-sized businesses lack the resources and capacity to make needed investments to decarbonize industrial operations. As these firms account for an estimated 40% or more of exports, their inability to invest will constrain capacity to export. CME called for the government to more actively assist with the net zero transition strategy by focusing on education and global supply chain competitiveness.

As discussed above, half of cleantech exports are complex manufactured goods, which are imported and re-exported with some intermediate processing, and waste and scrap that has been in surplus for several years.

But in services, Canadian exporters continue to show limited traction in export markets. Scientific work, R&D and support services have remained at about \$1 billion in annual exports since 2012, ranging from a low of \$885 million in 2016 to a high of \$1,192 million in 2019⁵⁷. This accounts for only 5% of the ISED 2025 target. While construction services may add to this, in all likelihood such services would only bring cleantech services exports up to about \$3 billion a year, or 15% of the 2025 target.

This observation is unchanged from prior years since the inception of the ISED strategy, and constitutes an area where Canadian exporters have shown limited capacity to increase market share or export value⁵⁸.

An additional area of support to achieve success may come from outside Canada. Cleantech exporters are supported by the Government of Canada through the

presence of the Trade Commissioner Service (TCS) around the world where embassies are located, and/or where regional development banks are based (e.g., Washington, London, Manila, Abidjan)⁵⁹. The TCS helps Canadian companies operating in a variety of subsectors such as renewable energy, water and wastewater treatment, green building, smart and micro-grids, and clean technology solutions for the mining and oil and gas sectors⁶⁰.

As exports to non-U.S. markets increased in 2020, some of this progress has likely been enabled by TCS. But the main export market remains the U.S. Therefore, efforts to increase dollar volume to the primary export market need to continue, particularly given longstanding trade integration in North America dating back to the early 1990s. In this regard, closer integration with Mexico is encouraged as a starting point for export marketing efforts in cleantech goods and services.





CANADIAN SUCCESSES AND PROSPECTS FOR THE FUTURE

A look at major Canadian success stories as identified in the Cleantech Group's 2022 Global Cleantech 100 list provides insights on how to achieve \$20 billion in exports by 2025. (The most innovative privately held Canadian companies are presented in Table 2 by sector of activity as classified by the Cleantech Group⁶¹.)

While the export figures of the 13 Canadian companies identified among the Top 100 aren't known, their profile, activities and focus offer insights on areas of cleantech innovation and opportunity, as well as the potential challenge of capital structure and how quickly favourable prospects can be upended.

Canadian strengths appear specifically in energy and power (five out of 14 are

Canadian firms) and resources and environment (six out of 21 are Canadian). But Canada added a presence in materials and chemicals (one out of 11) in 2021 while retaining a presence in transportation and logistics (one out of 14). Therefore, the spread of elite performance in cleantech innovation is spreading beyond traditional areas of strength and focus. On the other hand, Canada's one company in transportation and logistics (Effenco) has since gone bankrupt (at least temporarily)⁶².

A second strength is that six of the 13 Canadian firms in the Top 100 are repeats from the previous year. This demonstrates capacity to sustain performance and innovation, both of which bode well for future funding, market share, exports

and ecosystem development. But Effenco is one of these six firms, so nothing is assured for even the most successfully innovative firms if they're unable to scale up. Given the limitations of the domestic Canadian market, this challenge demonstrates the importance of export markets and the potential of cross-border joint ventures and/or mergers and acquisitions to achieve scale.

Developments in 2021 also exposed areas where Canadian performance appears to lag. There was no Canadian representation in agriculture and food, nor in enabling technologies. While the latter only showcased one company among the Top 100, the former represents a foregone opportunity for Canadian firms in light of global food security issues.

Table 2: Innovative Canadian cleantech success stories through 2021

Company	Sector	Activity
Ekona Powerw	Energy and power	Developer of process for production of industrial scale hydrogen, clean power and pure CO ₂
e-ZINC	Energy and power	Developer of zinc reactor technology, which stores electricity in zinc metal for large-scale energy storage
General Fusion	Energy and power	Developer of private fusion energy systems, specializing in magnetized target fusion
Ionomr Innovations	Energy and power	Developer of durable anion-exchange membrane for fuel cells, fuel production and metal recovery
Opus One Solutions*	Energy and power	Developer of real-time control and optimization solutions for generation, storage and electric vehicle resources
CarbiCrete	Materials and chemicals	Developer of low-cost building materials from industrial CO ₂ emissions
Carbon Engineering*	Resources and environment	Developer of technologies for the capture of carbon dioxide from the atmosphere at industrial scale
CarbonCure*	Resources and environment	Developer of a permanent carbon removal technology for concrete production
GHGSat	Resources and environment	Provider of satellite-based remote sensing technology for detection of greenhouse gas emissions from industrial facilities
MineSense*	Resources and environment	Developer of sensor technology to bring operational efficiency to the mining industry
Pani Energy	Resources and environment	Developer of AI-powered water treatment operations and management software
Svante*	Resources and environment	Developer of energy-efficient technology for capturing CO ₂ from industrial sources
Effenco*	Transportation and logistics	Designer, manufacturer and marketer of technologies for the electrification and connectivity of heavy-duty vocational vehicles

Note: * Companies that were also among the Top 100 in the previous year

Another approach is to look at the Canadian environment for startup ventures, as some will be focused on innovation in the cleantech market. According to one source⁶³, Canada is the fourth most attractive business location for startups and innovation after the U.S., U.K. and Israel. These top rankings are all unchanged from the previous year. The index notes that Canada was successful in 2021 and has come closer to the U.K. and Israel in ecosystem capacity, while creating some distance from Sweden (fifth) and Germany (sixth). But Canada still lags in the “quality score” component of the index, which measures:

- Traction of more than 100,000 entities in all ecosystems, including traffic, domain authority, and customer base

- Presence of strategic branches and R&D centres of international technology corporations
- Branches of multinational companies (e.g., WeWork Spaces)
- Total private sector investment in thousands of startup ecosystems
- Number of employees per startup
- Number and size of global startup events and conferences
- Presence of unicorns, exits, and pantheon companies
- Presence of global startup influencers
- Global startup events (e.g., Web Summit)
- Number of startups backed by accelerators (e.g., Y Combinator)

As for cities, Canada is still shut out of the Top 20. Toronto (24th) and Vancouver (40th) each moved up two spots in 2021, while Montreal (45th) moved up one spot and Ottawa (89th) remained at the same ranking as in 2020. These are all ranked in the Top 100 cities for startup ecosystems and have been for at least the last two years. Another 37 cities in Canada are ranked among the Top 1,000, a sizable increase of 11 from the 26 identified the year before.

Particular ecosystem strength in Canada is noted for energy and environment technology where Vancouver, Calgary, Edmonton and Kingston are “overperformers”⁶⁴. This is directly linked to Canadian capacity to more fully develop cleantech and increase cleantech exports.

More broadly, Canada enjoys:

- A market-oriented economic system
- High standard of living
- Native English language capacity
- Proximity to the U.S.
- Strong position of the nation's startup ecosystems that make Canada attractive for foreign talent

The Startup Visa, tax breaks and increases in venture capital and private equity in 2021 have also added momentum.

But ecosystem weakness in Canada relates to difficulties generating a critical mass of scalable startups and unicorns, compared to the U.S., U.K. and Israel. More recent challenges to private equity and venture

capital, combined with bureaucratic snafus related to visa processing for the Collision tech conference and other events (not to mention for companies), are also slowing progress in 2022.



CLEANTECH TRENDS AND OPPORTUNITIES



The Cleantech Group presented key observations from 2021 and trends to monitor for 2022—and beyond—in each of the major sectors of focus. These are summarized in Table 3 below. A discussion of opportunities in Canada and for Canadian exporters related to these observations and trends follows.

Table 3: Summary of global cleantech trends by sector activity

Sector/ activity	Trends
Agriculture & food	Efficient protein production: The 2022 cohort signals a change in the alternative proteins sector as cultivated and fermented proteins outnumber plant-based alternatives for the first time. The market favours more resource-efficient production systems offering more flexible feedstock and production.
	A focus on soil health: The market is looking to manage soil health and improve soil inputs. Management and monitoring of soil are becoming a more prominent part of the sustainable agriculture and precision agriculture revolution. The value in measuring, monitoring and mapping soil to improve crop varieties, biological inputs, carbon sequestration and price ecosystem services has driven investment. This trend has been supported by elements of the Green Deal in the European Union, focusing on reduced fertilizer use and soil health. Similarly, the U.S. Agricultural Carbon Bank is set to incentivize investment.
	Crop genetics business model innovation: Ten years on from the invention of CRISPR gene editing technologies, the market is seeing commercialization of the technique in agricultural applications. Innovators are looking to capture value by working with downstream food companies or take on commercialization risk for new products. Business models include genetic editing and engineering services; variety/trait co-development projects with royalty payment on sales and crop variety design, breeding and distribution.
	Downstream innovation is under-represented: Supply chain innovation is under-represented. With key legislative, consumer preference and economic drivers increasing the importance of supply chain tracking, shelf-life extension and consumer food sourcing solutions, this theme is expected to see greater representation in future investment, including a focus on “last mile delivery marketplaces” and shelf-life extension innovation.
	Consumer-facing sectors are raising large rounds: As the majority of value is captured at the retail and consumer end of the value chain, the highest growth sectors are for consumer-facing products and services such as fresh produce delivery and alternative protein brands.
Enabling technologies	Protecting assets and data: With industries continuing to digitize, cybersecurity solutions will show strong demand. End-to-end encryption, identity management, and device and cloud security are areas opening to early-stage innovation. Corporates have been increasingly active in establishing strategic partnerships with innovators in the cyberspace, either directly or through their Venture Capital firms. Corporate participation is expected to increase as risk increases.
	Ramping up processing and computational capabilities: Quantum computing can drive innovation in security, material science, communications and simulation, among other applications. With current advances in the technology, quantum is headed for exponential growth with its market projected to exceed US\$64 billion by 2030. Quantum cryptography and Quantum Superposition are solutions to monitor. Google and IBM lead the race in quantum, but innovators are emerging.
	Standardization across smart devices: Standardization of technologies may see a drive from legislative bodies to uphold quality and safety of solutions. Internet-of-things (IoT) and other connected devices will be directed towards a base system to ease adoption. Partnerships between device developers and security providers are expected, as are full-stack developers.

Table 3: Summary of global cleantech trends by sector activity

Sector/ activity	Trends
Energy & power	Hard energy technology: Support for hard-tech innovators over software signals a renewed willingness and urgency to decarbonize, as well as overcome capital-intensive commercialization hurdles. Challenging themes such as fusion, long-duration storage, marine energy and geothermal are also attracting attention and investment.
	Clean hydrogen production: Strong presence of hydrogen production innovation is well-aligned with cost reduction requirements over the next five to 10 years. Renewable production innovators are scaling to drive down per-unit costs and to address expensive critical metallurgy bottlenecks. Low-carbon hydrogen production innovators are increasing the percentage of CO ₂ captured, while decreasing capture costs.
	Alternative refrigerant systems: Despite the presence of heating and cooling innovators, innovators using alternative refrigerants are missing. Given hydrofluorocarbons refrigerants are the most harmful components in buildings, regulation across the world is accelerating phase out and driving demand for low-carbon alternative options for use in heat pumps.
	Creating carbon-aware energy networks: Electricity grids, hydrogen and heat networks are just a few examples of where carbon intensity needs to be tracked and accounted for in real-time for corporates to accurately account for their CO ₂ impact. Tech corporations, including Google and Microsoft, are among the first creating carbon-aware energy transactions while transitioning towards 24/7, 365 renewables, matching renewable supply and demand in real-time.
	Deep-water renewable markets: 80% of the world's offshore wind resource potential obtainable in waters deeper than 60 metres remains untapped. After a decade of pilots and demos, deep-water wind is entering a rapid scale-up phase. Globally, the market is projected to reach 26GW installed capacity by 2035. Floating technologies will see significant consolidation in the next five years. The Biden administration plans to install 30GW of offshore wind by 2030, and South Korea has a US\$31 billion plan for a 6GW floating wind project for 2030.
	Hardware-as-a-service for consumer-facing business models: Consumer willingness to pay remains a challenge for scale deployment. Innovators are increasingly tapping third-party financiers to provide a pay-as-you-save model, which will remain important until green premiums reduce.
	Green mortgages: These are another innovative financing mechanism to incentivize investment in consumer-facing, energy-efficiency solutions. Given housing shortages and the need for new construction, green mortgage concepts can be integrated into broader housing market and housing finance programs to head off energy waste in coming decades.
	Record investment in energy & power in 2021: Record levels of investment have been driven by support for technologies and business models such as batteries, long-duration storage and solar-as-a-service. Corporates are driving commercialization efforts and aligning strategy with climate goals, which means they're investing more than ever in innovators to support the transition to consumer-centric business models at the grid edge. Batteries, in particular, received major investment, driven by automotive original equipment manufacturers' (OEM) desire to reduce the cost of electric vehicles, lithium-ion battery manufacturing and advanced battery technology, including silicon anodes and metal battery technology.
Materials & chemicals	Progress in hard-to-abate sectors: Innovation focused on addressing emissions in hard-to-abate sectors in 2021. Interest in basic materials is increasing.
	Biotech: Biotechnology continues to feature in 2022 with renewed focus on materials. Biological manufacturing of chemicals has historically faced economic and technical challenges. Biotech platforms and cell-free manufacturing are both set to address these challenges. Cell-free manufacturing enables manufacturers to synthesize materials from enzymes, which circumvents some of the challenges associated with traditional fermentation approaches.
	Chemical industry: The chemical industry is under-represented considering the impact of chemicals and decarbonization trends in other challenging sectors. Opportunities for innovators exist in electrification, efficient separations, and biomanufacturing targeting higher volume chemicals.
	Looking further up the value chain: Basic material production innovations are likely to remain well-represented as high emissions are likely to persist. Innovators in superior and low-impact battery materials and solar PV components will also see opportunities.
	Batteries and EVs: A key element for success in the electric vehicle (EV) space remains the cost and performance of batteries. Materials innovations are set to drive improvements. Innovators solving technical challenges associated with silicon anodes to improve energy density will receive further attention. Niobium anodes are set to make fast charge a reality and new materials processing technology is set to address manufacturing waste and lower costs of production.
	Oil and gas refocus: Oil and gas majors are looking to reimagine themselves in a world beyond peak oil. Many have made commitments to reach net zero by 2050 and have raised funds to invest in a broad range of clean technologies. Saudi Aramco, Shell and BP all have large US\$500 million+ venture funds. Shell, BP, Repsol are engaging in early-stage innovation via accelerator and incubator programs, but it's currently unclear how mid-2022 market turmoil triggered by Russia's invasion of Ukraine will affect current plans, near-term trends and ability to meet 2050 targets.
	Carbon pricing: Carbon pricing is driving investment in emitting industries, including steel, cement and chemicals. Record carbon prices in the EU ETS, alongside implementation of the Carbon Border Adjustment Mechanism (CBAM) is likely to spur EU emitters into action and support innovation. Procurement policy, predicated on environmental product declarations (EPDs), will be important for stimulation of demand for green steel and low-carbon construction materials. But as with O&G, it remains to be seen how the war in Ukraine will affect European and other carbon pricing markets.

Table 3: Summary of global cleantech trends by sector activity

Sector/ activity	Trends
Resources & environment	<p>Emissions monitoring: Mandatory disclosure regulations across the globe are forcing large companies to provide high-quality data. From direct monitoring with satellites to emissions accounting software, 2022 signals a strong market shift towards startups helping clients track their climate goals.</p>
	<p>Monitoring climate-related physical risk: Similar mandatory disclosure regulations for climate-related financial risk have boosted the market for risk assessment tools.</p>
	<p>Offsets: The rapidly expanding voluntary carbon offset market (VCM) has come under scrutiny due to incidence of double-counting and failed projects due to forest fires. Corporate buyers are seeking high-quality offsets and transparency, fuelling the market for remote monitoring and verification technologies.</p>
	<p>Carbon capture usage and storage (CCUS): CCUS players are now a regular feature of the Global Cleantech 100, raising large growth equity rounds for capital expenditure (CAPEX)-heavy technologies, reflecting increasing market confidence.</p>
	<p>Air quality: COVID-19 highlighted the importance of indoor air quality for health. The return to commercial buildings, following lockdowns, is driving building owners and managers to look to tools to assure safety and comfort. Transportation (e.g., airlines, rail) and other enclosed facilities (e.g., schools, warehouses, multi-family dwellings), likewise, show demand for improved and more efficient air purifiers.</p>
	<p>Wastewater treatment: The increasing criticality of water to business, alongside corporate goals to reduce the energy intensity of wastewater treatment, continue to fuel the market for wastewater treatment optimization tools.</p>
	<p>Recycling and the circular economy: EU legislation has started to transform Europe's waste system with a specific focus on plastics. The EU's waste export ban has incentivized domestic recycling and with it, demand for robotic autonomous sorting technologies. Automotive OEMs and energy majors are entering partnerships with lithium-ion battery recyclers to facilitate circular business models for end-of-life car batteries. Chemical, fast-moving consumer goods corporates and plastics producers continue to invest and partner with chemical plastic recycling innovators to provide CAPEX for recycling infrastructure. Corporates are securing long-term partnerships across the value chain to supply waste plastic feedstock, secure a steady supply of recycled plastic, and track plastic as it moves through value chains to ensure circularity.</p>
Transport & logistics	<p>EV charging takes centre stage: As an increasing portion of the global vehicle fleet electrifies, infrastructure solutions in both hardware and software need to scale up to meet projected demand for electric vehicles. Markets are increasingly looking beyond passenger vehicles to innovate with electrification and develop disruptive business models that move people and goods more efficiently.</p>
	<p>Corporates are investing in decarbonization: Participation from corporates is increasing, particularly with automaker commitments to ramp up EV production. Automakers are looking for technology partners to expand into new business lines, improve production of EVs, drive down battery costs, and improve battery performance.</p>
	<p>Government regulation: Regulation and government targets are beginning to drive markets and innovation in hard-to-abate sectors. Government targets for net zero emissions and accompanying regulations (e.g., carbon taxes, low-carbon fuel standards, sustainable fuel-blending mandates) are creating markets for zero- and low-emission solutions in harder-to-abate sectors (e.g., maritime shipping, aviation).</p>
	<p>Supply chain constraints and batteries: Supply chain constraints and range limitations are driving innovations in components. Innovation in batteries, fuel cells and hydrogen storage are becoming critical to unlock longer ranges and overcome supply chain bottlenecks in metals for lithium-ion batteries. Investment in new battery types and chemistries such as solid state and silicon anode will likely accelerate in the coming years.</p>
	<p>Acquisitions: Automakers, charging providers, oil & gas majors and energy companies are expanding their offerings across the electrification value chain. As vehicles and the surrounding ecosystem (e.g., charging/fuelling, maintenance) become increasingly electrified and digitized, incumbents are looking to own more of the "customer experience" and generate recurring revenue.</p>
	<p>Record-breaking investment in 2021: The pace of transformation towards connected, autonomous, shared and electric mobility is accelerating across the industry, driving investment in innovation higher. Total venture investment in 2021 exceeding US\$51 billion was much higher than the previous highest total of US\$41 billion in 2018. The trend is likely to continue as new funds emerged in 2021 to target technologies and challenges in decarbonization in vehicles and automotive supply chains, new mobility and batteries.</p>

Canadian context for cleantech opportunities

The Minister of Environment announced key priorities for the Government of Canada in 2020 that directly involve cleantech⁶⁵. Among the key sector-oriented priorities announced—and how these relate to opportunities for Canadian cleantech firms and exporters—were:

- **Oil and gas:** O&G accounts for 26% of Canada's emissions and these emissions were growing, at least up to the temporary impasse in 2020 caused by COVID-19 disruptions.
 - More recent geopolitical disruptions and increased production and consumption of fossil fuels will increase global emissions in the near term.
 - Canada's focus will be on ways that make continued use of these resources possible during the transition and eventual reduction in their use (in the context of a very carbon-constrained world) with a focus on decarbonizing the sector by:
 1. Reducing emissions intensity from existing technologies, including solvents, carbon capture and storage, and methane;
 2. Unlocking energy value without carbon in a manner consistent with climate objectives; and
 3. Applying new technologies and standards for broader decarbonization work in the natural resources sector.
 - Canada's new carbon pricing framework will add costs to producers and consumers across the spectrum, but will also spur investment into innovation that's needed to achieve net zero targets for 2050.
- **Transportation:** Transportation accounts for 25% of Canada's emissions.
 - These come from personal vehicles, heavy-duty vehicles, and other modes of transportation. Therefore, the focus will be on achieving short-term

objectives, like reduced emissions via light-duty vehicle standards, use of incentives, and possible mandates to enhance zero emissions vehicle deployment, while moving towards long-term mechanisms in the auto sector and elsewhere to achieve climate objectives. **Opus One Solutions** is a developer of real-time control and optimization solutions for generation, storage and electric vehicle resources that has been recognized for innovation in this segment of the market.

- Mining sector developments are highly important for the transportation sector. With the recent push by western countries to secure more stable supplies of minerals, ores and rare earths, much of the future in transportation will depend on success in securing adequate supplies of required materials for the production of electric vehicles and other electronic goods (e.g., cell phones, laptop computers). This represents a major opportunity for Canada in terms of domestic production, as well as mining company opportunities abroad. For instance, **MineSense** is a developer of sensor technology that helps bring operational efficiency to the mining industry.

These two sectors alone present considerable opportunities in the use of clean technology, including hydrogen, renewable natural gas, carbon capture and storage, water technologies, sensing and monitoring technologies, and fuel cells. Further opportunities are expected to be found in:

- Electrification
- Transportation modernization
- Heavy industry decarbonization
- Innovations in agriculture and food processing
- Smart buildings and construction
- Energy storage

Electrification

Electrification is a big part of the ECT story, with Canadian exports of clean electricity and electricity from renewable sources at nearly \$2 billion in 2020. Most of these exports are derived from renewable sources, and along with low-carbon (i.e., nuclear) sources, are expected to increase in the coming years.

- Electrification will be all-encompassing across the industry, as well as in housing and commercial construction.
 - This bodes well for Canadian cleantech firms since much of the focus in Canada has been on the renewable energy sector—mainly wind and solar.
 - These activities offer potential for micro-grids or “non-utility” production, combined with advancements in storage that can cater to the needs of large energy consumers without depending on provincial energy operators or governments. This is a more decentralized business model powered by smart grids, owned by private landowners or communities, and capable of generating and distributing power to meet local needs, while also generating cash flows to cover investment and operating costs and generate positive returns.
- Such grids have potential worldwide and are most needed in emerging markets where electricity access is much lower.
 - For instance, less than half of Sub-Saharan African households and small businesses have access to electricity. There are several countries in the world outside of Africa where access to electricity is at or below 75%⁶⁶.
 - With the Trade Commissioner Service (TCS) posted in cities where major development banks are located, there'll be opportunities for Canadian

exporters to make investments in support of clean power production, transmission and distribution in emerging markets.

- Generally, Canadian exporters have shown limited success in the export of ECT services with no upward trajectory based on 2012-2020 figures.
- Despite relatively limited growth in cleantech exports from Canada since 2018, several Canadian firms are showing favourable prospects for the future. They include:
 - **Ekona Power**, a developer of process for production of industrial scale hydrogen, clean power and pure CO₂
 - **General Fusion**, a developer of private fusion energy systems, specializing in magnetized target fusion

Transportation modernization

Since transportation methods are more challenging to electrify—at least until batteries have more capacity—biofuels or low-carbon fuels present an opportunity if production costs can be managed.

- Much is already known about the evolution and adoption of electric vehicles, including:
 - Battery innovation
 - Dependence on differing minerals, ores and rare earths
 - Infrastructure needs for recharging
 - Policy incentives for market-based adoption and expansion of production capacity for scale and per-unit affordability
- While there are still questions about the pace of adoption, there's a general consensus that land-based vehicle technologies are undergoing a major transformation driven by concerns for the environment.

- Most major automobile manufacturers have announced shifts to EVs and are in the process of designing and/or building facilities to be able to produce and catch up with industry leaders, like Tesla. This results in opportunities for electrification in the transport sector, building on progress with EVs to potentially address more challenging transportation methods such as heavy-duty, long-haul transport.
- Many markets and regions are still seeking to attract needed investment to develop required ecosystems. As global automakers depend on a large number of suppliers and vendors for procurement requirements, ecosystem development with secure supplies of goods and services and skilled labour are indispensable. While R&D and other proprietary technologies don't need to be localized, many of the requirements of auto manufacturing and assembly plants require proximity. Therefore, there'll be opportunities for Canadian cleantech exporters of goods and services to fit into emerging transportation ecosystems around the world as these ecosystems take shape.

- Additional opportunities are likely to be found in major metropolitan areas for fleets of electric buses and metro transit systems, although ridership may be disrupted for several years due to the pandemic. For instance, **Lion Electric** is a Canadian company that designs and manufactures zero-emission vehicles, like electric school buses, minibuses for special needs or urban transit, and urban trucks.

- As air travel has surged in 2022, there'll be demand for better air purification systems on a growing fleet of planes, as well as advances in reducing emissions produced by the aviation sector from jet fuel and other resources.
 - The aviation industry is pursuing climate action goals to reduce CO₂ emissions by 50% by 2050 compared to 2005 levels through:
 1. A global offsetting scheme
 2. Adoption of less carbon-intensive technology
 3. More efficient operations
 4. Better infrastructure
 - Innovations related to air filtration systems will be essential as part of a larger package of transportation modernization efforts.
 - Advances in air purification technologies could have implications for additional advances in other transport sectors, as well as for the construction industry and application to heating, ventilation and air conditioning (HVAC) systems.

Heavy (and light) industry decarbonization

Many industrial sectors will be expensive and challenging to decarbonize, as noted in the CME survey responses.

- Solutions aren't fully available now, at least at affordable costs for industries undertaking the effort.
 - Affordability is a key challenge for small- and mid-sized companies, and investment is estimated to be seriously deficient relative to requirements for net zero in the industrial sector.
 - In some cases, new solutions such as the use of natural carbon sinks, power from hydrogen, and/or small nuclear reactors may be required.
- Decarbonization of heavy industry (e.g., energy, steel, concrete and cement) is difficult to implement because these operations are often slow-moving, capital-intensive, low-margin businesses that depend on long-term asset durability.
- These challenges and weaknesses are creating opportunities for industrial process efficiency, as well as industrial production. Several Canadian firms are capitalizing on opportunities, including:
 - **Svante** is developing energy-efficient technologies to capture CO₂ from industrial sources.
 - **Carbon Engineering** is developing technologies to capture carbon dioxide from the atmosphere at industrial scale.
 - **GHGSat** is providing satellite-based remote sensing technology for the detection of greenhouse gas emissions (GHG) from industrial facilities.

Agriculture and protein alternatives

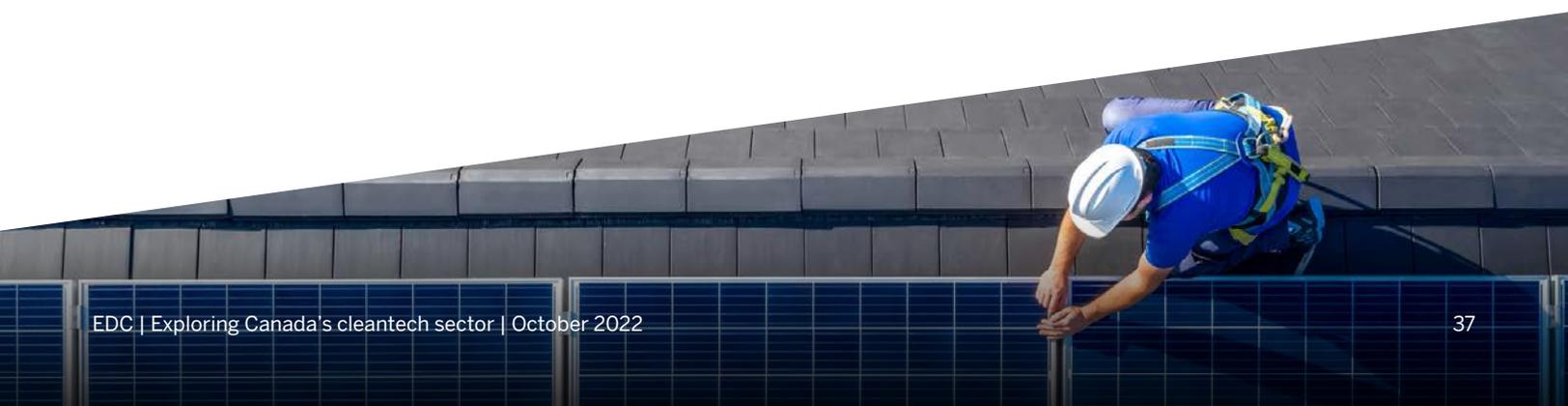
Industry specialists believe future growth will come from changes in agricultural practices focused on plant-based diets and reduced food waste, as well as the use of microbes for regeneration and improved soil management practices.

- Regenerative agriculture represents a group of farming and grazing practices that seek to reverse climate change by rebuilding soil organic matter and restoring degraded soil biodiversity, resulting in both carbon drawdown and improvement of the water cycle.
- As one example, 13 of the Top 100 cleantech companies in the Cleantech Group's Global Cleantech 100 for 2020 were in agriculture and food, with another 12 in 2021. None were from Canada, but given Canada's land mass and position in global agricultural production, there should be opportunities for Canadian producers in this segment.
 - This includes output and processing of nutritionally dense food that relies more on plant protein and less on animals, which should lead to opportunities for multiple enabling technologies, including synthetic biotechnology, blockchain and artificial intelligence.
 - Such opportunities would help promote value-added in the primary sector, where most output is in commodity and resource production—and prices are lowest—with limited share of processing and transformation—where margins are often higher.
 - Soil health, local food networks, indoor farming and alternative proteins are all considered growth opportunities for the future.

Smart buildings and construction

With urbanization and a general retooling of national infrastructure, “smart” buildings represent an opportunity to reduce the amount of heat, cooling and water used.

- This applies to residential and office buildings, work sites and industrial processes used in construction.
- In general, these activities highlight the importance of energy efficiency in buildings and the importance of retrofits and building management systems. This should also be an area of policy importance in light of the need to address infrastructure and urbanization needs (described above). This includes water management and wastewater treatment, an area in which **Pani Energy**, a developer of artificial intelligence-powered water treatment operations and management software, is focusing.
- Several other Canadian firms are capitalizing on opportunities, including:
 - **CarbonCure Technologies**, which is developing a permanent carbon removal technology for concrete production that should open up construction industry and export opportunities for goods and services
 - **CarbiCrete**, which is developing low-cost building materials from industrial CO₂ emissions, which may also have significant beneficial effects on future construction and boost export opportunities for goods and services



Energy storage

Energy storage offers considerable opportunities for firms to provide power, including at peak use times, while storing the cheapest renewable power.

- Innovation and off-grid solutions have been found in multiple locations, with the benefit that many can be implemented at the micro- or small-scale level. Therefore, they represent solutions that aren't capital-intensive and can be implemented across a broad array of locations to complement or supplement grid sources of power. But they remain expensive, so scale to reduce per-unit costs may help to

promote this as a solution, offering opportunities for targeted subsidies and blended finance.

- Progress has also been made on carbon capture. Carbon-capture solutions are capital-intensive and complex to implement. Therefore, as with off-grid solutions, a key challenge will be scaling up, increasing market acceptance, and identifying use cases for the captured carbon. CCUS is demonstrating increasing ability to attract investment funding, reflecting growing market confidence.
- Broader energy storage innovation is being pursued, with some Canadian

success stories that include:

- **e-Zinc**, a developer of zinc reactor technology, which stores electricity in zinc metal for large-scale energy storage
- **Ionomr Innovations**, a developer of durable anion-exchange membrane for fuel cells, fuel production and metal recovery
- **Hydrostor**, a developer of utility-scale energy storage facilities.



CONCLUSION

The global cleantech market is projected to exceed US\$2.5 trillion by 2022, about 2% to 3% of anticipated global GDP. Canadian output as a share of this total is about 1%, while value-added approximates less than 1%.

Part of the challenge for Canadian cleantech exports is that manufacturing accounts for about 10% of total Canadian GDP, with most economic output found in resources, construction and services. Yet, the bulk of cleantech exports are in manufactured goods (e.g., complex manufactures, waste and scrap), which also translates as weakness in international cleantech services transactions. This has culminated in cleantech trade deficits for Canada, partly reflecting the difficulty of Canadian cleantech services exporters in penetrating the U.S. and other export markets. ECT, in general, registers trade deficits for Canada, as environmental products are also in deficit due to the importation of biofuels and primary goods that far exceed the export of clean electricity.

For Canadian cleantech exporters to achieve the 2025 target of \$20 billion in exports, YOY growth will need to be at least 15.7% per year from 2021-2025. This means Canadian manufacturers and service providers will need to increase market penetration abroad.

On this note, Canadian exporters have registered some successes. Exports increased in 2020 to non-U.S. markets. But most ECT trade remains with the U.S., and the biggest risk to achieving the 2025 target is losing market share in the U.S.

Another challenge for Canada's cleantech sector is it's predominantly composed of small- and medium-sized enterprises (SMEs). Many of these firms struggle to:

- Achieve market acceptance
- Build their teams
- Attract funds for growth
- Become cash flow-positive as they pursue innovative research and development.

Challenges in commercializing intellectual capital have constrained their ability to achieve scale, while international competition has made it challenging for Canadian firms to penetrate markets outside North America. Manufacturing sector investment in emissions-reduction technology also lags what's needed to achieve net zero targets due to financial and technical resource constraints faced specifically by small-scale industrial enterprises.

Despite an increase in private equity and venture capital funding in 2020-2021, accessing needed funding for scale remains a challenge for most cleantech companies. Market developments in 2022 add to the challenge. But on a positive note, Canada gets good ratings for innovation and ecosystem support for startups, and 13 of the Top 100 innovative cleantech firms in 2021 were based in Canada, second only to the U.S. Therefore, Canada is sustaining success in the market. Proximity to and active integration with the U.S. market helps to position Canada for future success.

However, heavy reliance on public sources of financing, liquidity pressures partly

brought on by supply chain disruptions, and the inability to scale up production fast enough to reduce per-unit costs can shutter a company, even when it's recognized for its innovation. Therefore, financing remains a persistent challenge.

Another risk for cleantech companies and exporters relates to the macroeconomic environment. The shift in monetary policy to contain rising inflation rates has already set in motion a reallocation of capital into value stocks and safer securities. This has been reflected by equity markets, which have begun to "correct," with an outflow of private equity and venture capital in some innovative sectors of the economy that has contributed to the considerable decline in SPAC values. This could make access to finance more difficult and costly for early-stage cleantech startups in 2022 and beyond.

In Canada, a significant share of private equity and venture capital is derived from pension funds, foreign investors and Government of Canada Crown corporations. With competing demands on what will potentially be scarcer fiscal resources from the federal government, many of Canada's cleantech innovators may find financing harder to access, not only when starting up, but after several years of operation.

In addition, geopolitical and health-care system stresses may require a significant shift in fiscal policy resources. Military budgets will need to increase to meet minimum NATO and other requirements, while COVID-19 has exposed capacity limitations of Canada's health-care system. At a time when federal debt to GDP has increased and rising interest rates are portending greater interest expense on public debt, support for cleantech innovation from federal and other public sources will be more challenged. While major commitments are in place (e.g., Net-Zero Accelerator Fund, Clean Fuels Fund, Sustainable Development Technology Canada), adding to these commitments may be more challenging in the future.

In response, geopolitical stresses could encourage an increase in joint ventures and R&D collaboration among "friendly nations" and firms. In this regard, North American companies may increase collaboration with European and Asia-Pacific firms (e.g., Australia, India, Japan, Korea) on proprietary technologies and processes in the coming years as supply chains and energy market relationships realign.

Therefore, geopolitical stresses may also present export opportunities in cleantech. The need for energy independence has been identified as a priority in many

parts of the world. And if global supply chains are partly reconfigured to be more "regional" in focus, there could be new investment opportunities in property, plant and equipment for areas of the world that will expand manufacturing and other industrial capacity.

Access to clean and affordable electricity and power will be an important part of this mix, and the North American market will provide ample opportunities over time as these countries (i.e., U.S., Mexico, Canada) all expand domestic production capacity. Degrees of co-ordination will need to be determined, but this is an area where Canada's cleantech and broader ECT market should find considerable trade and investment opportunities. This includes opportunities in the mining sector to enable the shift across sectors towards increased electrification.

Such developments may also occur in places like Africa, where food security and climate change issues are having a devastating impact on underlying security. Climate change is likewise impacting capacity to transport and ship food commodities in Latin America, such as in the Amazon due to low sea levels, much like the Rhine in Europe where barge traffic is under threat due to low water levels. These climate change effects could lead to opportunities for Canadian cleantech firms.

Canadian companies should be able to capitalize on the many opportunities that exist, given the high-level demand globally for innovative solutions. But interim disruptions in trade that created trade frictions prior to COVID-19 were subsequently exacerbated by the pandemic. The impact on supply chains continues to interrupt trade and has triggered a major reconsideration of investment and how to ensure supply chain security.

Further disruption has occurred in recent months due to the war in Ukraine, which looks to be a protracted conflict that'll continue to cause economic and political uncertainty. Against this backdrop is a resumption of increased fossil fuel use for an interim period, pushing back prospects for achieving net zero targets by 2050-2070 as major economies have declared.

Despite the many opportunities that exist in Canada, North America and globally, the economic, financial and business environment for the foreseeable future will pose significant challenges. This could make it difficult for Canadian exporters to hit 2025 targets and to achieve nearly 16% YOY growth in cleantech exports.



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- <https://www150.statcan.gc.ca/n1/daily-quotidien/220106/dq220106d-eng.htm>
- <https://www150.statcan.gc.ca/n1/daily-quotidien/220323/dq220323e-eng.htm>
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- <https://www150.statcan.gc.ca/n1/daily-quotidien/220428/dq220428f-eng.htm>
- <https://www150.statcan.gc.ca/n1/pub/16-001-m/16-001-m2019001-eng.htm>
- <https://www150.statcan.gc.ca/n1/pub/16-511-x/16-511-x2022001-eng.htm>
- <https://www150.statcan.gc.ca/n1/pub/13-605-x/gloss/gloss-g-eng.htm>
- <https://www150.statcan.gc.ca/n1/pub/16-511-x/16-511-x2022001-eng.htm>
- <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610022201>
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- <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610063101>
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- Ottawa must get serious about net zero strategy: industry group*, *Globe and Mail*, June 24, 2022
- The Innovation and Competitiveness Imperative: Seizing Opportunities for Growth Report of Canada's Economic Strategy Tables: Clean Technology*, ISED.

ENDNOTES

¹Data collection can be challenging nationally and globally in the absence of standardized industry classifications.

²Greater specificity in terms of products can be found in https://publications.gc.ca/collections/collection_2021/statcan/16-511-x2021001-eng.pdf

³The estimate of \$2.5 trillion was made in 2018. (See <https://www.smartprosperity.ca/content/308>)

⁴The forecast for global GDP in 2022 approximates \$104 trillion in current U.S. dollars based on IMF growth projections in the April 2022 *World Economic Outlook* report. See <https://www.imf.org/en/Publications/WEO> The July 2022 update reduced the growth forecast from 3.6% (April) to 3.2% (August), which would bring global GDP closer to \$103.5 trillion for 2022. <https://www.imf.org/en/Publications/WEO/Issues/2022/07/26/world-economic-outlook-update-july-2022#:~:text=The%20baseline%20forecast%20is%20for,April%202022%20World%20Economic%20Outlook>.

⁵Calculated from Statistics Canada Tables 36-10-0645-01 (numerator) and 36-10-0222-01 (denominator).

⁶Global GDP was US\$85 trillion in 2020, or C\$106 trillion. See <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD>

⁷\$31 billion (Canada's cleantech GDP in 2020)/\$3 trillion (estimated ECT share of 2020 global GDP).

⁸These include but aren't restricted to investments in **1.** Clean and renewable energy sources for electricity production, transmission and distribution; **2.** Transportation, including public transit, electric buses, and battery recharging stations for electric vehicles; **3.** Digitization and smart cities, to reduce waste; and **4.** Waste management, to reuse materials, reduce carbon emissions from new product output (e.g., plastic and food waste recycling), and use as a source of cogeneration for off-grid energy to small businesses and households.

⁹As one example, SPACs in the U.K. lost an average of 61% of their value in the last two years due to investor sell-offs. See First FT Europe/Africa <FT@newsletters.ft.com>, June 30, 2022.

¹⁰The global cleantech market is geographically diverse. The most developed markets include those with the most stringent environmental regulations such as the European Union, Germany, and U.S. states, particularly California), as well as those with strong public sector demand. They're also often supported by venture financing and research and development clusters. Major global cleantech clusters are largely found in the U.S. (Boston, Austin, Los Angeles, Silicon Valley and Seattle), Stockholm, and Beijing. In Canada, major clusters include Toronto, Montreal and Vancouver, all with links to one or more U.S. or other international clusters to boost access to venture capital and to cross-fertilize ideas linked to innovation and ecosystem development.

¹¹See Global Startup Ecosystem Index 2022© StartupBlink

¹²See *Global Cleantech 100: From Commitments to Actions*, Cleantech Group, 2022.

¹³See Global Startup Ecosystem Index 2022© StartupBlink

¹⁴See *Global Cleantech 100: From Commitments to Actions*, Cleantech Group, 2022.

¹⁵See Global Startup Ecosystem Index 2022 © StartupBlink

¹⁶China (10), India (19), Brazil (26), United Arab Emirates (27), Russia (29), Chile (34), Mexico (35), Argentina (37), Indonesia (38), Malaysia (42), Colombia (44), Turkey (46), South Africa (49), and Ukraine (50).

¹⁷Beijing (6), Shanghai (7), Bangalore (8), New Delhi (13), Sao Paulo (16), Mumbai (17), Shenzhen (18), Moscow (29), Hangzhou (30), Jakarta (32), Hong Kong (36) and Mexico City (44).

¹⁸Value-added is defined as output by the industry minus the value of intermediate inputs that were purchased from other industries, domestic or foreign. Gross domestic product by industry for the economy as a whole is the sum of values added by all industries in Canada. See <https://www150.statcan.gc.ca/n1/pub/13-605-x/gloss/gloss-g-eng.htm>

¹⁹Cleantech output from 2011-2020 was \$542 billion, and cleantech value-added was \$257 billion. See <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610062701>

²⁰This definition is broader than the EDC definition.

²¹See <https://www150.statcan.gc.ca/n1/pub/16-511-x/16-511-x2022001-eng.htm>

²²See https://publications.gc.ca/collections/collection_2021/statcan/16-511-x2021001-eng.pdf

²³See <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610064501>

²⁴There are minor discrepancies in Statistics Canada figures for value-added versus GDP at current market prices, depending on the tables utilized. For example, Table 36-10-0627-01 shows value-added at \$69.1 billion in 2020 while GDP contribution from all industries in Table 36-10-0645-01 was \$67.5 billion.

²⁵See <https://www150.statcan.gc.ca/n1/daily-quotidien/210302/dq210302a-eng.htm>

²⁶GDP at current market prices in 2020 was \$2.2 trillion. See <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610022201>

²⁷Based on 2012-2020 data in Statistics Canada Table 36-10-0645-01.

²⁸Based on data found in <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610062701>

²⁹According to the *Labour Force Survey* for December 2020, total employment was 18.485 billion. See <https://www150.statcan.gc.ca/n1/daily-quotidien/210108/dq210108a-eng.htm>

³⁰ These three accounted for 40% of ECT employment in 2011.

³¹ See <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610064501> for compensation, and <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610063201> for employment. \$31,096 million (in ECT compensation)/322,972 (ECT employment) = \$96,281.

³² See Statistics Canada, April 28, 2022: Environmental and Clean Technology Products Economic Account: Human Resource Module, 2020

³³ See Statistics Canada, April 28, 2022: Environmental and Clean Technology Products Economic Account: Human Resource Module, 2020

³⁴ If the lower ECT figure of \$80,834 from Statistics Canada is applied, the premium paid to ECT employees is only 18%.

³⁵ See <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610063101>

³⁶ Scrap consists of recyclable materials left over from product manufacturing and consumption (e.g., vehicle parts, building supplies, surplus materials). Unlike waste, scrap has monetary value, especially recovered metals, and non-metallic materials are also recovered for recycling. Processing of scrap is a growth market that is part of the movement towards a more “circular economy.”

³⁷ See <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610063101>

³⁸ Cleantech services exports were \$1,192 million in 2019 and \$1,102 million in 2020.

³⁹ See <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610063101>

⁴⁰ Cleantech goods imports declined from \$12.8 billion in 2019 to \$12.3 billion in 2020. Cleantech services imports declined from \$2 billion in 2019 to \$1.5 billion in 2020. See <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610063101>

⁴¹ No trade figures for Construction Services were reported. This is the largest category of Canadian cleantech services.

⁴² See Statistics Canada, March 23, 2022: *Annual Survey of Environmental Goods and Services, 2020*. Some of the information applies to both environmental and cleantech, not just environmental goods and services.

⁴³ Ontario (\$3.2 billion) and Quebec (\$2.1 billion) businesses exported \$5.3 billion worth of ECT goods and services in 2020. This accounted for 74.6% of all Canadian exports in this sector. See Statistics Canada, March 23, 2022: *Annual Survey of Environmental Goods and Services, 2020*.

⁴⁴ The \$2.6 billion export figure in 2020 to non-U.S. markets represents a 3.5% YOY increase. Therefore, exports in 2019 to these markets approximated \$2.5125 billion. Therefore, the increase approximated \$87.5 million. The total decrease in ECT exports in 2020 was \$381 million. Therefore, the decrease in exports to the U.S. market \approx \$87.5 million + \$381 million = \$468.5 million \approx \$470 million.

⁴⁵ Total ECT import volume decreased 3.7% in 2020. See Statistics Canada, Jan. 6, 2022: Environmental and Clean Technology Products Economic Account, 2020.

⁴⁶ See <https://www150.statcan.gc.ca/n1/pub/16-001-m/16-001-m2019001-eng.htm>

⁴⁷ \$87.5 million/\$468.5 million = 19%. Figures derived and calculated by the author from Statistics Canada data and sources.

⁴⁸ See [https://clean50.com/canada-cleantechs-2022-budget-assessment/#:~:text=%242.2B%20over%20seven%20years,Small%20Modular%20Reactors%20\(SMRs\)](https://clean50.com/canada-cleantechs-2022-budget-assessment/#:~:text=%242.2B%20over%20seven%20years,Small%20Modular%20Reactors%20(SMRs))

⁴⁹ See <https://www.ic.gc.ca/eic/site/125.nsf/eng/00039.html>

⁵⁰ See <https://www.nrcan.gc.ca/climate-change-adapting-impacts-and-reducing-emissions/canadas-green-future/clean-fuels-fund/23734>

⁵¹ *Ottawa must get serious about net-zero strategy: industry group, Globe and Mail, June 24, 2022*

⁵² See <https://ised-isde.canada.ca/site/tables-sectorielles-strategies-economiques/fr> and <https://www.ic.gc.ca/eic/site/098.nsf/eng/00023.html>

⁵³ These figures are specifically for cleantech, and exclude environmental product exports.

⁵⁴ See <https://www.ic.gc.ca/eic/site/098.nsf/eng/00023.html>

⁵⁵ See Cleantech Report, EDC Economics, August 2021.

⁵⁶ See *Ottawa must get serious about net zero strategy: industry group, Globe and Mail, June 24, 2022*.

⁵⁷ It's unclear if this presents the full picture, as trade-related data for Construction Services aren't reported. However, in the absence of trade figures, the assumption is that there's nothing to report in Construction Services, or these activities are embedded in other product categories.

⁵⁸ The Cleantech Report, EDC Economics, August 2021 noted that success in achieving targets is likely to require **1.** Better performance in services exports; **2.** Faster commercialization of innovative businesses engaged in R&D; and **3.** Assistance with testing, staging and preliminary market introduction. The report also noted that commercialization of intellectual property and ongoing global competition remained persistent challenges for Canadian cleantech SMEs.

⁵⁹ See <https://www.tradecommissioner.gc.ca/sectors-secteurs/clean-technologies-technologies-propres.aspx?lang=eng>

⁶⁰ Areas of strength specifically identified in the strategy include renewable energy, water and wastewater and sustainable resource management, particularly in clean technology in mining and clean technology in oil and gas. For more on Government of Canada support for cleantech exports, see <https://www.international.gc.ca/gac-amc/publications/evaluation/2020/ibd-ct-tp-pci.aspx?lang=eng>

⁶¹ See *Global Cleantech 100: From Commitment to Actions*, 2022.

⁶² See <https://www.lapresse.ca/affaires/entreprises/2022-05-07/electrification-des-vehicules-lourds/les-coffres-se-vidaient-trop-vite-chez-effenco.php>

⁶³ See Global Startup Ecosystem Index 2022© StartupBlink

⁶⁴ Other “overperforming” industries are marketing and sales in Toronto, Foodtech in Montreal, e-commerce and retail in Ottawa, Edtech in Kitchener Waterloo and social and leisure in Quebec City.

⁶⁵ See Industry Strategy Council Meeting, July 20, 2020

⁶⁶ Haiti (47%), Myanmar (70%), Pakistan (75%), Papua New Guinea (60%), Solomon Islands (73%), Vanuatu (67%) and Yemen (74%). See <https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS>

About this report

This Economic Insights report is part of a publication series of concise reports written by Export Development Canada’s Economics staff on the future potential for Canadian exports. The views expressed in this report are those of the author and shouldn’t be attributed to Export Development Canada or its Board of Directors.

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