THE ASIA FACTOR IN ATLANTIC CANADA'S CLEAN TECHNOLOGY SECTOR:

OPPORTUNITIES AND CHALLENGES

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THE ASIA FACTOR IN ATLANTIC CANADA

The Asia Factor in Atlantic Canada's objective is to assist the region in better responding to Asia's rising global economic importance by providing critical information on the opportunities and challenges for Atlantic Canadian business and trade with Asia.

The project represents the Atlantic side of The Asia Factor, a nationwide, multi-year project launched in 2014 by APF Canada that examines the interaction of each province and territory with Asia. The Asia Factor provides comprehensive resources, information and analysis on provincial level Canada-Asia relations.

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ABOUT THE SECTORAL REPORT SERIES

Atlantic Canada's traditional export markets have been the United States and Europe. Spurred by the economic effects of the 2008 financial crisis, and motivated by Asia's growth, this has started to change.

In order to help Atlantic Canada respond to Asia's rising economic importance, APF Canada contracted Canadian experts to write sector specific reports to analyze Atlantic Canada's trade with Asian markets.

Each report provides sector-specific overviews and critical information on the opportunities and challenges for Atlantic Canadian business and trade with specific Asian markets. Each report concludes with actionable, sector-specific opportunities to help increase business and trade with Asian markets.

Céline Bak, president of Analytica Advisors Inc. wrote this report on the clean technology sector that offers an assessment of this sector's trade and future prospects in China, India, Indonesia, Japan, and South Korea.[1]

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EXECUTIVE SUMMARY

- Canada's clean technology sector is economically material in terms of employment, research and development (R&D) investment, number of firms and exports, with 6% of the sector's firms based in Atlantic Canada.
- The strategic intent of investors and full-scale domestic and Asian market demonstration sites are key factors in enabling clean technology firms to move from startup, to scale-up and on to exporting, to challenging markets such as in Asia.
- In many cases, the markets for clean technology are a function of regulation and policy covering a broad array of files including energy security, environmental protection, climate change, bio-economy, and public procurement to name a few.
- While Canada's clean technology sector is economically material in terms of employment and other indicators, global market share declined from 2.2% to 1.3% from 2005 to 2013.
- Certain Atlantic Canada clean technology companies have indicated an interest in exporting to Asian markets. All are still developing their strategies for these markets.
- China, India, Japan, and South Korea are the four largest Asian markets for manufactured environmental goods. Indonesia was included as one of the markets in Southeast Asia.
- Building understanding of both the regulatory and competitive environment in each Asian market is both necessary for competing in Asian markets and a difficult undertaking. The Canadian Trade Commissioner Service (TCS) can assist in this process and has provided guidance in this report, but firms must undertake the work on the ground themselves.
- Atlantic Canada clean technology companies will benefit from policies that leverage existing public and private investments. Eight best practices to leverage these investments are provided in this report.

1 THE CLEAN TECHNOLOGY SECTOR IN CANADA

1.1 WHAT IS CANADA'S CLEAN TECHNOLOGY INDUSTRY?

Canada's clean technology sector is the country's first new industry of the 21st century.

In fact, with 50,000 people employed directly in more than 800 Canadian-owned firms, Canada's clean technology sector is economically material and still emerging. Direct national employment in the clean technology industry now exceeds that of the aerospace manufacturing, forestry, and logging industries as well as pharmaceuticals and medical devices. Consolidation, which has created original equipment manufacturers and supply tiers of first-, second- and third-level suppliers in industries such as aerospace and automotive, has not yet occurred in Canadian clean technology industry, which is still largely made up of small, Canadian-owned firms.

Regulatory environments for clean technology are emerging and provincial carbon regulation initiatives are a case in point. While domestic policy frameworks emerge as low-carbon/green-economy initiatives take shape, global markets for clean technology goods (excluding services) nearly doubled in eight years from C$550B in 2005 to C$970B in 2013. These now represent markets 2.5 times the size of global trade in all wood-related goods, which grew from C$360B to C$390B over the same period, and which is a key industry in the Atlantic Canada economy. In 2013, Canada's clean technology exports were C$12B compared to C$11B of livestock and other animal product exports, another key sector for the Canadian economy.

1.2 WHAT IS CLEAN TECHNOLOGY AND WHAT IS A CLEAN TECHNOLOGY COMPANY?[2]

Clean technology refers to products, procedures, processes, and services that minimize the use of non-renewable resources and use resources in ways that reduce costs, waste, and pollution, leading to sustainable development. They include using renewable energy sources such as wind, solar, hydro, and geothermal, as well as low-carbon fuels; water management, and recycling technologies; waste management techniques; and environmentally friendly buildings and transportation.

A clean technology company is defined as a company with **proprietary technology or know-how** that addresses one or more of the markets below.

Figure 1

CANADIAN CLEAN TECHNOLOGY INDUSTRY TAXONOMY

Source: 2015 Canadian Clean Technology Industry Report (Analytica Advisors)

Firms operating in the industry are active in 10 clean technology areas falling under three broad sectors: upstream, downstream, and water and agriculture—taxonomy used to classify the main operation of companies.[3] Firms in the upstream sectors are engaged in producing equipment and plants that turn out alternative forms of energy. Firms in the downstream sectors provide equipment and services that improve the productivity of energy use. Canada also has a vibrant water and wastewater subsector and an emerging agriculture subsector. Global trade in the goods produced by these companies is not shown here, but is discussed later in this report.

Many Canadian clean technology firms have business models that can be characterized as small-scale versions of multinationals. As with multinationals, the mature clean technology firms operate global supply chains, domestic manufacturing plants, global distribution networks, and globally competitive research and development (R&D). In many cases, these same firms offer project financing to customers who prefer to purchase the services of an operating plant (e.g., turnkey offerings) and many are engaged in global capital-raising. The owners and operators of these firms are dedicated to building profitable companies that protect or repair the environment and do so in areas that may offer expansion opportunities in Asia.[4]

The focus of this report is Canadian-owned clean technology firms in Atlantic Canada. This baseline may serve future consultations on opportunities for greater engagement by Atlantic Canada clean technology firms with utilities, agencies, and foreign-owned firms in Asian and other markets.

In addition to Atlantic Canada's domestically owned clean technology firms, the region is home to publically owned utilities with foreign operations. These regulated entities may be vehicles for engagement with electricity utilities in Asia via consulting services. Initial market assessment points to opportunities to provide expertise to Asian utilities in areas such as dam maintenance, safety, transmission, and micro-grid management as well as the integration of intermittent renewable energy and storage.

Atlantic Canada is also home to agencies such as Fundy Ocean Research Centre for Energy (FORCE) and other entities that may facilitate scientific collaboration and demonstration at scale. They may also be able to support regulatory development initiatives or capacity building at international financial institutions such as the Asian Infrastructure Investment Bank.

Subsidiaries of foreign-owned firms also operate in Atlantic Canada. These firms have Canadian manufacturing and sales operations and may provide potential pathways to export to home-country or third markets.

1.3 EXPORTING AND THE STRATEGIC INTENT OF FIRM SHAREHOLDERS

Atlantic Canada's clean technology industry is largely made up of still-small Canadian-owned firms at different stages of commercialization maturity (See, Figure 3.3 and Company Commercialization Model box on page 15). The shareholders of these firms have different strategic intents. In 2013, 3% of Canadian clean technology firms indicated that their strategic intent was to remain locally focused and use profits to reinvest in the business. The remaining firms intend to compete in global markets, with 28% of them intending to remain closely held and using profits as capital to grow the business. The remaining firms either intend to target global niche markets or dominate global markets.

As the Atlantic Canada Opportunities Agency (ACOA) engages with clean technology firms, it may wish to confirm whether there is a difference between the stated strategic intent of the company and how the company's leadership is deploying resources vis-à-vis export markets. Monthly engagement with the Trade Commissioner Service (TCS) in markets beyond North America is one indication of a strategic intent that could include exporting to Asian markets.

1.4 EXPORTS AND SMALL AND MEDIUM ENTERPRISES (SMEs)

It may be helpful to bear in mind that there are likely fewer than 10,000 Canadian innovation-based SMEs across all sectors whose business model and strategic intent are consistent with the demands of exporting to Asian markets. There are fewer than 1,000 Canadian firms in clean technology, 5,000 in information and communication technology, 2,000 in life sciences, and another 2,000 in other sectors including advanced materials. For each of the 10,000 innovation-based SMEs, strong domestic and export market demonstration sites are the key to transitioning from startup to scale-up and to global export capacity. To put the figure of 10,000 innovation-based firms in context, there are 700 firms operating in the Canadian aerospace industry and 450 firms operating in the Canadian automotive industry—both mature and consolidated industries.

This report refers to several dozen Atlantic Canada clean technology companies and to about a dozen potential exporters as a focused set of firms.

1.5 CLEAN TECHNOLOGY, THE LOW-CARBON ECONOMY AND MULTIFACETED POLICY

As is the case across Canada, most of the "pain points" addressed by clean technology companies in Atlantic Canada are connected to more than one policy file.

In addition to climate change, trade, innovation, and economic development, policy files include environmental regulation such as pollution control and remediation (industrial products and processes; extractive products and processes; remediation/recycling and recovery; water and wastewater), energy security (e.g., power generation), the bio-economy (bio-refinery products), infrastructure renewal (transportation, smart grid/energy infrastructure), and energy efficiency regulation (energy efficiency/green building). Public procurement is also used as a lever to enable greater take-up and demonstration of new solutions domestically.

Finally, all 10 clean technology subsectors are relevant to international development, overseas development assistance and climate finance. This industry sits at the crossroads of public policy concerns including jobs and the economy, air quality/health, environmental stewardship/regulation, innovation, international development/aid, and climate change.

Because of these strategic considerations, and how these policy domains may be treated at the sovereign level in Asia, it is worth considering the state of clean technology nationwide in addition to considering the specific characteristics of Atlantic Canada's clean technology sector. Doing so will help guide Atlantic Canada's policy-makers as policies to decarbonize the global economy become more widespread.

With public resources stretched in all jurisdictions, Atlantic Canada agencies will find their efforts are more effective when targeted at federal entities with mandates in Asia such as the TCS on export promotion, Natural Resources Canada (NRCan) for engagement with scientific entities on air-, water-, and energy-related matters, and Environment Canada on regulatory co-operation.

1.6 CANADA'S POSITION IN THE GLOBAL MARKET FOR CLEAN TECHNOLOGY—SERIOUS CHALLENGES

Canada's exports of clean technology equipment are on par with mineral products, wood, livestock, and processed food. There is evidence to suggest that current approaches to the clean technology sector are less than optimal because Canada has lost more market share than all but two other countries since 2005.

Canada's share of global clean technology export market declined by 41% from 2.2% to 1.3%, and Canada's global ranking fell from 14th to 19th. After the U.K. and Japan, Canada shows the steepest decline in global market share for clean technology goods spanning both energy- and water-related products. This change in market share represents C$124B in lost trade over the eight-year period from 2005 to 2013.

For energy-related clean technology goods excluding water and wastewater equipment, Canada's global market performance is worse. Between 2005 and 2013, no

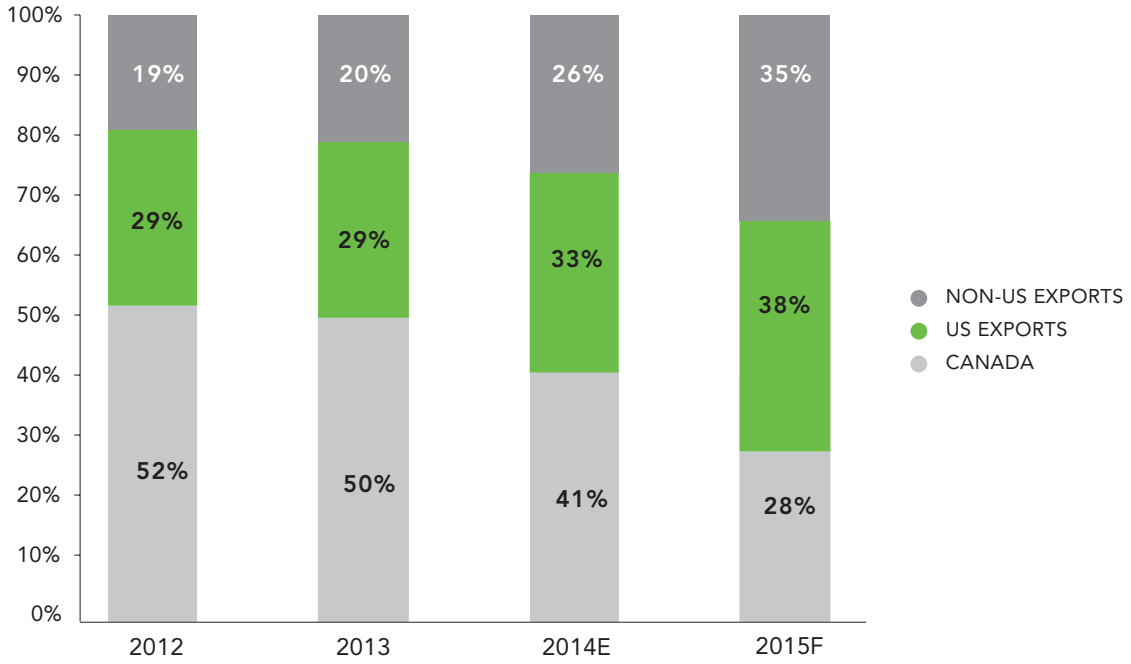
other country among the world's top 24 exporting countries lost more market share than Canada, which lost 71% of its 2005 market share.

Ironically, Canadian clean technology companies are very active exporters. The firms already generate half of the industry's revenues from exports and expect this to grow to 70% of revenues by 2015. Canadian clean technology firms are more than 10 times more likely to export than average Canadian SMEs. (See Figure 2.)

This export performance comes at a time when clean technology became the country's number-one investor in R&D, outpacing aerospace and pharmaceuticals as the largest investor in R&D. Three-quarters of Canadian clean technology R&D investment was by SMEs. (See Figure 3.)

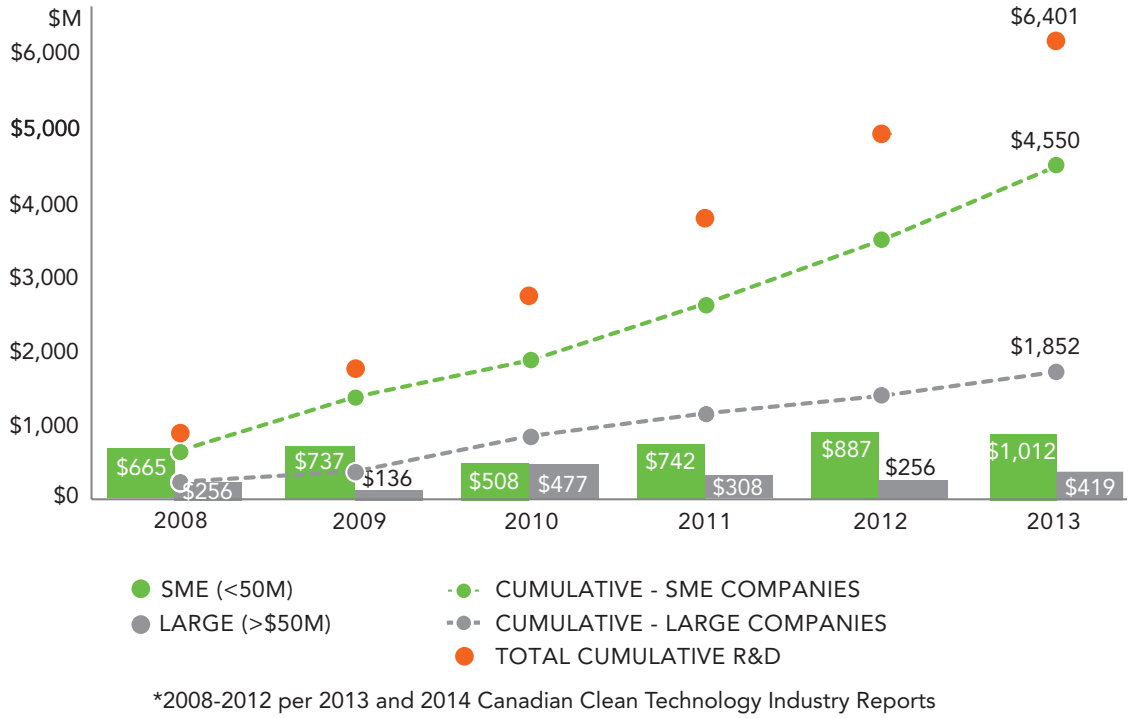
For our Asian trading partners, this sector is top of mind due to concerns over the health of citizens and the risks posed by climate change. Though it is not the case today, the sector could be at the forefront of Canadian international affairs, trade, and development policy given its R&D investment and its potential impact on health, productivity, climate change, and environmental stewardship in a lower-carbon global economy.

Figure 2 Percentage of revenues from exports for Canadian clean technology firms



Source: 2015 Canadian Clean Technology Industry Report (Analytica Advisors)

Figure 3 Annual and cumulative R&D investments by Canadian clean technology companies—SMEs versus large companies (2008-2013)



*2008-2012 per 2013 and 2014 Canadian Clean Technology Industry Reports

Source: 2015 Canadian Clean Technology Industry Report (Analytica Advisors)

The remainder of this report will paint a picture of the clean technology industry in Atlantic Canada. It will then discuss the size and trade dynamics of major clean technology markets in Asia including China, India, Indonesia, Japan, and South Korea. This will be followed by an analysis of the strengths and weaknesses of the Atlantic Canada clean technology industry. Specific companies that are engaged in business development in Asia or have expressed an interest in doing so will be presented. Next, market intelligence for these firms is presented from the perspective of Canadian TCS officers working in China, India, Indonesia, Japan, and South Korea. Finally, observations are presented in light of opportunities and threats to support the industry in Asian markets.

2 CLEAN TECHNOLOGY IN ATLANTIC CANADA

In Atlantic Canada, 2,000 people are employed directly in Canadian-owned clean technology firms, which represent 6% of the country's Canadian-owned companies and 4% of employment in these firms. Since Atlantic Canada clean technology companies are smaller than the average Canadian clean technology firm, the challenge will be to develop strategies that enable these firms to export to highly competitive Asian markets.

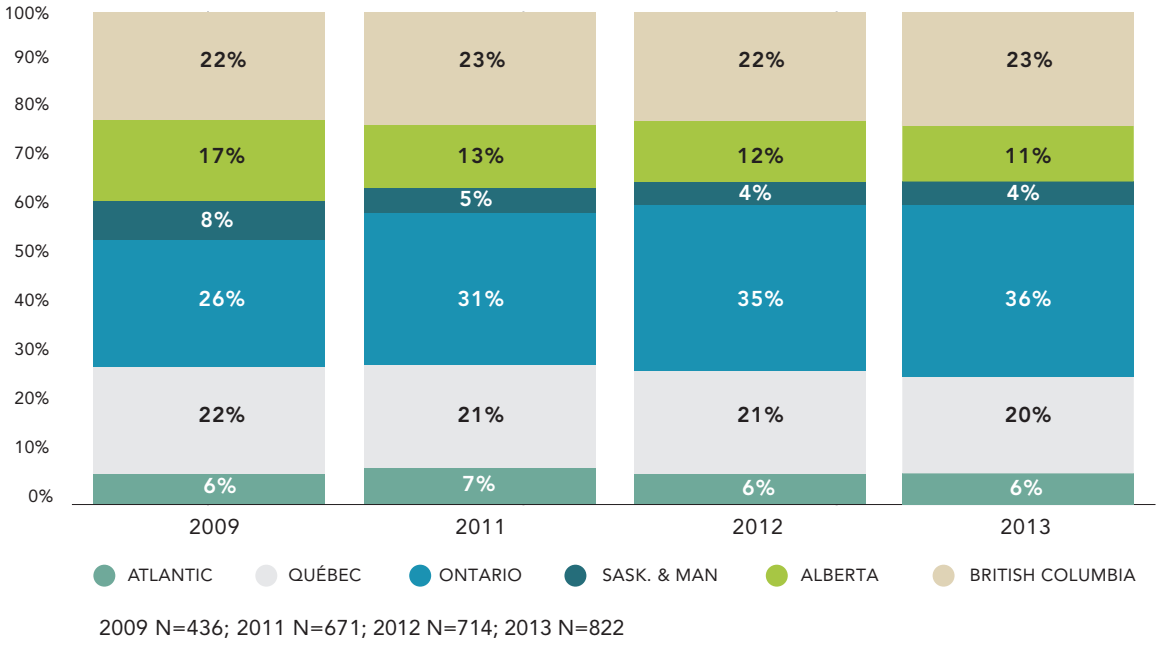
Quick Facts: Atlantic Canada Clean Technology Companies[5]

- The average age of the company is 17 years compared to 19 nationally;
- Atlantic Canada firms employ an average of 47 people each compared to 68 nationally;
- Less than one-third of Atlantic Canada companies have over 20 full-time equivalent;
- Less than one-third of Atlantic Canada companies have revenues of over C$2M;
- Two-thirds have commercial products and are engaged in one or more markets, whereas only 10% are in the earliest R&D stage; and
- Atlantic Canada clean technology companies are increasingly engaged in exporting, as reported in the shift in their responses to the 2014 and 2015 Canadian Clean Technology Industry surveys.

2.1 WHAT IS THE MAKEUP OF ATLANTIC CANADA'S CLEAN TECHNOLOGY INDUSTRY?

Figure 4 presents Atlantic Canada clean technology companies in the context of the national industry. The share of Atlantic companies has remained steady in the last several years, representing about 6% of the national industry.

Figure 4 Importance of the Atlantic Canada region to the Canadian clean technology sector

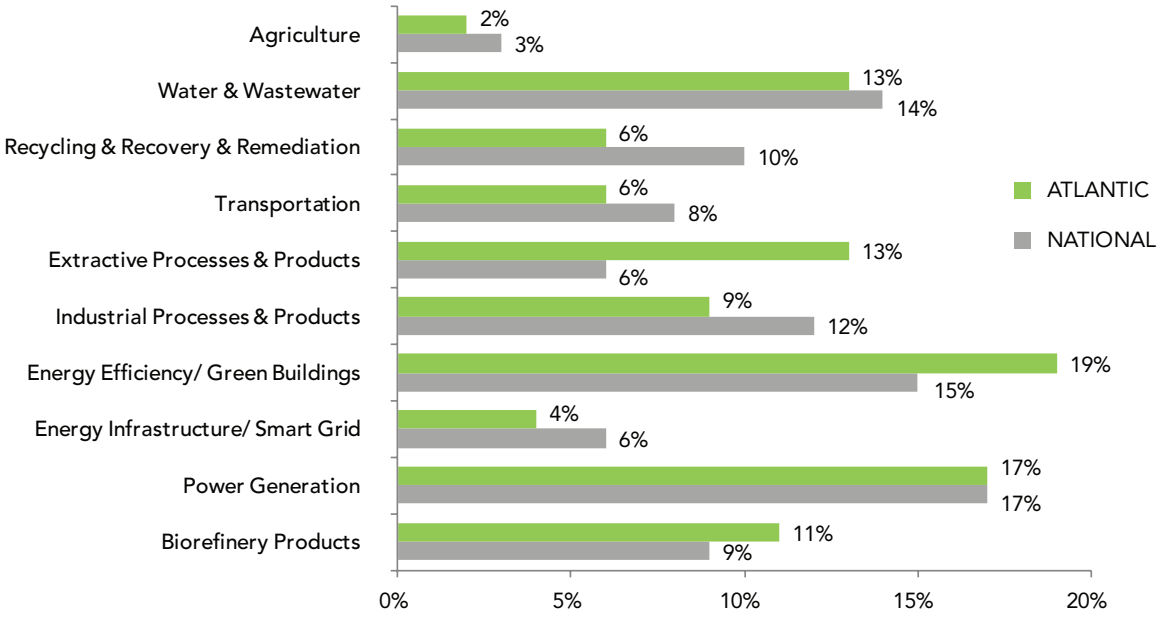


2009 N=436; 2011 N=671; 2012 N=714; 2013 N=822

Source: 2015 Canadian Clean Technology Industry Report (Analytica Advisors)

By number of companies, the largest subsectors in Atlantic Canada are energy efficiency/green buildings (19%), power generation (17%), as well as extractive processes and products (13%), water and wastewater (13%), and bio-refinery products (11%). Compared to Canada overall, where extractive processes and products account for only 6% of companies and power generation is the predominant sector, Atlantic Canada's clean technology industry is more focused on energy efficiency, extractive processes and products, and bio-refinery products. This profile is indicative of both the region's energy and its natural resource profile. (See Figure 5.)

Figure 5 Percentage of companies by sector nationally versus Atlantic Canada



Source: 2015 Canadian Clean Technology Industry Report (Analytica Advisors)

The rate of company incubation and entrepreneurialism in the sector has generally been reflective of regional/provincial gross domestic product (GDP) since 2009. The number of companies in Atlantic Canada has hovered around 6% since 2009, thereby demonstrating incubation and entrepreneurial capacity that is consistent with the rest of Canada.

Since 2011, the proportion of companies at pre-revenue R&D and early demonstration stages has declined in both Canada and Atlantic Canada. This reflects the maturation of companies within emerging markets. The slowdown in company incubation may also reflect a gap between innovation policy capacity, financing availability, and entrepreneurial capacity. (See Figure 6 and the definition of company maturity stage is discussed in the Company Commercialization Model box on page 15.)

It may also be reflective of the economy's overall capacity. As mentioned above, in more mature sectors such as automotive and aerospace, there are in the order of 450 and 700 firms respectively in Canada. At 800-plus Canadian-owned firms, the clean technology industry may have reached a point of equilibrium before industry consolidation begins. When consolidation begins, Atlantic Canada firms that have proved to be globally competitive may continue to operate as stand-alone companies or may be acquired by multinationals seeking to complement internally developed innovations and market presence. Where Atlantic Canada firms are not globally competitive, they will either disappear or reinvest profits from local markets to focus domestically.

Company Commercialization Model[6]

Research and Development (R&D)

Companies in R&D seek to prove that the science will deliver potentially valuable new technical properties and to understand whether the application of the technology provides a functional improvement over current technologies or methods.

Technology Development and Demonstration (TD&D)

Companies in the TD&D phase seek to prove that the technology delivers economic value for specific products and to service applications at commercial scale. Leaders at TD&D companies are focused on proving the technology at commercial scale and converting it to a product or service. They may choose to enter into licensing agreements to ensure that technology commercialization occurs.

Product Commercialization and Market Development (PC&MD)

Companies in PC&MD are establishing business processes for the product or service that will allow profitable sales and meet requirements for investor returns. These business processes include testing offerings that may combine services and technology, and proving-out direct and indirect distribution channels for different geographic markets. The goal is to define a scalable and profitable go-to-market strategy for the company.

Market Entry and Market Volume (ME&MV)

Companies in ME&MV are building multiple channels to market and may have multiple products to address different geographic and vertical markets. Examples of vertical markets include mining, forestry, municipalities, and international development.

Figure 6 Atlantic Canada clean technology companies by commercialization stage

Source: 2015 Canadian Clean Technology Industry Report (Analytica Advisors)

3 CLEAN TECHNOLOGY TRADE MARKETS IN ASIA

Asian markets for clean technology are among the most competitive globally. Using *imports* of manufactured environmental goods (see Appendix 1 for a definition of manufactured environmental goods) as a proxy for clean technology global markets, in 2014, China was the region's largest market (US$182B) followed by Japan (US$58.8B), South Korea (US$57.2B), India (US$31.5B), and finally Indonesia as a representative market for Southeast Asia with US$16.5B in imports of manufactured environmental goods.[7]

Based on the value of *exports* of manufactured environmental goods as a proxy for domestic competition for Canadian firms looking to do business in Asia, the most competitive markets in 2014 were China and Japan, where exports were valued at US$227B and US$97.8B respectively. South Korea was third in terms of exports with US$49.2B, followed by India with US$14.8B and Indonesia with US$7.1B.

Another way to characterize Asian markets is to consider the ratio of imports to exports of manufactured environmental goods. Of countries eligible for overseas development assistance (ODA), Indonesia's import/export ratio is the highest at 232% followed by India's at 213%. South Korea's imports of manufactured environmental goods slightly exceeded exports at 116%. China has strong and still-growing industrial capacity in environmental goods, with imports of manufactured environmental goods valued at 80% of exports. Of the major Asian markets, Japan has the strongest industrial capacity, with imports representing only 60% of the value of exports of manufactured environmental goods.

For the purpose of this analysis of trade, manufactured environmental goods exports have been further refined to four categories to gain a better understanding of market sizes and growth rates. These categories are similar to some of the clean technology industry subsectors used to classify the operations of companies, but some subsectors have been grouped for ease of analysis of global trade statistics. (See Appendix 1 for reference mapping of the 10 clean technology subsectors to the four classes of manufactured environmental goods. See Appendix 2 for detailed findings on manufactured environmental goods trade).

The four categories of manufactured environmental goods discussed below are the following:

1. Industrial and extractive processes including carbon capture, use and sequestration (CCUS);
2. Water and wastewater;
3. Renewable energy and storage; and
4. Energy efficiency.

For each of these categories, the 2011–2013 compound annual growth rate (CAGR) was calculated for trade in these goods in China, India, Indonesia, Japan, and South Korea. The same CAGR has been calculated for Canada in order to understand the attractiveness of domestic versus Asian markets and the degree to which firms will be compelled to seek opportunities internationally due to low-growth Canadian markets. (See Appendix 2.)

A summary of these findings is as follows:

1. Industrial and extractive processes: The most attractive markets for this category can be found in China, Canada, and South Korea.
2. Water and wastewater: South Korea, Indonesia, and China lead growth in water and wastewater markets at a time where growth in Canada is half that of the fastest-growing markets in Asia.
3. Energy efficiency: Indonesia's focus on development initiatives in this sector shows a modest growth in energy efficiency imports, followed by a similar growth in Japan. In contrast, Canada's market for energy efficiency equipment is stagnant.
4. Renewable energy and storage: Post-Fukushima Japan leads the way in terms of imports of renewable energy and storage goods, followed by China and Canada. Markets for renewable energy and storage imports were flat or negative between 2011 and 2013 in Indonesia, India, and South Korea.

Atlantic Canada companies have limited resources to develop business in Asia. The current size and rate of growth of markets for clean technology in specific Asian markets can be the basis for decision-making regarding investments for business development in Asian markets. Trade information can provide both the current size and rate of growth for markets and is summarized here for industrial and extractive processes equipment, water and wastewater equipment, energy efficiency equipment and renewable energy equipment.

For industrial and extractive processes equipment, the two-year import CAGR was highest in China (8.4%), followed by South Korea (6.8%) and India (4.8%). Firms may find Canada's domestic markets to be more attractive than Asian markets at this time with a CAGR equal to that of China's. The two-year CAGR in Japan and Indonesia was negative for industrial and extractive processes goods.

The story was quite different for imports of water- and wastewater-related goods, with South Korea recording the highest two-year CAGR at 13.3%, followed by Indonesia (11.1%), China (9.8%), and Japan (6.4%). All of these markets exceeded Canada's relatively robust CAGR of 6%. India's import of water- and wastewater-related equipment barely grew over the period with a 2011 to 2013 CAGR of 1.2%.

Growth in energy efficiency goods imports was slower overall in Asia, with Indonesia and Japan both recording CAGRs of 6% and 5%. There are energy efficiency initiatives in Indonesia being financed by international financial institutions such as the Asian Development Bank (ADB) that may offer pathways to transparent procurement for Canadian firms. Elsewhere in Asia, China and South Korea recorded energy efficiency import CAGRs of 3% and India's imports were flat. Canada's import CAGR of energy efficiency goods was also very low at 1.4%, suggesting that Canadian firms will be hungry for export opportunities.

While the sector is a focus for only a few Atlantic Canada firms, renewable energy equipment exports do present opportunities for growth and may represent an opportunity for utilities that have experience with hydroelectricity and other low-carbon power generation. Japan's focus on energy security post Fukushima has led to very high growth in renewable energy goods imports with a two-year CAGR of 23% or nearly twice the rate of growth of China at 12%. Canada's own two-year CAGR for imports of renewable energy goods was a robust 10%. As for the rest of Asia, the market for renewable energy goods was either flat or negative in South Korea, India, and Indonesia. Changes in India's renewable energy policy environment may become evident in trade figures going forward.

4 STRENGTHS AND WEAKNESSES OF THE SECTOR IN ASIA

4.1 ATLANTIC CANADA COMPANIES ARE BUILDING MODELS OF ENGAGEMENT WITH MARKETS IN ASIA

There are a number of Atlantic Canada clean technology companies that are either engaged in or considering Asian markets. However, these companies are still engaged in business development. A few are generating revenues, but most are gauging market opportunities and discerning if they have a competitive value proposition vis-à-vis domestic providers and other foreign-based competitors. Few companies have advantages that are specific to Atlantic Canada, but rather benefit from strengths that are common to Canadian clean technology companies.

Strengths

- Some Atlantic Canada companies are well informed of the resources at their disposal. The TCS is well understood as a resource by some firms and is used by companies that have moved to active business development in Asian markets. The TCS, in turn, is able to provide advice and direction on local service providers, industry associations, demonstration partners and potential joint venture partners.
- Canadian companies are generally viewed as having competitive technology due to high R&D investment, and therefore Atlantic Canada companies benefit from the Canadian brand. Working with the TCS further leverages this brand.
- Canadian higher education (and therefore R&D capacity) is viewed positively in countries such as South Korea where industry leaders have experience with Canadian higher education either personally or through their children. This may be less so in China, where relatively fewer senior leaders have personal experience with Canadian higher education. Over the long term, programs that enable graduate students from Asia to attend university in Atlantic Canada may have a positive impact on Canadian business prospects in Asia, as appears to be the case in South Korea, where some senior business leaders who are engaged with Canadian clean technology firms experienced university education in Canada 20 to 25 years ago.
- Canadian business leaders are viewed as good to do business with due to honest business practices and a strong rule of law in Canada. Atlantic Canada business leaders can be explicit about values such as the importance of the rule of law.
- Companies are investing in local language collateral materials and in some cases have websites to present their value proposition to potential buyers in Asian languages. There appears to be sufficient private-sector capacity to meet the translation needs of the industry.

- Some companies that are investing in local engagement in Asia are building the network of relationships that will lead to greater probability of success. Once these companies are established, they may be willing to provide guidance to peers that enter the market later.
- In the form of Export Development Canada (EDC), Canadian firms have the benefit of an Export Credit Agency that can deploy pull credit facilities to enable purchase of Canadian products. Pull credit facilities are loans made to large corporations that can potentially be deployed for procurement from Canadian firms. EDC has deep expertise in the deployment of pull credit facilities in the oil and gas industries. Depending on regulation, oil and gas companies may seek clean technology solutions to address air and water regulation. To the extent that Atlantic Canada companies have solutions for oil and gas applications, they should seek out EDC pull credit facility customers in Asia.

Weaknesses

Doing business in Asia is challenging even for the largest of multinationals. By comparison, Atlantic Canada clean technology firms have limited financial and managerial resources. Therefore, the weaknesses outlined here reflect areas that are particularly challenging for Atlantic Canada clean technology firms given resource constraints.

- In markets such as China, all companies including Atlantic Canada companies must invest to determining who the competition is. Regardless of the origins of companies, establishing the basis of this competition is a long and arduous process. Firms, whether big or small, must be prepared to invest time and management resources to determine competitive market factors. These include:
    - » Current and expected regulation;
    - » Current and expected enforced regulation;
    - » Current and expected incentives;
    - » Providers of current installed equipment;
    - » Performance of current installed equipment; and
    - » Price-per-performance attributes of current installed equipment.
- In most Asian markets, local demonstrations are de facto market requirements, regardless of how many times a product has been deployed in other markets. For Atlantic Canada clean technology firms, there are at least two challenges with this requirement. The first hurdle is finding the right demonstration partner. Again, time must be invested to find a demonstration partner who brings to the table both local market credibility and respect for intellectual property. The second challenge is the fact that, unlike more mature markets, demonstrations are generally funded by demonstrating firms, not the local customer or partner. For firms in Atlantic Canada, financing will be needed first to identify the right demonstration partner and then to fund the demonstration project.

- Asian countries eligible for ODA, such as China, India, Indonesia, and other South Asian countries, rely on concessional finance from international financial institutions (IFIs) such as the ADB and the World Bank. Engineering, procurement, and construction firms are prime contractors for infrastructure such as energy and water infrastructure to IFIs. As an example, some Nordic countries have deployed strategies to build ties between prime contractors and clean technology solution providers, so that smaller clean technology firms can be included by larger firms within infrastructure projects. A federal-provincial co-operative approach may be an effective way of identifying global prime contractors to make them familiar with Atlantic Canada companies and solutions.
- Similarly, even as the Asian Development Bank decentralizes operations into borrowing countries, technical expertise on energy and water may remain a shared service for some time. Many lenders to the ADB have seconded technical experts to the centres of excellence for low-carbon energy and energy efficiency. For example, South Korea, Spain, Germany, as well as other European countries have seconded technical experts to these centres. Canada has not seconded private-sector technical experts to Asian IFIs. Atlantic Canada firms may consider seconding technical staff if financial support were made available in Atlantic Canada.

4.2 STRENGTHS, WEAKNESSES, AND STRATEGIC INTENT

As outlined in this report, many Atlantic Canada clean technology companies are small. Regardless of size, if a firm's strategic intent is to become globally competitive, it will establish a business model that reflects the financial means it has at its disposal. Venture-capital-backed firms may establish direct-to-market strategies where they seek strategic partners who will invest equity in the firm. Closely held firms may establish agreements with agents and networks of representatives where they share margin with their representatives. Firms of largely the same size can establish very different go-to-market approaches to Asia. For innovation-based firms, participating in global value chains is not a priority. Their strategic intent is to provide whole solutions based on unique, competitive technology. Physical distance to the market is less of a factor than is strategic intent.

In summary, foundations will be needed so that firms can invest in building long-term, profitable business ties with customers in Asian markets. Some of these gaps, such as market intelligence to establish competitive positioning, are in the realm of each firm. However, other gaps, such as ties with IFIs, are the purview of the public sector. Still others, such as identifying demonstration project partners, financing the demonstrations, and establishing supply chain connections between prime contractors (including engineering firms and clean technology solution providers), would benefit from public-private partnerships. In all of the above cases, a period of economic slowdown in Asia represents an opportune time to prioritize where to invest in these foundations.

4.3 ATLANTIC CANADA COMPANIES ARE BEGINNING TO

BUILD MODELS OF ENGAGEMENT WITH MARKETS IN ASIA

The following represents a sample of companies engaged with the TCS and/or have indicated an interest in Asian markets. Some of these companies have established strategies for Asia and are already frequently engaged with the TCS in executing these strategies.

New Brunswick

1. LuminUltra Technologies Ltd.—water and wastewater | Fredericton, NB

LuminUltra provides rapid, accurate, portable testing equipment for determining whether industrial processes have contaminated water sources with micro-organisms. Analytical software helps users interpret the results and take the right steps to correct the problems. The equipment is used in drinking water, wastewater, water management, and many industrial applications including oil and gas production or any environment where microbiological contamination can occur.

2. ProCare Water Treatment Inc.—water and wastewater | Dieppe, NB

ProCare Water's systems are commonly used in health care, hotels, nursing homes, schools, military facilities, and other large buildings for long-term control and prevention of Legionnaire's disease. The innovative clean technology behind this company's success in providing safe, potable water networks in large buildings is copper and silver ionization rather than the chlorine, ammonia, and other high-impact chemical processes used in other technologies.

3. ChemGreen Innovation Inc.—industrial processes and products | Sackville, NB

ChemGreen has patented clean technology green polymerization processes, novel polymers, and nano materials. It is looking at partnership opportunities with companies that have an addressable market and a need for its innovation, products, and scalable solutions.

4. Geomembrane Technologies Inc. (GTI)—water and wastewater | Fredericton, NB

GTI custom designs, fabricates, and installs innovative tank and lagoon covers as well as containment liners for water and wastewater applications. It has over 30 years' experience and more than 250 installations worldwide. Its covers have been used in industrial, municipal, and agricultural enterprises to collect and store biogas, reduce greenhouse gases, and reduce dependency on imported energy.

Newfoundland and Labrador

5. Fay Environmental Canada Ltd.—water and wastewater | St. John's, NL

Fay Environmental Canada specializes in water treatment processing, and provides turnkey water and wastewater treatment solutions that deliver clean and wholesome drinking water and support environmentally sustainable wastewater treatment. Its client base consists of governments (local, provincial, and federal), food processors, property developers, hoteliers, golf and country clubs, hospitals and long-term care facilities, and private water companies.

6. Hi-Point Industries—industrial and extractive processes | Bishop's Falls, NL

Spills of oil and other fuels at bulk fuel stations, at airports, or on highways can devastate local ecosystems, draining into storm sewers and rivers and creating hazards for emergency professionals and local communities. The impact on humans and wildlife can last for decades. This Canadian company's Oclansorb product mops up fuel spills on contact, with an all-natural, environmentally friendly, safe product made from naturally occurring blond sphagnum peat moss. The product is light and easy to store, absorbs up to six times its own weight of fuel and oil but does not absorb water, can be disposed of by incineration, and can even be used as a fuel source after absorbing the spilled oil.

7. Phase Separation Solutions (PS2)—industrial and extractive processes
St. John's, NL

This company, a subsidiary of West Mountain Environmental, has been operating in China since 2010 through its Shanghai registered sister company Shanghai Phase Separation Environmental Technology or PS2 China. It is a specialist in the remediation of post-industrial contaminated sites making them suitable for urban redevelopment. Since being developed in 1996 in Newfoundland, PS2's proprietary Thermal Phase Separation (TPS) has successfully treated hundreds of thousands of tonnes of contaminated soil and sludge around the world. The technology allows for the safe and ecologically responsible on-site extraction of polychlorinated biphenyl (PCB), dioxin, chlorinated pesticides (DDT), polyaromatic hydrocarbons (PAH) and solvents from soil and returns the site back to productive use. The same technology is widely used at oil production facilities. In China, this company's technologies are used at several hydrocarbon waste reclamation facilities in Zhejiang, Daqing and Sichuan Provinces. PS2 assists new and innovative Canadian environmental technologies with the challenging transition into the Chinese environmental services market.

Nova Scotia

8. CarbonCure Technologies—industrial and extractive processes | Halifax, NS

CarbonCure Technologies produces concrete with a smaller carbon footprint. Waste CO_2 that would otherwise be released into the atmosphere from industrial plants such as oil refineries, power plants, and cement plants is recycled to make more environmentally friendly concrete. The technology is retrofitted to existing concrete plants, which add stored CO_2 to the concrete while mixing, and this waste CO_2 is then permanently converted into a fine, solid, limestone-like substance within the concrete, so it is not released again during demolition.

9. Green Power Labs—renewable/power generation and energy efficiency
Dartmouth, NS

Green Power Labs is a predictive analytics and controls company focused on forecasting and managing the sun's immense capacity as a power generation resource and its passive heat impact on our living spaces. Solar is a highly variable energy source. This variability creates grid stability challenges limiting its capacity as an energy source. The same variability has direct impact on heating and cooling needs in our buildings. Predictive analytics and controls effectively manage this variability allowing for the smooth integration of distributed and utility scale solar projects into the grid and better management of heating and cooling equipment. As a result energy costs and GHG emissions are reduced and solar's potential as an energy source is improved.

10. LED Roadway Lighting Ltd.—energy efficiency | Halifax, NS

Street lighting often represents more than 30% of municipal energy budgets. Converting to a lower-energy-use and lower-maintenance light source can have a big impact on the amount of energy used and money spent to keep towns and cities bright and safe at night. Headquartered in Halifax, Canada, with manufacturing plants in Canada, the U.K., the U.S., Brazil, and Australia, LED Roadway makes light-emitting diode (LED) lighting and control systems both for new builds and as easy upgrades for existing systems. LED Roadway Lighting installations typically deliver an average 60% saving in energy usage against existing systems and provide reduced maintenance costs in systems that are smart-grid enabled.

11. Eosense—industrial and extractive processes | Dartmouth, NS

Accurately and continually measuring what gases – especially CO_2 – are produced and then pass into the atmosphere through the soil during extractive and other processes is crucial to controlling emissions during extraction. Eosense produces highly accurate, ultra-robust instruments to measure soil gas in field conditions for soil scientists and for upstream oil and gas service providers. The instruments measure the passage of produced or consumed gases across the soil surface and in aquatic conditions – commonly referred to as soil gas flux – using its proprietary, forced-diffusion method, with no moving parts, making it much more reliable than other methods for long-term use in harsh conditions.

12. Highland Energy Inc.—industrial and extractive processes | Bedford, NS

Recognized as one of the most knowledgeable, innovative, creative, and persistent developers in the renewable energy industry in Canada, Highland Energy Inc. is an independent developer of landfill gas-to-energy projects with over 20 years of experience. It collects gas produced in landfills and turns it into environmental and economic benefits.

Its areas of expertise include site assessment; contract negotiations; design and construction of landfill gas collection systems and gas-to-energy power plants; and daily operations, maintenance and management of landfill gas collection systems and landfill gas utilization systems.

Highland has international experience and interest in markets including China, India, and the Philippines.

13. Solar Global Solutions—power generation | Halifax, NS

Solar Global Solutions (SGS) is a manufacturer of Net-Zero Energy and Off-Grid Lighting renewable energy systems. SGS specializes in the design, supply, and construction of high quality solar photovoltaics, combined heat and power generators, and battery storage systems. The team at SGS has over 25 years of experience successfully developing projects for residential, commercial, government and utility clients. To date, the company has installed over 500 solar power systems globally.

5 ASIAN TRADE COMMISSIONER SERVICE MARKET INTELLIGENCE

The Trade Commissioner Service is increasing the number of officers focused on clean technology in Asian markets. Depending on their focus, companies engaging in Asia can leverage the TCS officers either with responsibility for infrastructure or with responsibility for sustainable technologies. Infrastructure includes building energy efficiency, transportation, and some water-related projects. Sustainable technologies include renewable energy, some industrial applications, and water-related technologies. Export-focused Atlantic Canada clean technology companies are engaged with TCS officers upwards of twice a month. Others are engaged with TCS officers less than twice a year. For Atlantic Canada companies, more business opportunities in Asia will be vetted professionally if companies build relationships with TCS officers to leverage their knowledge, experience, and networks.

The following are country profiles for China, Indonesia, India, Japan, and South Korea based on responses to four questions we asked TCS officers focused on clean technology (see Appendix 3 for trade commissioner contact information). This information could later be supplemented with Atlantic Canadian expertise to develop strategies for enhancing engagement with Asian markets.

5.1 CHINA

There are currently 21 TCS officers covering the sustainable technologies and infrastructure sectors in Greater China including Hong Kong and Taiwan (Taipei). In mainland China, TCS officers are located in Beijing, Shanghai, Guangzhou, and Chongqing. Through market engagement with these TCS officers, the TCS has identified a number of priority areas. These in-market TCS offices can help bolster government and business work to expand and leverage opportunities.

Carbon capture use and sequestration:

- There are significant emerging opportunities;
- Demand stems from anticipated government policy and regulatory initiatives;
- State-owned enterprises (SOEs) are aware of upcoming policy changes and potential implications; and
- There is a willingness to implement/pilot strongest in Beijing, Shanghai, Guangzhou and Shenzhen.

Soil remediation:

- Large-scale issue in China and may be treated as a priority area
- The market in China estimated to be 10 trillion yuan over the next 10 years

Power Generation:

- Strong interest in best practices of Canadian utilities, particularly in the area of dam safety
- Conversion from coal to cleaner energy (such as biomass) is of interest but presents a longer-term opportunity

- Municipal waste-to-energy is an area of significant interest
- Ocean monitoring and tidal energy are of interest particularly in the coastal cities of Zhanjiang and Shantou

Water and Wastewater:

- Wastewater treatment solutions are of significant interest; and
- Treatment of rainwater to protect the watershed is of significant interest in Shanghai.

Energy efficiency:

- The most immediate need/interest is in industrial energy efficiency and industrial applications; and
- Energy efficiency industrial education networks can be leveraged in Guangzhou province. TCS contacts in these networks can be leveraged.

Which companies or entities (Canadian/Chinese/international) present in China should be partners for clean technology companies?

- For remediation of Chinese brownfields, Canadian engineering/infrastructure companies such as Golder Associates Ltd. and Hatch (each with multiple Atlantic Canada offices and a presence in China) may be able to strengthen their bids by incorporating leading remediation technologies from Canadian firms;
- Canadian firms have successfully partnered with local academic/researchers with in-depth local sector/regulatory knowledge and a strong network of contacts;
- Large companies outside of the clean technology sector, such as real estate firms, may also be interested in partnering where the Canadian technology is beneficial to the company or provides an alternative revenue stream at some point in the future; and
- Finding a partner that can help with scale-up can be valuable.

Which institutions are good partners for local demonstration?

Demonstration project partners can be found through one of the Chinese Academies of Science or Environmental Science. Firms could benefit if Canadian regional or federal entities leverage federal departments such as Natural Resources Canada (NRCan) and the National Research Council (NRC) to engage with academies of science. Engaging with NRCan and NRC on these matters can help build the case for funding for greater engagement. Some examples of entities for science-focused collaboration as a steppingstone to commercial opportunities include:

- Branches of the Chinese Academy of Sciences;
- Shanghai Academy of Environmental Sciences;
- Institute of Soil Science;
- Nanjing Institute for Environmental Sciences;
- South China Institute of Environmental Sciences; and
- Guangzhou Research Institute of Environmental Protection, which plays an analysis and advisory role on environmental remediation projects (particularly water and air related).

Some large state-owned enterprises (SOEs) may, on occasion, be given a "research project" by municipal or provincial governments and may be interested in new technologies to complete demonstration projects for the purposes of carrying out this research. For example, a recent outcall with Shenzhen Energy revealed its interest in CCUS technologies, which is directly related to a tasking received by the local government. CCUS falls outside Shenzhen Energy's current areas of expertise. The company is keen for information and may be happy to take on partners to realize this research, and has also applied for government funding to partially cover the costs of the demonstration project.

China Energy Conservation and Environmental Protection Group (CECEP), the largest SOE under the direct management of central government specialized in energy conservation and environmental protection, has funding for demonstration projects, especially in the energy efficiency and waste management sectors. A focus on remediation could also conceivably be added to CECEP's brief.

Huaneng Clean Energy Research Institute, which is affiliated to Huaneng Group, the largest power generation company in Asia, is interested in demonstration of tidal energy and hydro. Utilities such as Southern Company (U.S.) are engaged with Huaneng today on matters to do with coal-based power generation.

What possible changes in regulation do you foresee in energy efficiency, renewable energy, water, and other clean technology infrastructure?

All sectors:

- In addition to the gradual increase of water standards, a similar mandate has also been announced for air standards, and there are rumours of new soil standards as well (水十条，大气十条，土十条 – all "pollution prevention plans of action");
- Energy efficiency standards in certain regions of East China are among the world's highest;
- Markets will open up as greater enforcement occurs;
- China will continue to be the world's #1 investor in renewable energy;
- Outside of regulatory changes, provinces may have their own mandates related to continued development. For instance, in Guangdong, a recent meeting with the vice-governor of the province revealed a desire to "sustainably develop" the 60% of the province that remains (by their definition) underdeveloped. For example, a provincial government focus will have a trickledown effect on infrastructure projects; and
- Canada can also leverage its experience in the oil sands to supply environmental solutions to China's developing shale gas and tight oil sector. Major SOEs (Sinopec Ltd., China National Offshore Oil Corporation) are logical partners, as are engineering and oil field service companies.

Remediation:

- On July 2, 2015, China's Ministry of Environmental Protection announced that the central government will allocate RMB2.8B (C$604M) to treat heavy metal polluted soil in 30 cities across China—1 cities are from Hunan province; and
- China will issue the 10 methods to prevent soil pollution in late 2015 or early 2016.

Industrial and extractive processes:

- Green mining is an emerging industry with China's Green Mine initiative, which became effective in 2010 under the Ministry of Land and Resources and is administered by the China Mining Association;
- The Green Mining Certification is voluntary and is granted to companies that can meet the standards in nine aspects of a mining operation;
- Chinese industry associations and companies have expressed interest in learning about Canadian practices and capabilities in green mining;
- Natural Resources Canada (NRCan) has a memorandum of understanding (MoU) with China Nonferrous Metals Industry Association (CNIA) on green mining co-operation. CNIA led a delegation to Canada in June 2015 to learn about Canadian capabilities;
- After the visit, both sides confirmed their interest in further collaboration and in promoting Canadian green mining technologies in China;
- Areas of interest identified during this trip include: soil remediation, removal of metals from tailings and/or water systems, metal recovery processes, health and safety, and proactive planning and design of mine sites; and
- In order to ensure that Atlantic Canada capabilities are showcased as part of NRCan's information about Canadian capabilities, ACOA should educate NRCan.

Water and wastewater:

- Water standards will rise, particularly in second- and third-tier cities;
- There are expanding opportunities for drinking water companies, especially those with an established presence;
- Recent outcalls in Shenzhen revealed an apparent hurried implementation of new municipal water standards, making local companies rapidly search for technology to be able to comply with the standards; and
- China Everbright Water Group is an example of a company looking for new potable water solutions.

Transportation:

- In Guangdong, there is a growing desire to incorporate natural gas solutions in the transportation network and make it easier for local businesses to use this type of fuel;
- Discussions regarding using natural gas for public transportation and transport vehicles all over Guangdong are emerging, along with a desire to build infrastructure to support this (fuelling stations along major highways); and
- There may also be an interest in using this type of fuel in cargo ships.

What must clean technology companies bear in mind when considering China as a market?

- Personal as well as financial resources will need to be invested over the medium to long term;
- Companies should be capable of doing business in Chinese. This can be through a trusted local partner, but ideally the company will have a Chinese-speaking executive or employee;
- Detailed Chinese-language promotional materials and case studies are required;
- Companies should have a clear business model in mind before approaching potential Chinese partners;
- Careful due diligence should be carried out on potential partners/clients before committing;
- Professional service providers can help with matters such as ensuring Internet Protocol is effectively protected;
- Companies should research the market, be knowledgeable of local requirements, propose solutions that are in line with local requirements, and have the flexibility to scale-up or modify technologies to suit the local context;
- Competition is fierce, therefore a foreign technology that is not clearly better than domestic alternatives already in use will not be considered;
- Part of understanding the market is knowing what solutions the local authority already has at its disposal;
- Canadian companies that present their technology without a detailed understanding of what is currently implemented risk being told that it doesn't differ markedly from what is already in use; and
- Canadian companies must be prepared to speak in detail about their value proposition in relation to what is currently deployed.

5.2 INDIA

The TCS has 17 officers covering sustainable technologies and infrastructure located in New Delhi, Ahmedabad, Bangalore, Chandigarh, Chennai, Hyderabad, Kolkata, and Mumbai. Educating TCS officers on company activities in a given region will enable them to be more focused in their efforts to support Canadian companies. Overall, India's policy environment focuses on economic development. For example, India's Make in India campaign is geared to attract foreign investors to set up manufacturing facilities in India.

Which companies (Canadian/Indian/international) present in India should be partners for clean technology companies?

Canadian companies currently in the Indian clean technology market operate across a range of subsectors including wastewater, renewable energy, energy efficiency, and smart grids. The following companies have offices and are active in India.

- Wastewater: Premier Tech Aqua, AWT Technologies, EnviroWay, Endetec (supply agreement with an Indian company), Napier-Reid Ltd., Eco-Tec, Ovivo India, RV Anderson Associates Ltd., Clearford Water Systems Inc., IBI Group Inc.;
- Solar: Canadian Solar, SkyPower Global Group, AMP Solar Group (joint venture with local company Sun Group), Morgan Solar Inc. (partnering with Forbes and Company Ltd.), Solantro Semiconductor Corp.;
- Hydrogen/fuel cells: Ballard Power Systems, Hydrogenics;
- Biofuel: NuLife Fuels, Biocube Corp.;
- Energy efficiency: Energy Advantage Inc.;
- Small hydro: P2 Solar, Inc. (no office but joint project), RSW International Ltd. (a division of a U.S. company); and
- Smart grids: eCamion, Inc., Corinex Communications Group, Vizimax Technologies, Awesens Inc. (all targeting), Survalent Technology Corp.

Which institutions are good partners for local demonstration?

Private as well as government organizations in India are interested in hosting demonstration pilots for clean technologies. The type of organization will depend on the technology interest.

For example, the Ministry of New and Renewable Energy (MNRE) (http://www.mnre.gov.in/) is the nodal ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the ministry is to develop and deploy new and renewable energy to address India's energy requirements. MNRE can provide up to 50% funding for demonstration of new technologies.

Private companies also offer their infrastructure support to test new technologies as part of joint collaboration efforts.

In regards to earlier-stage R&D, collaboration between IC-IMPACTS (http://www.ic-impacts.com) of Canada and the Department of Science and Technology (http://www.dst.gov.in) of India offers potential opportunities for research activities that might lead to technology commercialization. The Canadian International Innovation Program is another opportunity for research collaborations.

What possible changes in regulation do you foresee in energy efficiency, renewable energy, water, and other clean technology infrastructure?

Energy efficiency is one of the major programs in India and includes efficient lighting, efficiency standardization of electrical appliances, efficient buildings, commercial establishments, and energy efficiency in energy-intensive industries.

The emergence of privately operated energy service companies has been very slow but the Bureau of Energy Efficiency (https://beeindia.gov.in/), the nodal agency for energy efficiency under the Ministry of Power, has raised the idea of venture capital funds to promote energy efficiency. The recently formed, government-owned energy service company, Energy Efficiency Services Ltd (http://www.eeslindia.org), has been very successful in promoting LED lighting in the country.

India has already set ambitious targets for renewable energy such as solar, large wind, small hydro, and biomass. These technologies have a large private-sector presence. Technologies such as hydrogen/fuel cells, small wind, or hybrid technologies will require more government support to achieve full-scale commercialization.

What must clean technology companies bear in mind when considering India as a market?

- It is "long haul" in the Indian market;
- Local presence or representation is very important to understand the market and also to make progress on pursued projects;
- Since states have different policies for the same type of project, companies need to understand the policies and market structure very well to compete with others;
- Companies must also understand that India is a highly price-sensitive market; and
- There are opportunities for R&D collaborations to lead the way to commercialization.

5.3 INDONESIA

There are three TCS officers covering sustainable technologies and infrastructure in Indonesia. All are based in Jakarta. Indonesia is also one of seven Asian countries of focus for ODA for Canada. Federally, there are three goals for engagement in Asia, with clean technology being relevant to all three: building partnerships, providing development assistance, and strengthening economic engagement.[8] Clean technology companies with solutions that are relevant to development should engage with development officers from Global Affairs Canada.

It is important to note that Canadian companies should have strong local partners to jointly develop projects in advance of requests for proposals from local procurement agencies including IFIs.

Which Canadian/Indonesian/international companies present in Indonesia could be partners for clean technology companies?

Companies that could be partners for clean technology companies in Indonesia include divisions of multinational enterprises, state-owned enterprises/utilities, and Indonesian corporations:

- Medco Power Indonesia;
- Indika Energy;
- Sintesa Group;

- PT Adaro Energy Tbk;
- Vale Canada Ltd.;
- Sinar Mas Group;
- Indonesia Power;
- Perusahaan Listrik Negara; and
- State-owned enterprises in electricity distribution.

As well, Econoler, Inc., a Quebec company, has just won an Asian Development Bank contract on energy efficiency and may provide helpful guidance to other companies wishing to engage in Indonesia via the ADB.

Which institutions are good partners for local demonstration?

As is the case in other Asian markets, establishing local demonstrations provides foundations for longer-term business opportunities. Potential partners for local demonstrations include the following:

- Agency for Assessment and Application of Technology (BPPT);
- Ministry of Research and Technology;
- Ministry of Energy and Mineral Resources;
- Directorate General of New, Renewable Energy and Energy Efficiency; and
- Medco Power Indonesia.

The Ministry of Energy and Mineral Resources announced during ADB's Asia Clean Energy Forum that it will set up the Bali Clean Energy Centre of Excellence. Should this plan go ahead, the Centre will be a good option for local demonstration. Medco Power and Bandung Institute of Technology have already set up a research centre for leading-edge energy generation.

What possible changes in regulation do you foresee in energy efficiency, renewable energy, water, and other clean technology infrastructure?

- The Government of Indonesia is very enthusiastic about increasing the private sector's participation rate in implementing renewable energy;
- The TCS expects more incentives/policies that favour the private sector for developing local renewable energy projects. For example: the government is continuously reviewing the feed-in tariff for geothermal, hydro, biomass, and solar based on input from the private sector; and
- Regarding energy efficiency, although it is a subsector that presents huge opportunities, a lot of capacity building is still needed in the industry and the financial sector to develop energy efficiency projects.

What must clean technology companies bear in mind when considering Indonesia as a market?

- Because Indonesia is an ODA-eligible country, clean energy sectors in Indonesia are dominated by international donor programs. The following are examples:

- Denmark provides technical assistance for implementation of energy efficiency through the Ministry of Energy and Mineral Resources;
- Austria has signed an MoU with PLN to develop hydropower projects;
- Germany provides technical assistance for rural electrification using renewable energy through the German International Development Agency (GIZ); and
- Through the United States Agency for International Development's (USAID) Indonesia Clean Energy Development II (ICED II) program, the U.S. is supporting Indonesia's efforts to transition toward a low-carbon energy path through the five-year (2015-2020) project, a continuation of the ICED Project, which occurred from March 2011 to February 2015.

There are many similar programs offered by other countries. Participating in these programs is one option to enter the market. Companies should be prepared to come with complete financing packages.

5.4 JAPAN

There are four TCS officers covering sustainable technologies and infrastructure in Japan. Following the Fukushima disaster, Japan's first energy strategy makes significant mention of hydrogen as a possible baseload power source. Engaging with Japanese corporations on business opportunities regarding hydrogen is a long-term process. In the shorter term, Atlantic Canada companies may wish to engage TCS officers in Japan to remain current on hydrogen-focused missions to Canada.

Notable activities in Japan

- Mitsubishi, Toyota Tsusho, and Kawasaki Heavy Industries plan large-scale visits to Canada on hydrogen research;
- Offshore wind power generation has become active through Marubeni, an offshore wind project company;
- Import of wood pellets from Canada has been increasing or stable due to application of feed-in tariffs (FIT) on biomass power generation;
- Trading houses are the major players;
- For the 2020 Winter Olympics in Tokyo, 6,000 hydrogen cars and 100 buses are scheduled to be in operation. Renewable energy will be the primary source used at the Olympians' village;
- There are four major smart cities in Japan (Yokohama, Kitakyushu, Keihanna-Kyoto, and Toyota);
- A number of smart towns (smaller scale than the smart cities) exist and they are mainly led by private firms such as Panasonic, NEC and Hitachi;
- The city of Kitakyushu has been focused on a number of projects: Smart City, Hydrogen Town, and G7 Energy Ministers' meetings; and
- In 2012, the Canadian company Hydrogenics signed an MoU with Iwatani Corp. to develop hydrogen energy for the Kitakyushu smart city project.

What possible changes in regulation do you foresee in energy efficiency, renewable energy, water, and other clean technology infrastructure?

- Electricity deregulation will take place in 2016 and more than 700 new distributors are registered. It is difficult to see foreign companies' involvement. There is a list of new applicants for electricity distribution on the Ministry of Economy, Trade and Industry (METI) website (Japanese only: http://www.enecho.meti.go.jp/category/electricity_and_gas/electric/summary/operators_list/);
- Gas deregulation will take place in 2017 (see http://asia.nikkei.com/Politics-Economy/Policy-Politics/Bill-offers-Japanese-consumers-new-choices);
- METI's energy mix target in 2030 is renewable energy up to 24% and nuclear up to 22% (see http://www.bloomberg.com/news/articles/2015-07-16/japan-confirms-nuclear-energy-to-supply-a-fifth-of-power-by-2030);
- Renewable energy feed-in tariffs are reviewed every year: they are 30% down on Photovoltaic (PV) from the initial rate in 2012, and the government is trying to promote other renewable energy sources (see FIT 2015: http://www.meti.go.jp/english/press/2015/0319_01.html).

Other matters that are of possible interest to Canadian firms

- New Energy and Industrial Technology Development Organization's (NEDO) Solar project in Oshawa under the Ontario Green Energy Act (2009) demonstrated NEDO's interest in FIT programs as a channel for Japanese companies;
- The Sendai Nuclear plant was reactivated on August 11, 2015, after two years of no nuclear energy generation in Japan (the last nuclear power plant was shut down in September 2013); and
- Two more nuclear plants passed the test for reactivation and are likely to be in operation in the near future.

5.5 SOUTH KOREA

There are three TCS officers who cover sustainable technologies and infrastructure in South Korea. South Korea and Canada have entered into a free-trade agreement. In the bilateral initiatives to realize deeper trade between South Korea and Canada, clean technology was identified as one of two priority sectors (along with food). There are longstanding educational ties between South Korea and Canada. As a result, there are senior Korean business leaders who have had personal experience with higher education in Canada, either themselves or via family members.

Which Canadian/South Korean/international companies present in South Korea should be partners for Canadian clean technology companies?

- **Canadian**: Power Stream, ON (local distribution company signed a Memorandum of Agreement (MoA) with KEPCO on July 13, 2015, to create a joint micro-grid system demonstration project in Penetanguishene, ON);
- **Hydrogen**: Hydrogenics;
- **Energy storage**: Temporal Power; and
- **Water**: Trojan UV, Puretech.

Other potential partners include the following:

Korean conglomerates[9]**:** KC Cottrell Inc. (CCUS, waste-to-energy), POSCO Energy (energy storage, CCUS, and overall clean technology), POSCO ICT (smart grid, micro-grid – it is supplying its power control system to PS-KEPCO), Kolon Water and Energy Company, Ltd., Doosan Heavy Industries (desalination), Daesung Group, Hyundai Heavy Industries, LG Electronics/Chemicals/CNS (energy storage, micro-grid), Samsung Construction and Transportation.

Korean second layer of industry: Seoul has targeted medium-sized environmental engineering/consulting firms to develop relations with. These companies are often well connected and eager to do business.

Multinational enterprises present in South Korea: Schneider Electric, Veolia Environnement S.A., General Electric, Siemens, ABB Group.

Which institutions would be good partners for local demonstration?

- Korea Power Engineering Company (KEPCO) (smart grid, micro-grid, CCUS);
- Korea Institute of Energy Research;
- Korea Institute of Energy Technology Evaluation and Planning;
- Korea Institute of Science and Technology (fuel cell);
- Korea Water Resources Corporation (K-Water) (water);
- Korea Environmental Corporation;
- Sudokwon Landfill Corporation;
- Korea Energy Management Corporation;
- Korea Gas Corporation (fuel cell, power to gas);
- Korea Hydro and Nuclear Power (nuclear);
- Korea Atomic Energy Research Institute; and
- Municipal and state governments

What possible changes in regulation do you foresee in energy efficiency, renewable energy, water, and other clean technology infrastructure?

The TCS does not foresee much change in regulation. However, the Korean government is leaning toward building two more nuclear reactors in Korea, adding to the nine reactors already planned, to meet the recent commitment of reducing greenhouse gases by 37% by 2030 versus business as usual. Local criticism is that the government opts for a "convenient" solution rather than investing in renewable energy and energy efficiencies.

Renewable energy targets were introduced to the Korean market in 2010, and implementation is on track to meet the goal set for 2020.

What must clean technology companies bear in mind when considering South Korea as a market?

- Face-to-face meetings are still valued highly in Korea. Visits are encouraged;
- Nova Scotia Premier Stephen McNeil visited Korea in 2014 and 2015. In both

cases, no private companies were involved. Nova Scotia companies should be encouraged to discuss their interest in the South Korea market with legislators so as to encourage inclusion of private-sector firms in future visits. It helps to open doors when political figures lead such missions;

- Consider speaking with Korean companies already in Canada, such as DSTN (DSME Trenton), which is manufacturing wind turbines in Trenton, NS. The entity is a joint venture between DSME and the Nova Scotia government. To improve business, DSTN is now looking at opportunities outside Canada, including Cuba, where Canada has been quite active;
- The Canada-Korea science, technology, and innovation agreement will be finalized and signed soon. Canadian companies are encouraged to utilize the agreement. There will be funding to support initiatives from the private sector;
- Attend major trade events in Canada, Korea, and third countries. TCS in Seoul can help with initial introductions and matchmaking. Examples of good venues to meet Korean companies include the Smart Grid Canada Conference and GLOBE 2016; and Some Canadian companies have experience/market knowledge in markets targeted by Korean firms. More and more Korean firms are going global and targeting North and South America as well as Africa, where Canadian companies may already have good country/market knowledge.

6 OPPORTUNITIES TO ACCELERATE GROWTH

Opportunities to accelerate the growth of the clean technology industry in Atlantic Canada are manifold. Below are presented a number of short-term initiatives that could help grow the Atlantic clean technology sector presence within Asian markets.

1. Facilitate engagement between clean technology SMEs and the TCS network in Asia

Personal engagement ranks highest for making connections. To capitalize on this, ACOA could organize a "mission" of Atlantic Canada clean technology company leaders to travel to Ottawa to meet with both Asia- and Canada-based TCS officers, when they meet in Ottawa for their annual professional development. This would provide an opportunity for Atlantic Canada firms to interact with TCS officers, a cost-effective way for an in-person exchange between companies with an interest in Asia and TCS officers with deep understanding of multiple Asian markets. Deliverables could include completed company and desired partner profiles, and maps of current Canadian presence as potential partners for Atlantic Canada firms (Canadian firms helping Canadian firms). A pilot is underway whereby a group of clean technology companies developing business in China is working intensively with the TCS, and Atlantic Canada companies should be aware of this if China is a priority market.

2. Refine competitive intelligence by partnering with the TCS to benchmark best practices for competitive approaches

Following engagement between TCS officers and Atlantic Canada clean technology firms, engage with TCS officers in target countries to understand the role in-country industry associations and other public-private entities play regarding state-sponsored priorities such as development of regulation, deployment of demonstration projects, and other areas of potential collaboration. There may be opportunities to have professional associations with strong membership in Atlantic Canada lead the development of relationships with counterparts in Asia or to have non-competing companies work with a mentor who is knowledgeable in a given market to learn from each other as they develop go-to-market strategies.

3. Engage with Natural Resources Canada to open a channel between Atlantic Canada and Chinese academies of environmental sciences

In China, the academies play a pivotal role in translating government priorities into action plans via demonstration projects and policy development. Shanghai Academy of Environmental Sciences, the Institute of Soil Science, Nanjing Institute for Environmental Sciences, the South China Institute of Environmental Sciences, and Guangzhou Research Institute of Environmental Protection are examples of such institutions. Establishing a partnership with a Chinese academy of science is a multi-year commitment that will require management and planning resources. Focus will be important. An Atlantic Canada regulator or an academic entity could establish a relationship with one of these entities in partnership with a federal entity such as Natural Resources Canada or Environment Canada. Co-ordination is key in China as

Chinese entities will look for confirmation from Beijing before they engage with potential Canadian partners.

4. Open a channel between Atlantic Canada and Asian utilities

Utilities in Asian markets such as China and South Korea have demonstrated capacity for engagement with utilities from mature energy markets. Huaneng Group (China) is engaged with Southern Company (US) on coal-based generation. KEPCO (South Korea) is engaged with Powerstream (ON). Atlantic Canada utilities have knowledge of dam safety and operations, which is an area of interest for China's largest utility. Indonesian utilities may be open to similar engagement. Clean technology companies such as CarbonCure and Green Power Labs have value propositions that solve problems for utilities regarding CCUS and integration of renewable energy into the grid. They could follow on Canadian utilities engaged with Asian utilities. Atlantic Canada governments can engage with utilities to explore the degree to which utilities have an interest in exploring Asian markets via consulting services.

5. Open a channel between FORCE and Asian utilities and tidal energy research institutes

This could be used to bring Atlantic Canadian expertise to Asia and Asian research institutions to Atlantic Canada. For example, utilities located on coastlines such as in all coastal Asian markets have shown an interest in tidal energy. Ocean monitoring and tidal energy are of interest in the coastal cities of Zhanjiang (1,000 kilometres of coastline) and Shantou (400 kilometres of coastline) in Guangzhou province. There is an opportunity in this interest via FORCE. In addition, because FORCE is home to a number of original equipment manufacturers (OEMs) that are developing tidal power technologies, cultivating relationships with Asian counterparts, such as the Huaneng Clean Energy Research Institute, could help foster opportunities for those OEMs as well as Atlantic Canadian firms that are building expertise in supplying goods and services to the tidal power sector. It could also provide an opportunity for Asian institutes to test their technologies at FORCE.

6. Fund energy efficiency, tidal energy, carbon, or water technical experts to work within key project origination entities such as the Asian Development Bank

Many projects funded by the ADB for borrowing members are shaped with the help of technical expertise from the bank. Canada has yet to second technical experts to any IFI. Atlantic Canada could build on its long tradition in energy efficiency by seconding an expert to the ADB. Such an expert could connect with engineering, procurement and construction firms that are prime contractors for the ADB and, with in-country ADB staff, are responsible for technical-capacity-building projects.[10]

7. Establish funds for feasibility studies and demonstrations

Whereas some countries including the United States have established strong ties to markets such as China via industry associations, others have put financing programs in place to fund feasibility studies and demonstration projects. This is a productive strategy wherever business requires in-country proof of a technology. In China, local demonstrations are required before a technology can be more broadly deployed. This is the case regardless of how often the technology has been deployed outside of China. In

Guangzhou, a U.K. company is deploying a plasma gasification demonstration project that is financed via the Guangzhou/Manchester sister-city alliance.

Benchmark what other OECD countries have done in emerging markets such as Indonesia. For many years, German companies have had access to funding for feasibility studies via KfW Development Bank's Climate Readiness Fund and are familiar to experts providing technical capacity building via the GIZ, which provides international development assistance much as the former Canadian International Development Agency did. Funds received from feasibility study financing vehicles may be refundable by a project proponent if a project feasibility study leads to a successful bankable project. Making funding refundable ensures programs can be evergreen.

8. Introduce Atlantic Canada companies with solutions to development challenges to firms leading international development projects

Other countries with industrial profiles similar to Canada's are working toward a goal of building awareness among prime contractors of technology solutions providers. In Denmark, larger firms, be they engineering firms or multinationals, are brought together with smaller innovation-based firms under the banner of supply chain development with a focus on Asian export markets. Here in Canada, companies such as CoWater are successful prime contractors for international development projects. With industrial partners, Atlantic Canada can engage with prime contractors such as CoWater to ensure they are familiar with potential Atlantic Canada solutions.

In the future, funds may be available to explore the feasibility of exports via federal repayable grants to support SME engagement in emerging markets. Details for such programs have not been released. However, ACOA can play an active role in communicating program modalities should details be finalized and made public.

APPENDIX 1: DEFINITIONS OF ENVIRONMENTAL GOODS TRADE DATA

Estimating market opportunities for clean technology is challenging. For example, there are 64 subsectors underpinning the 10 sectors described in this report. Each of these subsectors has its own market dynamics regionally. There is currently no agreed-upon way to track exports for the industry. As a result, clean technology exports are embedded in multiple national account classes, including machinery. However, this may change as a result of a World Trade Organization (WTO) Environmental Goods Agreement (EGA) initiative to gain consensus on which classes of exports should be included in the list of environmental goods tariffs that would be subject to tariff reduction by the countries participating in negotiations.

The following jurisdictions are engaged in the EGA: Australia, Canada, China, Chinese Taipei, Costa Rica, the European Union, Hong Kong, Iceland, Israel, Japan, New Zealand, Norway, Singapore, South Korea, Switzerland, Turkey, and the United States. The participants are now working actively in the plurilateral WTO negotiation process seeking tariff elimination for environmental goods in categories such as renewable energy, air pollution control (including CO_2 capture), energy efficiency technology, environmental monitoring and analysis, as well as water treatment and wastewater management. Of the 660 goods submitted in the EGA process, 450 were selected for consideration during negotiations.

Of these 450 export classes selected for future negotiations, at least 138 are for goods produced by the Canadian clean technology sector. These goods include wind turbines, energy efficiency components, solar panels, batteries, and water treatment components. Some of the remaining classes refer to byproducts or outputs of industrial and extractive processes that are used as inputs to other processes rather than released into the environment. Examples of these input products include slag, dross, parings, and scrap from extractive and commodity industries.

In order to provide an understanding of Asian demand for clean technology, we have separated the manufactured environmental goods (138 classes aligned with the Canadian clean technology industry) from those that are byproducts and inputs for industrial and extractive processes (the remaining classes of goods). According to these definitions, in 2013 Canada exported US$12B of goods under the 138 clean-technology-related goods. To put this in the context of our existing national accounts, Canada's exports of clean technology are on par with exports of mineral products, livestock, and prepared foodstuff.

To make the results easier to interpret, we have segmented these 138 classes into four categories grouping together two to three segments of the 10-sector taxonomy described above.[11]

1. Industrial and extractive processes, which encompasses product, industrial and extractive processes and products;
2. Water, which includes water and wastewater;
3. Renewable energy/power generation, which encompasses power generation and smart grid/energy infrastructure; and
4. Energy efficiency, which includes energy efficiency/green building.

The current trade activity for each of the countries in Asia is assessed using these four indexes.

APPENDIX 2: RECENT TRADE ACTIVITY FOR ENVIRONMENTAL GOODS WORLDWIDE, IN ASIA AND IN CANADA

WORLDWIDE

There has been recent acceleration in the growth of investment worldwide for goods import in the sector of industrial and extractive processes, despite its overall smaller size. Water and wastewater goods imports are growing faster worldwide than those in renewables/power generation goods and energy efficiency.

Industrial and extractive processes

- 2014 world imports: US$109B
- 2014 world exports: US$127B
- Four-year imports CAGR (2010-2014): 0.9%
- Two-year imports CAGR (2012-2014): 7.0%

Water and wastewater

- 2014 world imports: US$261B
- 2014 world exports: US$295B
- Four-year imports CAGR (2010-2014): 8.0%
- Two-year imports CAGR (2012-2014): 9.6%

Renewables/power generation

- 2014 world imports: US$508B
- 2014 world exports: US$570B
- Four-year imports CAGR (2010-2014): 4.0%
- Two-year imports CAGR (2012-2014): 6.2%

Energy efficiency

- 2014 world imports: US$595B
- 2014 world exports: US$588B
- Four-year imports CAGR (2010-2014): 6.4%
- Two-year imports CAGR (2012-2014): 4.8%

CHINA

- 2014 China GDP: US$10,380B
- 2014 China GDP growth rate: 7.4%

Compared to the world as a whole, China saw growth in imports across most sectors for the period from 2012 to 2014. This growth was most apparent in the renewables/power generation sector, where China had a 12.2% CAGR for 2012 to 2014, compared to the world CAGR of 6.2%.

China is a mature net exporter across every sector except energy efficiency, where it is still emerging, with imports valued at US$90B and making up almost 1% of GDP for 2014.

Water and wastewater imports have accelerated since 2012 with a 2012-2014 CAGR of 9.8%.

China was investing in industrial and extractive processes at a steady rate until 2011, but this declined significantly in 2012 and 2013, with 2009 levels of imports only re-gained in 2014, as shown by the 2012-2014 CAGR of 8.4%. This recent acceleration is evidence of positive policy change.

China continues to invest heavily in renewables/power generation, with 2014 imports valued at US$58B. This segment has seen huge import growth since 2005, with only a brief dip in 2012 and 2013. Exports in the sector accounted for 1.19% of GDP for 2014 and 0.55% of GDP for imports.

Industrial and extractive processes

- 2014 China imports: US$13B
- 2014 China exports: US$16B
- 2014 balance of trade: US$3B
- Imports as a percentage of GDP: 0.12%
- Exports as a percentage of GDP: 0.15%
- Four-year imports CAGR (2010-2014): -3.0%
- Two-year imports CAGR (2012-2014): 8.4%

Water and wastewater

- 2014 China imports: US$21B
- 2014 China exports: US$43B
- 2014 balance of trade: US$22B
- Imports as a percentage of GDP: 0.19%
- Exports as a percentage of GDP: 0.40%
- Four-year imports CAGR (2010-2014): 5.7%
- Two-year imports CAGR (2012-2014): 9.8%

Renewables/power generation

- 2014 China imports: US$58B
- 2014 China exports: US$124B
- 2014 balance of trade: US$66B
- Imports as a percentage of GDP: 0.55%
- Exports as a percentage of GDP: 1.19%
- Four-year imports CAGR (2010-2014): 3.6%
- Two-year imports CAGR (2012-2014): 12.2%

Energy efficiency

- 2014 China imports: US$90B
- 2014 China exports: US$44B
- 2014 balance of trade: -US$46B
- Imports as a percentage of GDP: 0.86%
- Exports as a percentage of GDP: 0.42%
- Four-year imports CAGR (2010-2014): 5.4%
- Two-year imports CAGR (2012-2014): 3.4%

JAPAN

- 2014 Japan GDP: US$4,616B
- 2014 Japan GDP growth rate: 1.3%

Renewables/power generation is the largest import market of the four for Japan, with a 2014 import market of US$26B and a 2012-2014 CAGR of a remarkable 23.1%. Imports and exports in this sector each account for half a percentage point of GDP for 2014.

Japan is a mature net exporter in energy efficiency, water and wastewater, and renewables/power generation, but its market in industrial and extractive processes is still emerging and Japan is a net importer. Japan is the only country profiled in this report that is a net exporter within the energy efficiency sector.

Investments in industrial and extractive processes, on the other hand, have slowed, with a 2012-2014 CAGR of -3.1%.

Water and wastewater continues to be an area of slow but steady growth for Japan, with 2014 imports valued at US$8B.

Imports in the energy efficiency sector experienced a significant drop during 2009 and 2010. After peaking in 2011, they fell again slightly, only regaining ground in 2014, when imports for the sector were valued at US$21.7B.

Industrial and extractive processes

- 2014 Japan imports: US$3B
- 2014 Japan exports: US$7B
- 2014 balance of trade: US$4B
- Imports as a percentage of GDP: 0.06%
- Exports as a percentage of GDP: 0.16%
- Four-year imports CAGR (2010-2014): -1.2%
- Two-year imports CAGR (2012-2014): -3.1%

Water and wastewater

- 2014 Japan imports: US$8B
- 2014 Japan exports: US$14B
- 2014 balance of trade: US$6B
- Imports as a percentage of GDP: 0.17%
- Exports as a percentage of GDP: 0.31%
- Four-year imports CAGR (2010/2014): 8.6%
- Two-year imports CAGR (2012/2014): 6.4%

Renewables/power generation

- 2014 Japan imports: US$26B
- 2014 Japan exports: US$32B
- 2014 balance of trade: US$6B
- Imports as a percentage of GDP: 0.55%
- Exports as a percentage of GDP: 0.69%
- Four-year imports CAGR (2010-2014): 14.7%
- Two-year imports CAGR (2012-2014): 23.1%

Energy efficiency

- 2014 Japan imports: US$21.8B
- 2014 Japan exports: US$44.8B
- 2014 balance of trade: US$23B
- Imports as a percentage of GDP: 0.47%
- Exports as a percentage of GDP: 0.97%
- Four-year imports CAGR (2010-2014): 5.1%
- Two-year imports CAGR (2012-2014): 5.4%

SOUTH KOREA

- 2014 South Korea GDP: US$1,417B
- 2014 South Korea GDP growth rate: 3.5%

Investment in renewables/power generation grew steadily until a peak in 2013, declining slightly in 2014. Still, it is a large market for South Korea, which is an established net exporter, with imports valued at US$17B for 2014 and a balance of trade of US$2B. Imports and exports each accounted for over 1% of GDP in this sector during 2014.

Despite South Korea being an emerging market, as a net importer in the sector, growth in water and wastewater imports has taken off since 2011, with a 2012-2014 CAGR of 13.3%.

The industrial and extractive processes sector is a smaller import market for South Korea, and it has remained fairly steady, with slight growth in the last few years.

In the energy efficiency sector, South Korea experienced a significant drop in imports during 2009. However the country's 2014 imports as a percentage of 2014 GDP is an impressive 1.89%, and South Korea is an emerging market in the sector, as a net importer.

Industrial and extractive processes

- 2014 South Korea imports: US$4.2B
- 2014 South Korea exports: US$4.5B
- 2014 balance of trade: US$0.3B
- Imports as a percentage of GDP: 0.29%
- Exports as a percentage of GDP: 0.31%
- Four-year imports CAGR (2010-2014): 0.1%
- Two-year imports CAGR (2012-2014): 6.8%

Water and wastewater

- 2014 South Korea imports: US$9B
- 2014 South Korea exports: US$8.7B
- 2014 balance of trade: -US$0.03B
- Imports as a percentage of GDP: 0.61%
- Exports as a percentage of GDP: 0.60%
- Four-year imports CAGR (2010-2014): 8.2%
- Two-year imports CAGR (2012-2014): 13.3%

Renewables/power generation

- 2014 South Korea imports: US$17B
- 2014 South Korea exports: US$19B
- 2014 balance of trade: US$2B
- Imports as a percentage of GDP: 1.22%

- Exports as a percentage of GDP: 1.35%
- Four-year imports CAGR (2010-2014): 4.0%
- Two-year imports CAGR (2012-2014): 1.4%

Energy efficiency

- 2014 South Korea imports: US$27B
- 2014 South Korea exports: US$17B
- 2014 balance of trade: -US$10B
- Imports as a percentage of GDP: 1.89%
- Exports as a percentage of GDP: 1.17%
- Four-year imports CAGR (2010-2014): 5.4%
- Two-year imports CAGR (2012-2014): 3.0%

INDIA

- 2014 India GDP: US$2,050B
- 2014 India GDP growth rate: 7.4%

India is a net importer across all four sectors, representing an emerging market opportunity. Growth has taken off in this sector since 2010, with a brief dip in 2013. The rate of growth has slowed for imports across all four sectors in the last two years, most dramatically in energy efficiency, where it fell from a 2010-2014 CAGR of 12.1% to a 2012/2014 CAGR of -0.8%.

India's investment in renewables/power generation has been unpredictable, with two major peaks in investment, around 2008 and 2011. Imports have declined in this sector in the last two years, with the 2012-2014 CAGR being -0.1%.

While still an emerging market for India, as net importers, energy efficiency represents a significant sector for India, with imports valued at US$18.2B in 2014 (almost 1% of GDP), which makes it India's highest of the four sectors.

Industrial and extractive processes

- 2014 India imports: US$2B
- 2014 India exports: US$1B
- 2014 balance of trade: -US$1B
- Imports as a percentage of GDP: 0.11%
- Exports as a percentage of GDP: 0.04%
- Four-year imports CAGR (2010-2014): 10.4%
- Two-year imports CAGR (2012-2014): 4.8%

Water and wastewater

- 2014 India imports: US$4.3B
- 2014 India exports: US$3.5B
- 2014 balance of trade: -US$0.8B

- Imports as a percentage of GDP: 0.20%
- Exports as a percentage of GDP: 0.17%
- Four-year imports CAGR (2010-2014): 7.7%
- Two-year imports CAGR (2012-2014): 1.2%

Renewables/power generation

- 2014 India imports: US$7B
- 2014 India exports: US$5B
- 2014 balance of trade: -US$2B
- Imports as a percentage of GDP: 0.34%
- Exports as a percentage of GDP: 0.23%
- Four-year imports CAGR (2010-2014): 6.6%
- Two-year imports CAGR (2012-2014): -0.1%

Energy efficiency

- 2014 India imports: US$18.2B
- 2014 India exports: US$5.3B
- 2014 balance of trade: -US$12.9B
- Imports as a percentage of GDP: 0.88%
- Exports as a percentage of GDP: 0.25%
- Four-year imports CAGR (2010-2014): 12.1%
- Two-year imports CAGR (2012-2014): -0.8%

INDONESIA

- 2014 Indonesia GDP: US$888.5B
- 2014 Indonesia GDP growth rate: 5.2%

Since 2007, Indonesia has dramatically increased investments in most sectors but remains a net importer across all four, representing an emerging market opportunity.

Investments in renewables/power generation peaked in 2012, fell slightly in 2013, and have returned to US$4.7B for 2014. The four-year CAGR (2010-2014) for this sector is 6.9%. Imports in the sector account for 0.51% of GDP.

Industrial and extractive processes is still a small import market for Indonesia, with a 2014 value of just over US$1B, and a CAGR showing negative growth in the last two years.

Indonesia has had slow but steady growth in the energy efficiency sector since 2005, with a minor drop during 2009. Imports were valued at US$7.1B for 2014, which represents almost 1% of GDP.

Indonesia is focused on investments in the water and wastewater sector, which continues to grow steadily, with a CAGR of over 11%.

Industrial and extractive processes

- 2014 Indonesia imports: US$1.3B
- 2014 Indonesia exports: US$0.3B
- 2014 balance of trade: -US$1B
- Imports as a percentage of GDP: 0.13%
- Exports as a percentage of GDP: 0.03%
- Four-year imports CAGR (2010-2014): 3.2%
- Two-year imports CAGR (2012-2014): -6.2%

Water and wastewater

- 2014 Indonesia imports: US$3.4B
- 2014 Indonesia exports: US$0.7B
- 2014 balance of trade: -US$2.7B
- Imports as a percentage of GDP: 0.37%
- Exports as a percentage of GDP: 0.07%
- Four-year imports CAGR (2010-2014): 11.7%
- Two-year imports CAGR (2012-2014): 11.1%

Renewables/power generation

- 2014 Indonesia imports: US$4.7B
- 2014 Indonesia exports: US$2.5B
- 2014 balance of trade: -US$2.2B
- Imports as a percentage of GDP: 0.51%
- Exports as a percentage of GDP: 0.26%
- Four-year imports CAGR (2010-2014): 6.9%
- Two-year imports CAGR (2012-2014): -0.5%

Energy efficiency

- 2014 Indonesia imports: US$7.1B
- 2014 Indonesia exports: US$3.6B
- 2014 balance of trade: -US$3.5B
- Imports as a percentage of GDP: 0.79%
- Exports as a percentage of GDP: 0.40%
- Four-year imports CAGR (2010-2014): 9.8%
- Two-year imports CAGR (2012-2014): 5.7%

CANADA

- 2014 Canada GDP: US$1,789B
- 2014 Canada GDP growth rate: 2.3%

Canada is a net importer across all four sectors, representing an emerging market opportunity.

The import market for renewables/power generation is strong in Canada, with 2014 imports valued at US$17B, and a 2012-2014 CAGR of 9.9%. The sector's imports made up almost 1% of 2014 GDP.

Industrial and extractive processes has also had strong, steady growth of about 8%, however it represents a smaller market overall, reaching US$3B in 2014.

The growth in investment in water and wastewater has slowed down slightly, with the two-year CAGR falling to 6% from the four-year 8.8%. Imports in the sector account for over half a percentage point of the 2014 GDP.

Canada experienced two peaks in importing within the energy efficiency sector, first in 2008, then in 2011. We are close to regaining the 2011 import value, with 2014 imports valued at US$16.3B for the sector.

Both imports and exports in energy efficiency make up nearly 1% of 2014 GDP each, showing their relative importance, despite Canada's status as a net importer.

Industrial and extractive processes

- 2014 Canada imports: US$3.4B
- 2014 Canada exports: US$1.7B
- 2014 balance of trade: -US$1.7B
- Imports as a percentage of GDP: 0.19%
- Exports as a percentage of GDP: 0.09%
- Four-year imports CAGR (2010-2014): 7.8%
- Two-year imports CAGR (2012-2014): 8.4%

Water and wastewater

- 2014 Canada imports: US$10B
- 2014 Canada exports: US$5B
- 2014 balance of trade: -US$5B
- Imports as a percentage of GDP: 0.56%
- Exports as a percentage of GDP: 0.25%
- Four-year imports CAGR (2010-2014): 8.8%
- Two-year imports CAGR (2012-2014): 6.0%

Renewables/power generation

- 2014 Canada imports: US$17B
- 2014 Canada exports: US$7B
- 2014 balance of trade: -US$10B
- Imports as a percentage of GDP: 0.92%
- Exports as a percentage of GDP: 0.39%
- Four-year imports CAGR (2010-2014): 8.4%
- Two-year imports CAGR (2012-2014): 9.9%

Energy efficiency

- 2014 Canada imports: US$16.3B
- 2014 Canada exports: US$14.5B
- 2014 balance of trade: -US$1.8B
- Imports as a percentage of GDP: 0.91%
- Exports as a percentage of GDP: 0.81%
- Four-year imports CAGR (2010-2014): 3.5%
- Two-year imports CAGR (2012-2014): 1.4%

APPENDIX 3: CANADIAN TRADE COMMISSIONER SERVICE OFFICERS COVERING CLEAN TECHNOLOGY IN ASIA

CHINA

Sustainable Technologies

Ms. Helen Bao · Embassy of Canada to China, Beijing
Mr. Wesley Wei · Consulate General of Canada, Chongqing
Ms. Stacy Xiao · Embassy of Canada to China, Beijing
Ms. Claire Zhang · Consulate General of Canada, Shanghai
Ms. Rita Zhang · Consulate General of Canada, Guangzhou

Infrastructure*

Ms. Helen Bao · Embassy of Canada to China, Beijing
Ms. Xukun Cassie Cai · Embassy of Canada to China, Beijing
Ms. Melanie Klingbeil · Embassy of Canada to China, Beijing
Mr. Zhichao (Frank) Li · Consulate General of Canada, Shanghai
Mr. Duane Robson · Consulate General of Canada, Guangzhou
Mr. Jason Walsh · Consulate General of Canada, Shanghai
Ms. Rita Zhang · Consulate General of Canada, Guangzhou

HONG KONG, SAR

Sustainable Technologies

Ms. Fatima Lai · Consulate General of Canada, Hong Kong

Infrastructure*

Ms. Fatima Lai · Consulate General of Canada, Hong Kong

TAIWAN

Sustainable Technologies

Ms. Vanessa Chen · Canadian Trade Office, Taipei
Mr. Tom Cumming · Canadian Trade Office, Taipei
Ms. Angela Lu · Canadian Trade Office, Taipei

Infrastructure*

Ms. Venus Chen · Canadian Trade Office, Taipei
Mr. Tom Cumming · Canadian Trade Office, Taipei
Ms. Angela Lu · Canadian Trade Office, Taipei

INDIA

Sustainable Technologies

Mrs. Yasmine Dubash · Consulate General of Canada, Mumbai
Mr. Arjun Kumar Dutta · Canadian Trade Office, Kolkata
Mr. Stanley Gomes · Canadian Trade Office, Bangalore
Mr. Saroj Mishra · High Commission of Canada to India, New Delhi
Mr. Deepak Murthy · Canadian Trade Office, Bangalore
Mr. Joachim Savio Rocha · Canadian Trade Office, Ahmedabad
Mr. Gurbans Sobti · Consulate General of Canada, Chandigarh
Ms. Subha Sundarajan · Trade Office of Canada, Chennai

Infrastructure*

Mr. Arjun Kumar Dutta · Canadian Trade Office, Kolkata
Mr. Vikram Jain · Canadian Trade Office, Hyderabad
Ms. Nicole Lunstead · High Commission of Canada to India, New Delhi
Mr. Kapil Malhotra · Canadian Trade Office, Bangalore
Mr. Kishor Mundargi · Consulate General of Canada, Mumbai
Ms. Shriya Ramachandran · High Commission of Canada to India, New Delhi
Mr. Joachim Savio Rocha · Canadian Trade Office, Ahmedabad
Mr. Gurbans Sobti · Consulate General of Canada, Chandigarh
Ms. Subha Sundarajan · Trade Office of Canada, Chennai

INDONESIA

Sustainable Technologies

Ms. Dian Martosoebroto · Embassy of Canada to Indonesia, Jakarta

Infrastructure*

Ms. Dian Martosoebroto · Embassy of Canada to Indonesia, Jakarta
Mr. Ross Miller · Embassy of Canada to Indonesia, Jakarta

JAPAN

Sustainable Technologies

Mr. Koji Fujii · Canadian Government Trade Office, Kitakyushu
Ms. Sanae Yonemichi · Embassy of Canada to Japan, Tokyo

Infrastructure*

Mr. Thomas Abols · Embassy of Canada to Japan, Tokyo
Mr. Akira Kajita · Embassy of Canada to Japan, Tokyo

SOUTH KOREA

Sustainable Technologies

Ms. Hyun Ju Lim · Embassy of Canada to the Republic of Korea, Seoul

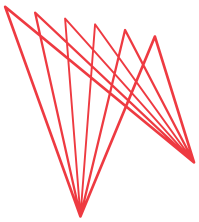
Infrastructure*

Mr. Young Jin Kim · Embassy of Canada to the Republic of Korea, Seoul
Ms. Hyun-Mi Park · Embassy of Canada to the Republic of Korea, Seoul

** Depending on the post, some Trade Commissioner officers covering infrastructure will have responsibility for smart grid and green building sectors.*

ENDNOTES

1. Analytica Advisors Inc., 111 Russell Avenue, Ottawa, Ontario, K1N7X2.
2. Analytica Advisors. 2011, 2013, 2014 and 2015 Canadian Clean Technology Industry Report. Ottawa.
3. While clean technology may have referred to renewable energy in its earlier days, Canadian firms are developing technological solutions to challenges throughout the energy, water and food nexus.
4. Analytica Advisors. 2011 Canadian Clean Technology Industry Report. Ottawa.
5. Analytica Advisors. 2015 Canadian Clean Technology Industry Report. Ottawa.
6. This report uses definitions for the stage of commercialization of Canadian-owned companies in the clean technology industry adopted by the Canadian Clean Technology Report series.
7. Efforts are underway at the World Trade Organization to establish consensus on a list of environmental goods that would be subject to zero tariffs.
8. For further descriptions of federal government policy, refer to http://www.international.gc.ca/asia_pacific-asie_pacifique/index.aspx?lang=eng
9. Korean conglomerates are referred to as "chaebols." The word is derived from "chae," meaning wealth or property, and "bol," meaning faction or clan.
10. Global engineering firms such as DNV-GL (Norway) are engaged as prime contractors and in channels that provide them with visibility to technology providers. See the ADB's Low Carbon Technology Market Place: http://ipexcleantech.com/.
11. For completion, there are an additional 125 non-manufactured environmental goods or inputs that are not referred to here. Made up of global commodities within the current national accounts taxonomy, Canada's exports of these environmental goods such as slag, dross, scrap, and other residual products may be accounted for within the US$13B of minerals and US$17B of pulp, among others.



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