CANADA'S CLEANTECH FUTURE LOOKS BRIGHT

With a global market projected to exceed $3.3 trillion in 2022, Canada's innovative cleantech companies must look abroad for opportunities to reach their potential

With 82,000 employees and annual revenues of $17 billion, Canada's promising cleantech industry is primed for growth, but its long-term strength depends on export sales. Read EDC's report on the opportunities and challenges for Canada and the top players globally and at home.

SUMMARY

The global cleantech market is projected to exceed roughly $3.3 trillion by 2022, about 2% of anticipated global gross domestic product (GDP). The potential for clean technologies permeates all sectors of the economy as there is a need to optimize the use of resources, reduce adverse environmental impacts, and create new ways to produce goods and services to meet the needs of households and the economy at large. While this applies across all sectors, the most common cleantech applications are found in:

- power generation;
- energy efficiency;
- water;
- agriculture and alternative proteins;
- industrial and extractive processes;
- transportation; and
- recycling.

The United States remains the main export market for Canadian cleantech producers. Some provinces have shown progress penetrating the European Union (EU) market now that the EU-Canada Comprehensive Economic and Trade Agreement (CETA) is in effect, while some other non-traditional markets are showing traction, like Japan, India and Latin America. Market expansion and trade diversification will help small innovative Canadian firms to link up with global/regional supply chains and/or to export goods and services. Likewise, boosting scale from investment and expenditure within Canada will encourage scale to increase prospects for export market penetration by individual firms.

Canada is the fourth-most greenhouse gas (GHG)-intensive economy by GDP and most intensive on a per capita basis. As a result, Canadian companies have developed solutions to improve our carbon footprint by innovating and partnering with industry. This has presented and continues to offer cleantech opportunities in:

- renewable energy;
- energy infrastructure and smart grids;
- power generation;
- biorefinery products;
- agriculture;
- recycling/recovery/remediation;
- water and wastewater;
- industrial processes and products; and
- transportation.

Statistics Canada estimates that, in 2018, environmental and clean technology (ECT) activities accounted for $66 billion, or 3.2% of Canadian GDP. This ratio of about 3% share of GDP has remained stable since 2007. Most cleantech growth has been powered by clean energy manufactured goods such as production of solar panels, and services related to the design and construction of energy-efficient buildings and clean electricity production.

In 2015, there were more than 850 cleantech firms in Canada, with more than $13 billion in revenues. These numbers have increased since then, and there are now more than 82,000 employees working in the sector. Cleantech is widely recognized as being innovative, and backed by a strong ecosystem of industry associations and federal and provincial governments that support leading edge R&D and development of practical solutions across a wide range of industries. More recently, these strengths and innovations have been recognized by non-traditional export markets, and sales are increasing across a range of industries and geographic locations.

Despite these positive developments, Canada's cleantech sector also faces challenges. The sector is predominantly composed of small- and medium-sized enterprises (SMEs), many of which struggle to gain market acceptance for their products, build their teams, attract funds for growth, and become cash flow-positive. Many pursue innovative research and development that's never successfully commercialized. Challenges in commercializing their 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.

Canada's cleantech exports have grown in recent years, but the share of the global cleantech export market is relatively small, estimated at 1% to 2%. In 2018, 78% of all ECT product exports were clean technology products, mostly manufactured goods, like solar panels, clean energy equipment, bioenergy production equipment and a broad range of technologies and services. Clean electricity exports accounted for 16% of ECT product exports.

GENERAL CONTEXT

Defining cleantech

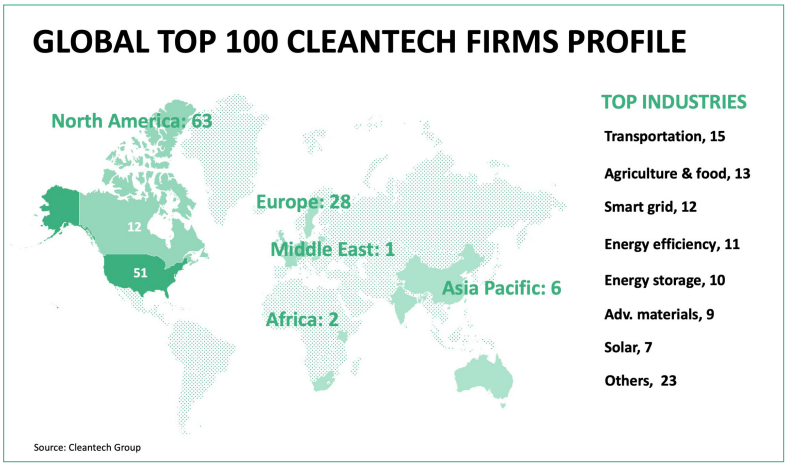
While there are variations in how clean technology is defined, it is generally viewed as any process, product, or service that reduces environmental impacts through environmental protection activities, sustainable use of natural resources, and/or use of goods that have been specifically modified or adapted to be significantly less energy- or resource-intensive than the industry standard. Since this is not the only definition for cleantech[1], data collection is challenging nationally and globally in the absence of standardized industry classifications and data collection. Elsewhere in the document, other relevant definitions are highlighted to enable a clear discussion of the data presented.

More broadly, cleantech potential permeates all sectors of the economy as efficiencies can be found and environmental impacts can be reduced. This applies across the board in sectors as diverse as agriculture, chemicals, transportation and resource extraction. The most common cleantech applications are found in:

- power generation;
- energy efficiency;
- water;
- agriculture and alternative proteins;
- industrial and extractive processes;
- transportation; and
- recycling[2].

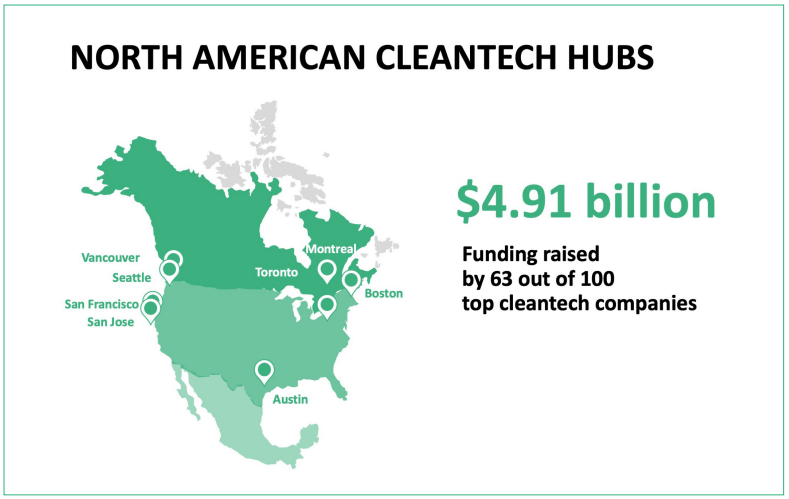
According to the Cleantech Group, the U.S. currently accounts for about half (51 of 100) of the most innovative companies based on its index that ranks the Top 100 firms from an original sample of 8,312 cleantech firms[6] . Other countries cited for innovation in order were Canada (12), Germany (11) and the United Kingdom (6), with 14 other countries cited once or twice. Meanwhile, 2015 estimates indicated that China was leading the cleantech export market with around 21% of global exports, much of it through subsidized solar panels. Germany, at 11%, and the U.S., at 10%, followed. France and Portugal have large players in the project development market, while Japan leads in hydrogen generation and smart grids. It's not known how these market shares have changed in recent years, but Canada continues to account for a relatively small share of global cleantech exports, particularly outside the U.S. market.

The global cleantech market



While global cleantech data aren't systematically available, previous estimates from 2015[3] suggest that the global cleantech market accounted for about US$1.2 trillion in exports, equivalent to 1%-to 2% of global GDP. The market is projected to exceed roughly US$2.5 trillion by 2022, about 2% of anticipated global GDP[4], although estimates vary and are sometimes more optimistic[5].

Despite the adverse effects of COVID-19 on the global economy, many countries, including Canada, have increased government spending and are looking at major and sustained investments in critical infrastructure as a means of supporting long-term economic recovery. These investments include widespread application of cleantech, which may lead to higher levels of expenditure and investment as a share of future GDP, particularly as concerns about climate change continue to mount.



The 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 are 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. The relevance of clusters in relation to funding is illustrated in the graphic showing nearly US$5 billion in funding mobilized by cleantech firms.

Global cleantech investment patterns

Cleantech solutions are often focused on large-scale solutions to attract funding. Together, based on an annual index compiled by the Cleantech Group, the 100 most highly innovative firms have attracted more than US$7 billion in equity investment and nearly US$10 billion in total funding, mostly since 2015[7]. In their 2020 Global Cleantech 100: Leading companies and themes in sustainable innovation report, North America had dominated with nearly US$5 billion in investment into 63 firms, followed by Europe and Israel at nearly US$2 billion into 29 firms. In 2019, the most innovative firms attracted nearly US$2 billion in equity investment from 608 investors in 45 countries. Average investment was approximately US$30 million.

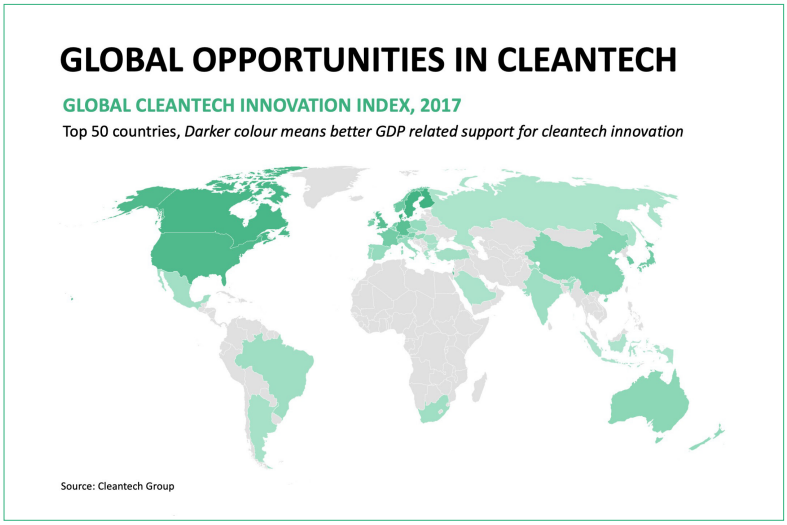
By sector and with numbers of companies from the Cleantech Group index in parentheses, cumulative investment among the innovative firms by sector was most commonly focused on:

- energy and power (46), which has attracted the most investment (US$ 2.4 billion)
- transportation and logistics (13) at US$1.8 billion
- agriculture and food (13) at US$1.7 billion
- technologies (9) at just under US$1 billion,
- resources and environment (12) at US$0.5 billion
- materials and chemicals (7) at US$0.2 billion

It's important to remember that these investments, important as they are, represent only a fraction of total investment or expenditure. As noted earlier, cleantech GDP likely approximates US$2 trillion, or about 2% of global GDP. Therefore, these investments help to power GDP growth and innovation in the field, but tell only part of the story.

The representation of several emerging markets, including Bangladesh, India, Kenya, and South Africa, also shows there is recognition of the potential to "leapfrog" larger and more expensive infrastructure. For example, in regions without reliable electricity or where coal-fired plants are damaging to the environment, it can be cheaper to set up a micro-grid rather than build a large, centralized power plant. Such projects in the future will also benefit from battery-based energy storage that will help mitigate the intermittent nature of some renewable energy sources. One of the more positive developments globally is with renewable energy sources and the new technologies harnessing wind and solar. As efficiency and scale increase, per unit costs to consumers have declined. Industry experts project a decline to 1.5% of global GDP, with less spending required to generate more electricity. While there may be increases in absolute spending, it's also expected that there will be a migration from operating expenditure to capital expenditure that reflects the level of investment required on grids and new renewable projects. As this trend continues, prices will continue to decrease. More than a decade ago, investors were concerned with how to reduce uncertainty of wind and solar. Those questions have now been answered, and the focus is currently on how to increase throughput despite policy uncertainty or contradictions on how incentives are deployed.

Canada's cleantech sector is 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, and become cash flow-positive as they pursue innovative research and development. Challenges in commercializing their 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.



Digital technologies are also helping with "smart" applications to reduce energy consumption. Linked sensors and the Internet of Things are being applied to a broad range of industrial, housing and construction activities to reduce carbon emissions. These and others described below are identified as areas of potential growth for Canadian exporters. Meanwhile, the graphic shows North America as a major centre of innovation, which should provide Canadian cleantech firms with considerable opportunities in the future for exports, research collaboration, and supply chain linkages to help lock in sustained sales and production.

CANADIAN CLEANTECH

The Canadian cleantech market

There were more than 850 cleantech firms in Canada (based on EDC's definition) in 2015, with greater than $13 billion in revenues. Through reviews of employment figures, the number of firms has grown. There were about 55,000 employees working in cleantech in 2015, and this number has grown to more than 82,000 employees based on more recent figures (see Annex 1 for employment estimates).

Most firms with commercial-level technologies and/or commercial products are exporters—sometimes to subsidiaries manufacturing in the U.S. market. However, Canada's share of the global cleantech export market is relatively small, estimated at 1%-to 2%. The government has set a target of C$20 billion in exports by 2025. This would constitute a tripling of export value, exceeding 11% growth per year[8]. According to Innovation, Science and Economic Development (ISED), key exports include:

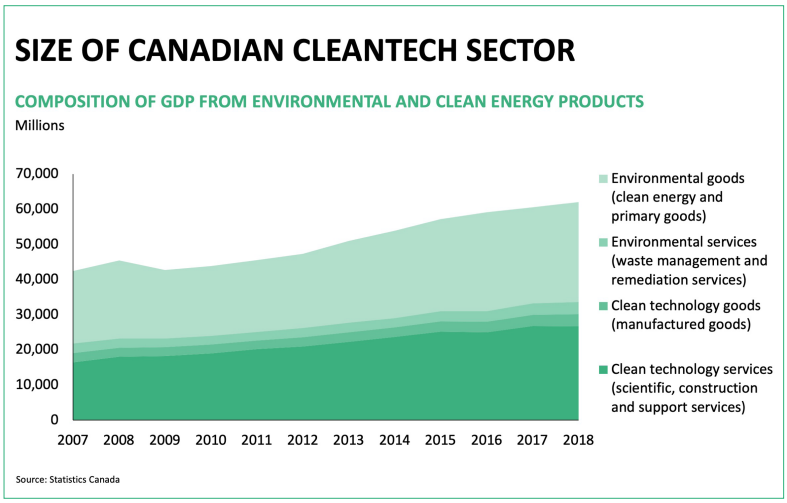
- transportation technologies and services;
- energy-efficiency technologies and services;
- clean energy equipment and services; and
- bioenergy production equipment + biofuel biomaterial and biochemical production.

Exports often focus on renewable power generation, industrial process improvement, and water/wastewater management and treatment.

More positively, government-supported financing programs—administered by Business Development Bank of Canada (BDC) and EDC, among others—in response to COVID-19 have helped to reduce immediate financing challenges faced by many cleantech firms. Provincial trade patterns have also shown some diversification with Europe and Japan being markets to which Canadian firms in about three provinces have been able to increase sales and market presence[9]. However, commercialization of intellectual property and ongoing global competition remain persistent challenges for Canadian cleantech SMEs.

The difficulties faced in penetrating global supply chains and achieving scale hurts Canadian prospects for competitiveness in the global energy economy. However, some have succeeded through direct investment abroad (mainly into the U.S., but slowly into other markets as well). This has helped to sustain benefits of integrative trade where manufacturing is carried out closer to end-use markets while proprietary technologies, management systems and other sources of value are generated from Canada-based headquarters and research stations. Solar panels are the best example of this for Canadian firms. As trade agreements with Europe and Asia take effect, there's a possibility that cleantech will serve as an enabler of trade diversification. Meanwhile, increasing investment at state levels in the U.S. will serve as an indispensable target for continued growth and export opportunity for Canadian cleantech firms.

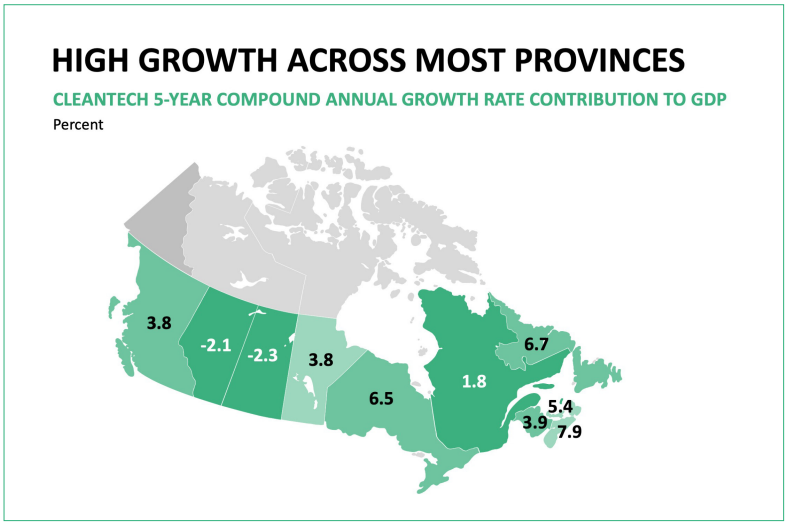
Cleantech economic impact in Canada



Statistics Canada estimates that, in 2018, environmental and clean technology (ECT) activities, which is a larger measure and includes "cleantech"[10], accounted for $66 billion, or 3.2% or of Canada's GDP. Ontario, Quebec and British Columbia accounted for about 78% of total[11].

The ratio of about 3% share of GDP has remained stable since 2007. The GDP generated by the ECT products sector grew 0.8% in real (volume) terms from 2017 to 2018. By comparison, the total Canadian economy grew 2.2% over the same period. Therefore, cleantech showed more modest growth than economy-wide trends in 2018. This partly relates to the termination of large-scale construction projects, which may otherwise mean that earlier growth was propped up by large-scale construction and that more sustained activity characterizes other segments of the cleantech market.

The rate of growth has been uneven across the country, with some provinces showing considerable growth rates in their cleantech sector's contribution to GDP while other provinces have fallen back. Most cleantech growth has been powered by clean energy manufactured goods such as the production of solar panels, and services related to the design and construction of energy-efficient buildings and clean electricity production. However, these growth trends have been partly offset by a decrease in construction services as large-scale projects were completed or coming to an end in 2018 (e.g., Muskrat Falls hydroelectric dam in Newfoundland and Labrador). New spending for infrastructure in the coming years is expected to restore major construction as an additional source of demand for "smart" cleantech products.



Cleantech employment

Statistics Canada data show that ECT employment is approximately 317,000, or 2%, with compensation that's well above the national average. Of this, 122,601 is cleantech employment based on the Statistics Canada definition[12], which results in a total of jobs that is about 40,000 higher than employment estimates based on EDC's definition (see Annex 1). The difference relates to the inclusion or exclusion of employment in waste management.

ECT employment grew 2% in 2018. Just more than 80,400 jobs were in the engineering construction industry (25.5% of all ECT jobs), followed by 69,900 jobs in the utilities industry. Ontario, Quebec and British Columbia employed 76% of ECT sector workers in 2018. These employment patterns are correlated with the presence of clusters, with Toronto, Montreal and Vancouver all serving as Canada's main cleantech hubs to date. From 2012 to 2018, employment in cleantech has increased by 20%[13].

Nationally, the 2018 average annual compensation per ECT job, including benefits, was $84,700 (up 0.1% from 2017), compared with an economy-wide average of $61,700 (up 3.2% from 2017). Therefore, compensation was generally about a third higher than the average despite slower growth than the average in 2018. From 2012 to 2018, compensation in cleantech has increased by 9% while labour productivity in the sector is about 20% higher than average in the economy[14]. These are considered to be technically skilled jobs that require high levels of education and training in a range of academic fields and highly sought-after trades.

Cleantech trade patterns

Exports have grown in recent years. According to Statistics Canada, volumes of ECT product exports increased 1% from 2017 to 2018[15]. Canadian ECT product exports totalled $13.6 billion in 2018, accounting for 2% of total Canadian exports. In 2018, 78% of all ECT product exports were clean technology products, mostly manufactured goods, like solar panels, clean energy equipment, bioenergy production equipment and a broad range of technologies and services[16]. Clean electricity exports accounted for 16% of ECT product exports. Ontario accounted for 49% of national ECT product exports, while Quebec accounted for 22%.

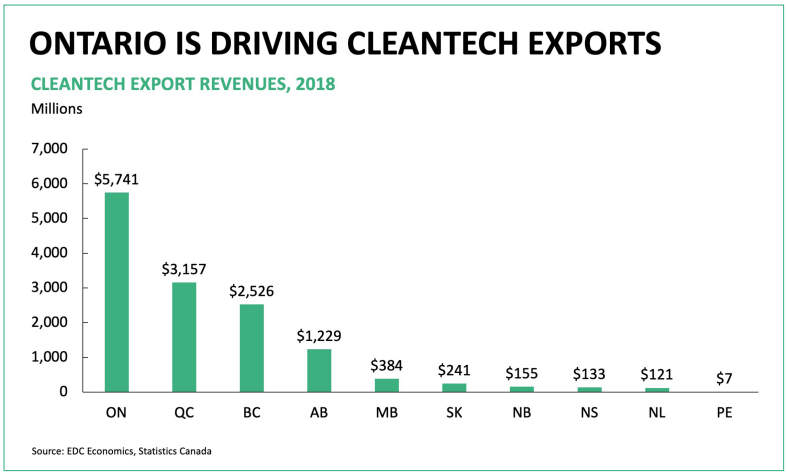
National import volumes of ECT products grew 20% in 2018[17], after decreasing 0.6% in 2017. The total value of Canadian ECT product imports was $19.5 billion in 2018, accounting for 3% of total Canadian imports. Clean technology products—mostly complex manufactured products—accounted for 77% of ECT product imports, followed by biofuels and primary goods, at 20%.

Cleantech and trade diversification

Based on the ISED categories of focus, the top three export destinations for Canadian clean technology are:

- United States (70%)
- United Kingdom (9%)
- Japan (3%)

China and India represented 2% and 0.3% of Canadian clean technology exports, respectively. Therefore, in the aggregate, there is a high degree of concentration. There is even a high degree of concentration in exposures to the U.S market, with 37% of export sales to California, New York, Texas, Illinois and New Jersey where the regulatory environment is often more conducive to sales and/or market development (e.g., air quality and auto emissions standards in California).



As for provincial trade patterns and contribution to trade diversification, profiles by province vary. For instance, in Alberta, Manitoba, Ontario, Quebec and Saskatchewan, total cleantech exports to the U.S. account for at least 69%. Therefore, cleantech in these provinces is making a direct contribution to the economy and to the environmental footprint of Canada, but they show less trade diversification.

By contrast, several provinces are showing more diversification in their exports. For example:

- **British Columbia:** 48% to Europe, 28% to the U.S. and 23% to Asia (of which 19% is Japan).
- **New Brunswick:** 55% to the U.S. and 39% to Europe.
- **Newfoundland:** 43% to the U.S. and 41% to Europe, and 11% to the Middle East and South America.
- **Nova Scotia:** 42% to Europe, 33% to the U.S., and 22% to Asia, South America and the Middle East.
- **Prince Edward Island:** 51% to Europe, 28% to Asia (of which 20% is China) and only 18% to the U.S.

In terms of markets, the U.S. remains the main export market for Canadian cleantech producers. Some provinces have shown progress penetrating the EU market now that the EU-Canada Comprehensive Economic and Trade Agreement (CETA) is in effect, and more opportunities may emerge as EU countries issue more green bonds and leverage spending on cleantech products as part of their plans for post-COVID-19 economic recovery. Other non-traditional markets are also showing traction, including Japan, India, and Latin America, as efforts to fight climate change intensify. Market expansion and trade diversification will help small innovative firms with opportunities to link up with global/regional supply chains and/or to export goods and services. Likewise, boosting scale from investment and expenditure within Canada will encourage scale to increase prospects for export market penetration by individual firms.

In the end, Canadian cleantech is most closely linked to the North American market, which is logical based on relatively free trade and common industrial standards. On the other hand, half of Canada's provinces have shown reasonable diversification where no single export market accounts for more than half (apart from New Brunswick, which also has nearly 40% of exports to the European market, and PEI, which sends about half of its cleantech exports to Europe). (Annex 2 highlights these features by province.)

Cleantech trends and opportunities

Canada is the fourth most GHG-intensive economy by GDP and most intensive on a per capita basis[18]. Therefore, as a resource-intensive economy, Canadian companies have been able to partner with industry and governments (federal and provincial) to form robust ecosystems that assist with R&D and result in innovations that help provide solutions to reduce their carbon footprint. This has presented and continues to offer many cleantech opportunities in:

- renewable energy;
- energy infrastructure and smart grids;
- power generation;
- biorefinery products;
- agriculture;
- recycling/recovery/remediation;
- water and wastewater;
- industrial processes and products; and
- transportation.

The Government of Canada is planning a major program in infrastructure investment across the country to reduce our carbon footprint and to transform how households, businesses and government carry out their daily operations. Part of this strategy involves a commitment to hydrogen to achieve net-zero emissions by 2050. This hydrogen strategy, combined with anticipated infrastructure investment across the country, can be expected to generate numerous opportunities within Canada, some of which can be leveraged for exports (e.g., technical know-how, management systems).

There are also long-term possibilities that remain to be defined by large-scale innovators in the U.S. market. For instance, California is looking to move away from natural gas. For the near term, this is not likely to happen, as gas is a cheap and plentiful source of power, and not easy to switch. As well, consumers are not currently prepared to pay more for power, particularly with uncertainty in the economy and political landscape. However, this is a trend to watch as California implements its approach and what it may mean for the rest of the U.S. market, as well as for hydrogen companies that could potentially meet market requirements as they emerge.

The Minister of Environment recently announced key priorities for the Government of Canada that will directly involve cleantech[19]. Among the key sector-oriented priorities are:

- **Oil and gas:** O&G accounts for 26% of Canada's emissions and these emissions have been growing. Therefore, the focus will be on ways that can make continued use of these resources possible in the context of a very carbon-constrained world. This will include emissions intensity from existing technologies, including solvents, carbon capture and storage, and methane, unlocking energy value without carbon in a manner consistent with climate objectives, and the application of broader de-carbonization work in the natural resources sector.

- **Transportation:** Transportation accounts for 25% of Canada's emissions. These come from personal vehicles, heavy-duty vehicles, and other modes of transportation. Therefore, a comprehensive strategy is needed for vehicles to achieve short-term objectives, like reduce emissions via LDV standards, use of incentives, and possible mandates to enhance zero-emissions vehicle (ZEV) deployment, while moving towards long-term mechanisms in the auto sector and elsewhere to achieve climate objectives.

OPPORTUNITIES FOR CANADIAN FIRMS

- Electrification
- Transportation modernization
- Heavy and light industry decarbonization
- Agriculture and protein alternatives
- Small buildings and construction
- Energy storage

Therefore, these and other climate-change challenges present considerable opportunities in the use of clean technology. These include hydrogen, renewable natural gas, carbon capture and storage, water technologies, sensing and monitoring technologies and fuel cells.

Canada has already invested more than $3 billion to support the development and commercialization of clean technology. With this initial investment, the energy transition slowly under way around the globe provides several opportunities for Canadian firms. These include:

1. Electrification
2. Transportation modernization
3. Heavy industry decarbonization
4. Innovations in agriculture and food processing
5. Smart buildings and construction
6. Energy storage

Electrification

Electrification is a big part of the story, as sources of electricity moving to renewables or low carbon sources are expected to increase from about 20% to as much as 50% to 60%. This will be all-encompassing across industry, as well as construction (housing and commercial). This also 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 return objectives. Such grids have potential worldwide, and are most needed in emerging markets where electricity access is much lower.

Transportation modernization

Since transportation methods are more challenging to electrify—at least until batteries have more capacity—biofuels or low-carbon fuels represent 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 rare earths, infrastructure needs for recharging, and policy incentives for market-based adoption and the 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. This results in opportunities for electrification of the transport sector, building on progress with electric vehicles (EVs) to potentially address more challenging transportation methods such as heavy-duty, long-haul transport.

Meanwhile, aviation can be expected to come into greater focus with opportunities to provide a wide variety of solutions from air traffic management to reduction of in-flight waste. Before COVID-19, travel levels were increasing, particularly in Asia, and technology improvements have not been impactful enough to offset rising levels of CO2 emissions. The aviation industry is pursuing climate action goals through a global offsetting scheme, adoption of less carbon-intensive technology, more efficient operations, and better infrastructure. Through a combination of these four areas, aviation is expected to reach a long-term goal of reducing CO2 emissions by 50% by 2050 compared to 2005 levels. Therefore, each of these pillars represents opportunities for firms able to provide solutions.

Heavy (and light) industry decarbonization

Other sectors will be very expensive to decarbonize, which will require other solutions such as the use of natural sinks. Decarbonization of heavy industry such as energy, steel, and cement is difficult to implement because they are slow moving, capital-intensive, low margin businesses that depend on long-term asset durability. These difficulties will create rewarding opportunities if solutions in these areas are found.

Meanwhile, there are opportunities across the industrial spectrum, including in light industries. For example, efforts to make clothing production more "responsible" by reducing water and chemical usage in the production of textiles, garments and apparel[20].

Agriculture and protein alternatives

Cleantech and other 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. 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.

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, as well as work sites and industrial processes used in construction.

Energy storage

Energy storage offers considerable opportunities for firms to provide the ability for power providers to provide power, including 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 of these can be implemented at the micro- or small-scale level. Therefore, they represent solutions that are not capital-intensive and can be implemented across a broad array of locations to complement or supplement grid sources of power.

Cleantech challenges

The cleantech industry faces several challenges in the domestic and global marketplace. Longstanding challenges include:

1. Inability of Canadian SMEs to scale up because of limited domestic market size compared with other major export markets[21] due to risk aversion and low adoption rates.
2. Firm-specific weaknesses such as lack of strategic expertise, limited entrepreneurship and marketing skills, and challenges accessing needed financing during startup phases.
3. Non-alignment in carbon pricing policies between federal and provincial authorities, as well as division within the U.S. on similar issues and the impact this has on cross-border trade and investment.
4. There is a fourth challenge that has eased more recently as EDC and BDC have matched investor financing. Nonetheless, there is still a persistent hesitation by equity investors to invest in Canadian firms until they prove their products work in the U.S., European or other markets. This also applies to institutional investors for major projects unless they also comply with corporate governance standards focused on environmental responsibility.

The predominance of SMEs in the cleantech market is important because of the long product development cycles, costly prototyping and testing, and capital-intensive scaling requirements that characterize cleantech. These apply across the industry globally, and are even more difficult challenges in countries, like Canada, where domestic markets don't offer sufficient opportunity to fully scale up. These challenges are also complicated by distortions in global markets, as many countries seek to protect "national champions" due to the R&D intensity, intellectual property and potential economic growth associated with such innovations[22]. In many cases, Canadian firms have firm-specific weaknesses due to their small management teams that need complementary skills to develop markets and access financing[23].

As for government policies, while federal and provincial governments have increased spending in these areas in recent years, there have also been delays in rolling out federal policy while there has been pushback from several provinces on the issue of carbon pricing. While temporarily in remission due to COVID-19, these differences remain in terms of policy setting, provincial authority, and effective incremental tax rates (and related uses of tax proceeds) that will be accepted by consumers and industry without undermining economic growth prospects. Such issues have also been complicated by the cacophony of views in the U.S., with the federal government at least temporarily pulling out of international climate-change agreements while states and municipalities continue to observe standards needed to help get climate change under control. As the Canadian economy is so closely linked with the U.S. economy, alignment of standards is needed for scale, just as agreement between federal governments and states/provinces are needed to reduce investor uncertainty for future investment in major capital projects.

The above issues of SME predominance and policy/regulatory uncertainty all point to the importance of large-scale firms as first movers and engines of innovation in cleantech and broader environmental issues. A major challenge is the costs associated with many new innovations, and the need for large-scale firms in many cases to commit major capital resources at a time when traditional revenue sources are at risk. For instance, Shell and Nutrien have Carbon Capture, Utilization and Sequestration (CCUS) projects under way at a time when these companies are challenged, respectively, by lower oil and gas prices and downward pressure on potash-based fertilizer revenues. The economics of CCUS projects and their long-term viability are still uncertain[24], as project costs are very high, uses of the captured CO2 are still being determined, and some critics claim investment in CCUS will perpetuate the use of fossil fuels. From a purely commercial perspective, without major capital expenditure from large-scale firms, there's less potential for domestic supply chain networks to develop, reducing the incentives for smaller cleantech firms to research, innovate and develop products and processes that solve environmental problems. Weaker domestic supply chains, likewise, translate into weaker capacity to generate exports.

The role of large-scale firms as drivers of cleantech will partly hinge on the role of public sector incentives and the regulatory framework. As large-scale firms are often publicly traded, their decisions on capital allocation are influenced by differing interests among shareholders and other stakeholders. Using CCUS as an example, although it's not the only one, many large-scale capital projects fail to generate the returns shareholders expect. At the same time, companies need to balance shareholder requirements with the interests of other stakeholders to avoid bad publicity, lawsuits, and other disruptions that can weaken earnings and market position. This has been most evident in both

Canada and the U.S. over pipelines, as highlighted in Canada by frictions over whether the federal government should finance the Trans-Mountain pipeline and barricades earlier in 2020 along rail routes to protest consideration of new pipeline construction. There have been similar frictions in the U.S. concerning pipeline construction from a broad array of stakeholders.

The role of institutional investors isn't to be underestimated, particularly as many of them steer resources away from hydrocarbons and towards more "socially responsible" investments. In Canada, as elsewhere around the globe, institutional investors like pension funds and life insurance companies seek out long-term investments that can generate a stream of cash flows to help them meet their long-term financial obligations to pensioners and policyholders. However, they have increasingly stressed the need to be compliant with innovations that help to address climate change and environmental stewardship needs.

The global cleantech market is geographically diverse. While Canadian firms are typically small and Canada has a limited share of global cleantech exports (1% to 2%), it is closely linked to the U.S. market where there is a high level of broad-based innovation and demand. Meanwhile, Canada has a number of important free trade agreements that should enable a rise in cleantech exports to other markets, as is beginning to happen with growing export sales to Europe and parts of Asia. As emerging markets seek out partnerships, the broad range of innovations developed and adapted in Canada's resource-intensive industries and geographically diverse economy should also find useful applications abroad from which Canadian cleantech firms can benefit.

CONCLUSION

The cleantech market is projected to exceed roughly US$2.5 trillion by 2022, about 2% of anticipated global GDP, although estimates vary. A driver for optimistic future growth scenarios is that increased public sector investments include widespread application of cleantech, which may lead to higher levels of expenditure and investment as a share of future GDP, particularly as concerns about climate change continue to mount.

Recent global investment patterns have shown considerable progress with renewable energy sources and the new technologies harnessing wind and solar. As efficiency and scale increase, per-unit costs to consumers have declined. Industry experts project rising levels of clean electricity generation and lower per-unit costs. Experts also expect digital technologies and "smart" applications to reduce energy consumption. Both of these trends represent areas of potential growth for Canadian exporters.

The Canadian government has set a target of $20 billion in exports by 2025, which would constitute a tripling of export value, exceeding 11% growth per year. Many believe this target can be achieved, particularly as public sector spending increases globally to address environmental issues. However, several conditions need to be in place, including:

1. Widely accepted global commitments to electrification powered by renewable sources of energy, like by solar and wind
2. Continued cost declines for solar and wind and especially batteries
3. EV market development to provide grid balancing and transport
4. Massive grid infrastructure investment around the globe
5. Investment in CCUS and determination of uses of stored carbon that are economically beneficial, issues on which there's no clear consensus or agreement
6. Policy certainty across countries and local jurisdictions to create a better environment for investors and long-term capital projects
7. Acceleration of technological innovation, including hydrogen
8. Clear and broadly accepted governance principles to guide capital allocation in a manner that supports sustainable development.

In Canada, specific additional requirements include greater scale and capacity of its SMEs, stronger domestic supply chains, and resolution of risk-aversion issues that hold back capital investment. A strengthening of the ecosystem that has emerged between industry associations, federal and provincial governments and cleantech innovators is needed to create greater domestic opportunities that could facilitate scale. In many ways, these issues are connected, particularly as investors are often global, understand innovations underway in markets around the world, and see Canadian SMEs as often lacking needed capacity. These will be needed as well for Canada to achieve trade diversification objectives.

The alignment of objectives and actions in the Canadian cleantech ecosystem in the last few years has provided the required insight into needs, specific programming to address them, and through COVID-19, several policy directives specifically intended to support cleantech companies through the crisis. The presence of strong industry voices across the country, in addition to increased alignment of the main funders (e.g., BDC, EDC, Sustainable Development Technology Canada (SDTC), ISED, National Research Council (NRC) and Natural Resources Canada (NRCan), means that Canadian cleantech companies are better supported with policies, programs and funding solutions to meet their needs. In addition, the strong presence of Canada's trade commissioners, who are focussed on cleantech, means that as companies prepare to enter new markets, they can be better supported.

A persistent weakness for all stakeholders active in the cleantech market is the fragmentation of definitions and data. Industry associations within Canada and with counterparts in other key markets would benefit from an effort to harmonize definitions and industry classifications, and to undertake joint data collection to better understand global trends. This might lead to an identification of gaps to serve as a trigger for collaboration and joint ventures. As with FinTech and other frontier industries, demand is expected to long outstrip supply. Therefore, in light of the growth prospects for cleantech in the face of accelerating climate change and rapidly deteriorating environmental conditions, a multilateral cleantech initiative to smooth out this fragmentation could serve as a catalyst for further innovation and exports.

ANNEX 1: EXPLANATION OF CLEANTECH EMPLOYMENT ESTIMATES

Step 1: Employment by environmental and clean technology industry, 2018 (Source)

Total employment is 122,601. This is comprised of:

1. 40,289 in the waste-management industry, and
2. 82,312 in all of the other cleantech industries.

The 82,312 figure accounts for employment in companies operating in cleantech based on the definition of cleantech that's the most similar to EDC's definition.

Step 2: Environmental and clean technology products economic account, employment, 2018 (Source)

Total employment attributable to the ECT sector is 317,085. This is comprised of:

1. Utilities: 69,911
2. Engineering construction: 80,451
3. Manufacturing: 30,894
4. Professional, scientific and technical services: 34,012
5. Administrative and support, waste-management and remediation services: 47,314
6. Other industries: 54,502

The 317,085 figure accounts for all jobs attributable to firms active in the markets specified by the ECT definition used by Statistics Canada. This includes EDC's definition of clean technology firms, waste-management firms and companies that aren't directly in the clean technology sector, but have partial involvement in it. For example, a manufacturing company producing parts for a cleantech firm.

ANNEX 2: PROVINCIAL CLEANTECH CHARACTERISTICS, BY EDC DEFINITION

PROVINCES TERRITORIES	CLEANTECH GDP (EST) CAD M 2018	Y/Y GROWTH 2018	5-YEAR CAGR 2018	SHARE OF PROVINCIAL GDP 2018	EMPLOY-MENT (EST) 2018	EXPORT REVENUE CAD M 2018
ALBERTA	3,594	4.5%	-2.1%	1.0%	8,624	1,229
BRITISH COLUMBIA	4,580	8.1%	3.8%	1.5%	9,733	2,526
MANITOBA	2,272	3.5%	11.4%	3.4%	4,266	384
NEW BRUNSWICK	459	0.3%	3.9%	1.3%	3,746	155
NEWFOUNDLAND AND LABRADOR	1,319	-25.3%	6.7%	3.5%	1,398	121
NOVA SCOTIA	414	-16.0%	7.9%	0.9%	223	133
ONTARIO	11,946	1.4%	6.5%	1.4%	33,988	5,741
PRINCE EDWARD ISLAND	74	2.4%	5.4%	1.2%	1,363	7
QUEBEC	8,543	4.1%	1.8%	1.9%	17,083	3,157
SASKATCHEWAN	729	1.3%	-2.3%	0.9%	1,663	241

Source: Statistics Canada

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- https://www.smartprosperity.ca/content/308
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ENDNOTES

[1] For instance, as examples within Canada, the contribution of environmental goods and services in the Canadian economy is reported in Statistics Canada's "environmental and clean technology" (ECT) products economic account measures. This includes products such as clean energy, environmental and clean technology product manufacturing and other technical services. This measure is different from the definition used by EDC. In addition, Innovation Science and Economic Development Canada (ISED) tracks a specific set of indicators that is broader than the definition used by EDC, but not as broad as ECT of Statistics Canada. Other definitions exist outside of Canada. One definition in the U.S. market for cleantech is "[t]he technologies, services and resources that increase renewable energy supply, enhance energy productivity, improve the infrastructure and systems that transmit, store and use energy while reducing carbon pollution." See https://cleanenergycanada.org/wp-content/uploads/2019/05/2019-03-13-Clean-Energy-Economy-FINAL-REPORT.pdf

[2] A breakdown by ISED of domestic clean technology adoption and 2018 sales values includes (1) energy efficiency technologies and services (CAD$7 billion), (2) clean energy equipment and services (CAD$3.4 billion), (3) site remediation and environmental emergency services ($2.5 billion), (4) environmental consulting services ($1.7 billion), (5) bioenergy production equipment and biofuel, biomaterial and biochemical production ($1.2 billion), (6) transportation technologies and services ($1.1 billion), and (7) precision agriculture technologies ($0.9 billion), with (8) the balance of $2.2 billion comprised of a mix of non-hazardous waste management technologies, industrial air pollution or flue gas management technologies, monitoring and reduction of greenhouse gases and air pollution technologies, water management, recycling and treatment of drinking water technologies, remediation of ground water, surface water and leachate technologies + remediation of soil, sediment and sludge technologies, and smart grid and energy storage technologies. See Clean Technology Macroeconomic Data, ISED, June 23, 2020.

[3] See 2017 CANADIAN CLEAN TECHNOLOGY INDUSTRY REPORT, Analytica Advisors. (Data references in this paper are from 2015.)

[4] The estimate of $2.5 trillion was made in 2018. (See https://www.smartprosperity.ca/content/308) It is assumed this is CAD and not US dollars. The US$ figure used in this note is rounded. No effort is made to forecast exchange rates or GDP for 2022.

[5] For instance, another source predicted the global cleantech market would approximate $3 trillion in value by 2020. See http://www.actioncanada.ca/project/launching-cleantech-ensuring-canadas-place-new-global-market/

[6] See Global Cleantech 100: Leading companies and themes in sustainable innovation, 2020. Innovation is found in a wide variety of sectors and industries. By order and with the number of companies in parentheses, innovation in the 2020 index (for 2019) was most commonly found in transportation (15), agriculture and food (13), smart grids (12), energy efficiency (11) and storage (10), advanced materials (9) and solar (7) and other cleantech (7). The balance included air (3), recycling and waste (3), water and waste water (3), biofuels and bio-chemicals (2), fuel cells and hydrogen (2), conventional fuels (1), geothermal (1) and nuclear (1).

[7] The Global Cleantech 100 publication noted US$7.4 billion, but the numbers added up to US$9.5 billion. It's possible the US$2.1 billion difference is loans or grants as opposed to equity investment. Data are generally from 2015-2019, although the Cleantech Group notes that it has been collecting data since 2009.

[8] See https://www.ic.gc.ca/eic/site/098.nsf/eng/00023.html

[9] Seven were from British Columbia, three from Ontario and two from Nova Scotia, with most product representation in energy efficiency and resources and environment. These were CarbonCure Technologies Inc. – Advanced Materials (Nova Scotia), CoolEdge Lighting Inc. – Energy Efficiency (British Columbia), Ecobee Inc. – Energy Efficiency (Ontario), Enbala Power Networks Inc. – Smart Grid (British Columbia), Metamaterial Technologies Inc.– Advanced Materials (Nova Scotia), Minesense Technologies Ltd. – Resources and Environment (British Columbia), SemiosBios Technologies Inc. – Agriculture (British Columbia), Terramera Inc. – Biochemicals (British Columbia), GaN Systems Inc. – Energy Efficiency (Ontario), Opus One Solutions – Energy Efficiency (Ontario), Axine Water Technologies Inc. – Resources and Environment (British Columbia), and Inventys Inc. – Resources and Environment (British Columbia)

[10] Statistics Canada has an alternative definition: "ECT is defined as any process, product or service that reduces environmental impacts through any of the following three strategies: 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. ECT products are reported in two broad categories: environmental goods and services (including clean electricity, biofuels and primary goods, and waste management and remediation services), and clean technology goods and services (including manufactured goods, scientific and research and development services, construction services, and support services). The products follow the Supply and Use Product Classification used in the Canadian System of Macroeconomic Accounts."

[11] Of the GDP from ECT products that was attributable to the generation of clean electricity in 2018, almost three-quarters was driven by the provinces of Quebec (43.6%) and Ontario (28.3%). Alberta, British Columbia and Ontario contributed the largest shares of the GDP from ECT that were attributable to biofuels and primary products (38.2%, 23.2% and 22.1%, respectively). The GDP from ECT products generated by manufactured goods was predominately driven by Ontario (43.9%), followed by Quebec (27.9%). More than half (57.6%) of the national contribution to the GDP from ECT that came from clean technology services was generated in Ontario (36.6%) and Quebec (21.1%).

[12] This is about 40,000 higher than cleantech employment based on the EDC definition. The difference is due to employment in waste management.

[13] See Clean Technology Macroeconomic Data, ISED, June 23, 2020.

[14] See Clean Technology Macroeconomic Data, ISED, June 23, 2020.

[15] ISED reported an increase of CAD$400 million in exports to $6.2 billion, a 6.5% increase based on the product categories it is tracking, which is narrower than those of Statistics Canada but broader than those of EDC.

[16] According to ISED, export sales were primarily (1) transportation technologies and services (CAD$3 billion), (2) energy efficiency technologies and services ($1.3 billion), (3) clean energy equipment and services ($0.7 billion), and (4) bioenergy production equipment + biofuel, biomaterial and biochemical production ($0.6 billion), with (5) the balance of $1.3 billion comprised of a mix of non-hazardous waste management technologies, industrial air pollution or flue gas management technologies, monitoring and reduction of greenhouse gases and air pollution technologies, water management, recycling and treatment of drinking water technologies and services, remediation of ground water, surface water and leachate technologies + remediation of soil, sediment and sludge technologies, precision agriculture technologies and services, and site remediation and environmental emergency services.

[17] ISED reported an increase of $2.6 billion in imports, a 26% increase based on the product categories it is tracking. In contrast to Statistics Canada, ISED showed an increase in imports in 2017, not a decrease.

[18] See https://stats.oecd.org/Index.aspx?DataSetCode=AIR_GHG

[19] See Industry Strategy Council Meeting, July 20, 2020

[20] It reportedly takes 7.6 k litres of water to make one pair of jeans. Most of the companies identified are chemical and materials companies that are making new textiles that are being used in the clothing.

[21] Apart from Canadian Solar (which is in the Top 3 or 4 of global solar panel manufacturers), leaders in the field in Canada tend to be large foreign companies, while Canadian firms (mainly from Ontario) have invested in the U.S. to manufacture and meet demand in that market. The global market is dominated by General Electric (USA), Siemens (Germany), EDF (France), EDP (Portugal), and a small number of large Chinese solar panel-makers. The absence of manufacturing capacity makes it harder for SMEs to become a part of supply chains, making it even more essential that these firms develop export capacity.

[22] Indicative of scale and financing challenges for Canadian firms is that there's virtually no renewable energy manufacturing in Canada outside of Ontario. Even that capacity has diminished in recent years. In 2013, the World Trade Organization ruled that Ontario's Green Energy Act minimum 60% local content requirement to receive subsidies for project development was illegal after the EU and Japan filed complaints. This contributed to a steady decline in renewable energy manufacturing capacity in Ontario, mainly focused on solar panel production.

[23] See https://www.canadianmanufacturing.com/environment-and-safety/canada-in-4th-position-on-cleantech-global-cleantech-100-list-revealed-226229/

[24] For instance, SaskPower announced in the summer 2018 that it wouldn't retrofit any additional plants because there was no business case.

About this report

Economic Insights is a publication series of concise reports written by Export Development Canada's Economics staff on timely issues of relevance for Canadian international trade and investment. The views expressed in this report are those of the author and shouldn't be attributed to EDC or its Board of Directors. This report was written by Michael Borish and reviewed by Lynn Côté and Stephen Tapp.

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