



EIGHT REASONS FOR CANADA TO BUILD A CLEAN ECONOMY NOW

DECEMBER 2019



**Smart Prosperity
Institute**

About Smart Prosperity Institute

Smart Prosperity Institute (formerly Sustainable Prosperity) is a national research network and policy think tank based at the University of Ottawa. We deliver world-class research and work with public and private partners – all to advance practical policies and market solutions for a stronger, cleaner economy.

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INTRODUCTION

The world is facing unprecedented environmental challenges characterized by climate change, unsustainable resource use, biodiversity loss, water scarcity and waste production. These challenges are further exacerbated by population growth and urbanization. There is a growing global recognition of the urgency of these problems, and the mounting demand for solutions has created an economic opportunity for the countries and companies that are able and willing to develop them.

This is the clean economy opportunity.

Canada's transition to a clean economy aims to harness this global shift and to capture the opportunities that a cleaner, more innovative global economy presents for all Canada's economic sectors — from clean technology and manufacturing to resources and agriculture. This report outlines eight reasons why accelerating that transition is the path to prosperity for Canada.

#1 Global market opportunities and jobs in the clean economy are growing fast.

In response to mounting environmental pressures, the demand for products and processes with a lighter environmental footprint is expected to continue to grow rapidly. These trends can be seen in the fast-growing markets for renewable energy, zero-emission vehicles, energy efficiency, water treatment and sustainable agricultural solutions. For instance, the global cleantech sector is on pace to surpass US\$2.5 trillion and renewable electricity capacity is forecast to grow by over 40% from 2017 to 2022. These trends present opportunities throughout the economy. For example, the global market potential for bioproducts is expected to exceed US\$500 billion in the coming years, opening new opportunities for Canada's forest sector. Overall, generating low-carbon solutions is projected to be a massive source of wealth and jobs across all parts of the economy, worth US\$26 trillion and creating 65 million new jobs by 2030*.

* Global Commission on the Economy and Climate, 2018. *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times*. Available at: <http://www.camecon.com/wp-content/uploads/2018/10/2020-11-03-NCE-2018-Technical-Modelling.pdf>

#2 **Canada is well positioned for success in many sectors.**

Canada has many of the ingredients needed to succeed in capturing a significant share of these growing global markets: strong education, research capacity and entrepreneurship. Combined with high levels of expertise in many of the sectors seeking clean technology solutions – including electricity, oil and gas, mining, forestry, manufacturing, information and communications technology, agriculture, finance and construction – Canadians have enormous potential to develop and export the cleaner technologies, products and services that are increasingly in demand globally.

#3 **More efficient use of resources lowers costs.**

By doing more with less, we can help save businesses, households and governments money while reducing vulnerability to commodity price fluctuations and resource scarcity. Energy efficiency investments alone have the potential to boost global economic output by US\$18 billion through 2035. Over time, investing in more efficient use of resources is likely to improve economic growth and competitiveness through cost savings and the creation of new business opportunities like using waste products from forestry for bio-based fuels and chemicals.

#4 **Strong environmental performance is becoming a competitive advantage.**

For many businesses, environmental performance is becoming a core part of competing in an increasingly globalized, low-carbon world. Consumers increasingly prefer environmentally-friendly products and make purchasing decisions based on rising concerns over environmental impacts. A survey found that 70% of CEOs feel that corporate responsibility will be core to everything they do within five years. Well-designed environmental regulations can also drive innovation within businesses, improve productivity and business performance, and attract investment.

#5 **Unleashing clean innovation can cut costs.**

Clean innovation is critical not only to help Canada meet its international environmental commitments, but also to reduce the cost of achieving them. Innovation in solar photovoltaic technology, for example, has reduced costs by 70% in the last 10 years while installed capacity has grown by more than 45 times. Clean innovation can also help businesses attract capital, increase competitiveness and reduce financial risks. Two major market failures

(knowledge spillovers and environmental externalities) as well as other market barriers mean that public policy needs to play an important role in accelerating clean innovation.

#6 **Climate-proofing investments improves resilience.**

Climate change and other environmental pressures pose not only major physical risks (like floods and fires), but also growing financial risks. The federal government spent more on recovering from large-scale natural disasters in the last six years than the previous 40 years combined. Increasingly, investors and insurers are insisting that environmental risks be tracked, publicly reported, and reflected in business plans. By taking steps to better address and prepare for environmental risks, Canadian businesses can improve their resilience and reduce their financial risks.

#7 **Conserving and protecting natural capital is critical to growth.**

Canada's economy relies on our vast natural capital, whether it is natural resources extracted from the ground such as oil or potash, industries that rely on healthy ecosystems such as agriculture and fisheries, or tourism and recreational industries that depend on Canada's natural beauty. This natural capital also underpins much of our economy through unseen (and often unaccounted for) ecosystem services. The global cost of ecosystem degradation is projected to increase to US\$28 trillion per year by 2050. Protecting and sustainably managing Canada's natural capital is integral to supporting the economy and can create significant savings by avoiding the need to restore destroyed, degraded and contaminated resources.

#8 **A clean economy improves health and quality of life.**

In addition to the economic and environmental benefits, seizing the clean growth opportunity can improve health and quality of life as well. It is estimated that the impacts of pollution on the health and well-being of Canadians amount to *at least* \$39 billion per year through healthcare costs, crop damage, and clean-up costs. By reducing pollution in our air and waterways, or reducing congestion on our streets, we can lessen these often-overlooked costs. At the same time, we can improve the quality of life for Canadians, while making Canada a more desirable destination for foreign businesses and talent.

#1 GLOBAL MARKET OPPORTUNITIES ARE GROWING

Environmental pressures are driving demand for solutions

In China, air pollution is causing as many as 4,000 premature deaths every day.¹ The cost of supplying water in water-scarce Singapore has doubled in 15 years.² Population density in Bangladesh has grown from 381 people per square kilometre in 1961 to 1265 people in 2017, with little land left to support agriculture.³ Around the world, climate change, resource depletion and other environmental pressures are causing health emergencies and hurting economic potential.

As governments and companies seek answers to these challenges, the market opportunities for those that develop solutions are growing.

Canada needs to embrace those opportunities and help its companies and entrepreneurs supply the solutions the world needs.

Markets for clean technologies are expanding rapidly

These environmental pressures — as well as government policies to address them — are creating market opportunities. There is growing demand across the economy for technological solutions that can produce the products and services people want, while reducing environmental impacts. Overall, generating low-carbon solutions is projected to be a massive source of wealth and jobs across all parts of the economy, worth US\$26 trillion and 65 million new jobs by 2030. The global cleantech market is projected to grow to US\$2.5 trillion by 2022 (larger than Canada's annual GDP), more than doubling in market size from 2015.⁴ And the opportunities extend beyond pure-play clean technology. McKinsey estimates that improvements in

resource efficiency — by reducing material waste in production processes transporting goods more efficiently, boosting energy efficiency in buildings, and improving water efficiency in irrigation systems — could represent a \$3.6 trillion global economic opportunity by 2030.⁵



US\$26 trillion: Global market for clean solutions by 2030



65 million: New jobs from clean solutions by 2030*

While demand for low-carbon technologies is projected to double by 2030 in Canada alone⁶, the enormity of the global demand means outsized rewards for companies that can supply those needs.

The first section of this report examines six of the many Canadian sectors that stand to win big in the global clean economy: renewable energy, transportation, energy efficiency, agriculture and food, water and wastewater, and waste and recycling.

1. Renewable Energy

Energy generated from the sun, wind, water and earth offers the opportunity to produce renewable electricity and heat that is virtually free of greenhouse gas emissions or air pollutants. While 20 years ago it may have seemed too expensive or intermittent to be a real solution, technological advancements and cost reductions have made it the go-to energy choice today. In 2017, renewables represented more than two-thirds of new global electricity capacity added.⁷

* Global Commission on the Economy and Climate, 2018. *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times*. Available at: <http://www.camecon.com/wp-content/uploads/2018/10/2020-11-03-NCE-2018-Technical-Modelling.pdf>

Going forward, renewable electricity is expected to continue to expand. Between 2017 and 2023, global renewable electricity capacity is forecast to grow by over 40%, reaching 30% of total global power generation.⁹ Bioenergy and hydropower remain the dominant sources, but wind and solar are expected to accelerate and represent more than 50% of new capacity.¹⁰ China is a major part of both the supply and demand of this growth, representing more than half of global solar photovoltaic (PV) growth and roughly 60% of solar cell manufacturing capacity.¹¹ By 2040, an estimated US\$10.2 trillion will be invested in new power generation capacity globally, with 72% spent on renewables.¹² If countries move towards a path consistent with global climate change goals, a further US\$5.3 trillion of investment in zero-emission electricity will be needed.¹³

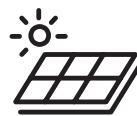
In many places, the cost of renewable energy has fallen below that of gas and coal generation.¹⁵ The affordability of renewable electricity is also expected to continue to improve over time, making it an even more attractive option. Solar PV costs have fallen by more than 70% between 2010 and 2019 and forecasts suggest a further 66% decline in their cost by 2040.¹⁶ Wind energy is expected to experience a cost decline of 47% for onshore generation and 71% for offshore generation by 2040.¹⁷ Alberta's 2017 renewable auction, for example, generated a record-setting median price of 3.7 cents per kWh for 600MW of wind energy over 20 years, the lowest price for electricity in Canada at that time.¹⁸ Renewables are also expanding to commercial, residential and industrial heating, with expected capacity growth of 20% by 2023, representing more than one third of new heat supply.¹⁹

Between 2017 and 2023, global renewable electricity capacity is forecast to grow by over 40%, reaching 30% of total global power generation

The rapid transition to renewable electricity is also increasing demand for technological and service solutions. Grid operators are looking for storage, batteries, and software to optimize distribution.²⁰ Software companies are increasingly offering products to help utilities integrate distributed and intermittent generation and manage distributed storage, with some incorporating the Internet of Things to gather real-time data on performance.²¹ Maintenance services for renewable energy are expected to grow along with generation. By 2022 the annual wind turbine maintenance market is estimated to reach almost US\$ 19 billion.²²



84%: Estimated increase in renewable electricity produced in Mexico by 2050



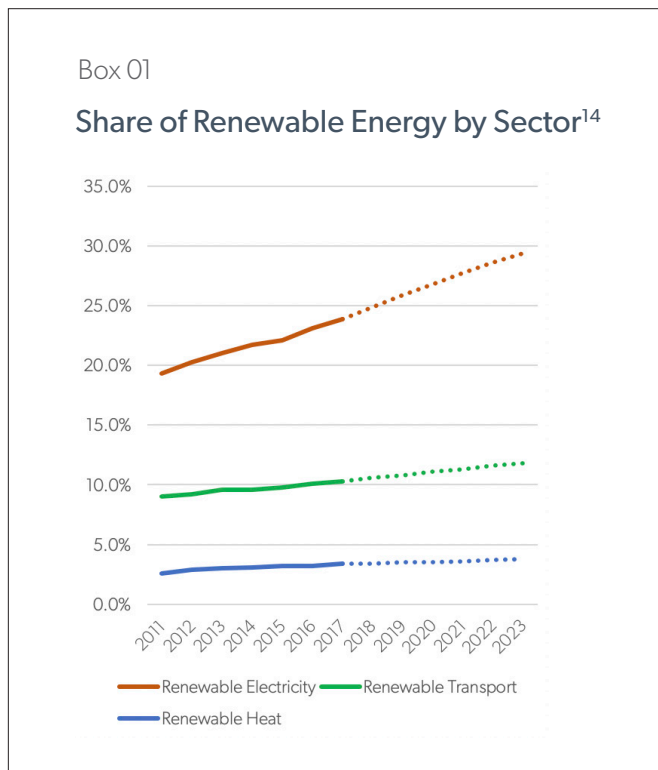
8X: Growth in China's wind and solar capacity by 2040



150%: Increase in renewable capacity in India 2017-2023



10X: Increase in EU investment in renewables from 2017-2040⁸



Electricity generation is also shifting to be more distributed, digital, and flexible.²³ Electricity can be generated on rooftops of businesses or houses, on vehicles, phones or even windows. Developing and emerging economies seeking to improve access to electricity are increasingly looking to off-grid solar and solar-plus-storage systems rather than make major investments in large centralized generation with power lines.²⁴



2. Transportation

Electric and alternative-fuel vehicles combined with ride-hailing, car sharing, autonomous vehicles and other innovations are revolutionizing transportation around the world, offering a significant opportunity to reduce greenhouse gas and air pollutant emissions. Ride-hailing and car sharing services have already taken hold, with the market projected to reach US\$218 billion by 2025. This could help reduce household greenhouse gas (GHG) emissions – particularly as fleets become electric and autonomous.²⁵ By 2040, more than half of new car sales and one third of the global car fleet are projected to be electric.²⁶

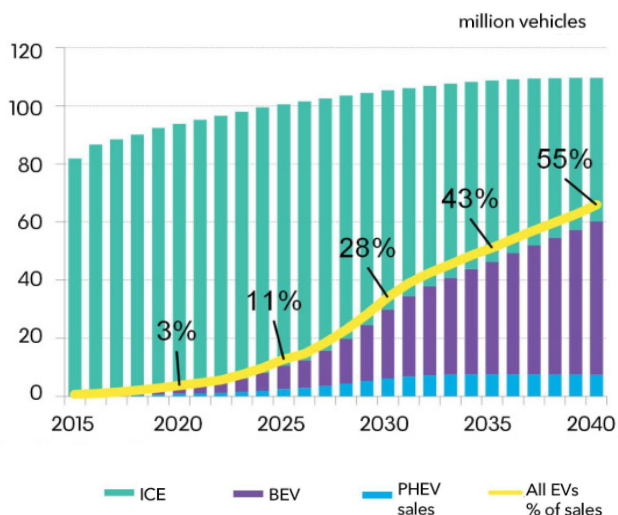
Large corporations around the world are investing in electric vehicles and supporting technologies. Demand for lithium-ion batteries and charging infrastructure is also increasing.²⁷ Shell, an oil and gas company, has announced plans to roll out electric vehicle charging stations at traditional gas and diesel stations, starting in Europe.²⁹

China has leapt into the EV market as a way to reduce its air pollution, limit reliance on foreign vehicles (and oil), and stimulate domestic car manufacturers, accounting for more than half of global EV sales in 2017.³⁰ More than 200 Chinese companies have announced plans to manufacture electric vehicles, and there are already more than 21 million public electric vehicle charging stations in China.³¹ Moreover, China has joined Norway, the UK, France, India, British Columbia and others in announcing that they will ban the sale of combustion engine vehicles, with most jurisdictions phasing-out sales between 2030 and 2040.³² In 2019, the federal government followed suit, setting 2040 as a voluntary target for 100% EV sales and announcing a suite of incentives to spur adoption.³³

While much of the focus to date has been on passenger vehicles, innovation is poised to revolutionize other forms of transportation as well. After 2025, electric vehicle demand is expected to expand across numerous vehicle classes — including pick-up trucks — as battery costs fall.³⁴ Battery electric vehicles will overtake plug-in hybrids in the market due to both cost and complexity. In early 2019, Ford announced the electrification of their F-series trucks, the best-selling vehicle in Canada.³⁵ Tesla’s electric semi-truck is winning over skeptics, as a cheaper alternative to diesel trucking with savings on fuel repair, and maintenance. Other manufacturers such as VW and Volvo are entering the heavy duty truck market.³⁶ Wrightspeed from California is working on turbine-electric powertrains for garbage trucks.³⁷ There is also a growing trend toward electrified public transportation, including buses. Metro Vancouver’s transit operator Translink has set a 100% renewable energy

Box 02

Electric Vehicles are Forecast to Account for over Half of Global Light Vehicle Sales by 2040²⁸



Source: Bloomberg New Energy Finance

target by 2050 and acquired their first all-electric bus in 2019.³⁸ Norway is pioneering the use of all-electric ferries that reduce GHG emissions by 95% and costs by 80% using energy storage technology developed by Vancouver-based Corvus Energy.³⁹ Aviation and shipping are making slower gains, with exploration of low-carbon fuels, improved efficiencies and possible electrification.

This transition in transportation is opening new opportunities in services and software. Electric vehicle software is a growing market, and companies are developing new tools that could reduce traffic congestion (and pollution) such as Apps that help find a parking spot, or software that optimizes freight logistics or matches shippers with haulers.⁴⁰ Canada's BlackBerry, for example, signed a deal with Chinese internet search firm Baidu in January 2018 to jointly develop self-driving vehicle technology, in an effort to capture a major share of the growing market.⁴¹

3. Energy Efficiency

Energy efficiency opportunities are abundant across all sectors of the economy. Not only does energy efficiency help to reduce air pollutant and greenhouse gas emissions, it saves money. Households around the world on average saved between 20% of annual energy costs due to energy efficiency gains since 2000 and annual investment reached US\$236 billion in 2017.⁴² Energy efficiency technologies have the potential to save industry US\$600 billion a year.⁴³ Buildings accounted for nearly 60% of global investment, with a focus on appliances, lighting and the building envelopes that separate the conditioned and unconditioned portions of a structure.⁴⁴

[Energy efficiency] is the one energy resource that every country possesses in abundance and is the quickest and least costly way of addressing energy security, environmental and economic challenges.

– International Energy Agency

Connected devices that allow for energy savings through more accurate control of consumption are also booming. The market for machine-to-machine connected devices is expected to grow from around US\$6 billion in 2017 to nearly US\$15 billion in 2022.⁴⁵ The overall smart thermostat market including hardware and service is expected to grow from around US\$1 billion in 2016 to US\$4.4 billion by 2025, with leading players including U.S.-based Nest and Canada's Ecobee.⁴⁶ As Internet

of Things (IoT) technologies continue to grow, it will allow for the connection of millions of devices over long distances at low cost, and will be important to the next generation of smart grids, oilfields, cities and agriculture. Software to efficiently use the large amounts of data generated will also be increasingly in demand.⁴⁷

Significant potential for further energy efficiency gains remains, particularly in buildings and in emerging economies. Energy efficiency is becoming a commodity in itself in many countries, with tradeable certificates in France and Italy, as well as acceptance of electricity demand savings in electrical capacity auctions in the U.S.



US\$3.6 trillion: Resource and energy efficiency market by 2030



US\$674 billion: Wastewater treatment market by 2025



US\$310 billion: Sustainable packaging market by 2024

4. Agriculture and Food

Agriculture is going high-tech, offering new opportunities for clean technology and services that improve environmental performance and sustainability, while also offering cost savings and productivity improvements. From drones and imaging from space to the Internet of Things and biotech, agriculture is adopting new technologies at a fast pace. At the same time, there are trends towards regenerative agriculture and growing food on roofs, walls and in parking lots in urban areas. The food industry is also responding to shifts in consumer demand towards more organic and sustainable products, leading to innovations such as insect-based livestock feed and use of DNA barcoding.⁴⁹

Clean technology products and services in the agriculture and food sector raised over US\$12 billion in venture capital in 2018 compared to only around US\$500 million per year between 2010 and 2012.⁵⁰ Solutions are being developed to several environmental challenges in the sector from chemicals to fossil fuel and water use, including pesticide alternatives,

electrification of farm equipment, and micro-irrigation.⁵¹ The Internet of Things allows sensors to measure aspects such as soil conditions and crop growth, and satellite imagery helps farmers monitor fields and compare across seasons. These new technologies offer opportunities to improve both environmental and business performance.⁵³ The possibilities are endless in the food sector, with innovations in everything from meat alternatives to bio-based food flavouring.⁵⁴

5. Water and Wastewater

Growth in population, urban expansion, aging infrastructure, agricultural growth, efforts to improve access to clean water in developing and emerging economies, expanding environmental policies, water scarcity, and growing industrial activities are driving continued strong growth in investment in water and wastewater treatment and desalination. The markets for both water and wastewater treatment as well as desalination are expected to grow significantly between 2016 and 2025 (see graphs to the right).⁵⁵ While municipalities continue to be a strong segment of demand, water-intensive industries such as food and beverage, chemicals, pharmaceuticals, pulp and paper, power, metals and mining, semiconductors, textiles, and oil and gas are also driving growth.

Water management is increasingly going digital, with sensors in pipes that detect leaks, real-time water quality monitoring and sophisticated software to optimize decision-making. Consumers are also increasingly focused on reducing energy costs from water systems and water scarcity. This is driving increased interest in water reuse, as well as industrial and agricultural water efficiencies. At the household level, innovations are emerging such as closed-loop showering systems and UV water disinfection.⁵⁸

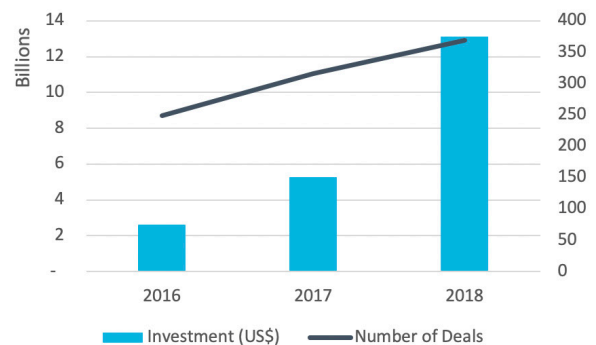
6. Waste and Recycling

While most of the economy continues to be based on a linear “take, make, and dispose” approach to material consumption, there are early signs of a shift towards a new circular paradigm that places a higher value on finite resources.* The circular economy model provides governments, businesses, and consumers with an approach to maximize value and eliminate waste. It does this by improving (and in some cases transforming) how goods and services are designed, manufactured and used (see SPI’s [Circular Economy Primer](#)).⁵⁹

*EMF. (2017) [Circular Economy Concept](#), Ellen MacArthur Foundation.

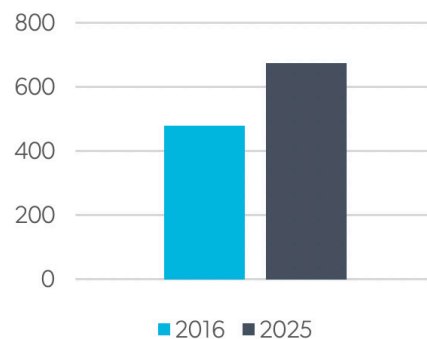
Box 03

Venture Capital Investment is Accelerating in Clean Technology for the Agriculture and Food Sector⁴⁸



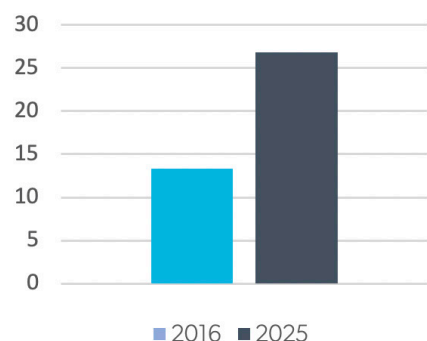
Box 04

Water/ Wastewater Treatment Market Size (US\$ Billions)⁵⁶



Box 05

Water desalination Market Size (US\$ Billions)⁵⁷



Waste is increasingly seen as a resource, for district heating, electricity, biogas, biofuel, biofertilizer and materials. Companies that find solutions to waste management challenges, profitable uses of waste streams, or ways to make or use materials more sustainably are poised to capture a share of this growing market, estimated to reach US\$530 billion by 2030, considering collection through to recycling.⁶⁰

A circular economy is one that recirculates materials using renewable energy. It does not deplete resources and can be perpetuated indefinitely, without any accumulation of waste (whether solid, liquid or gaseous) in the environment. A circular economy is characterized by a flow of materials in a closed loop. Value is returned into the cyclical, productive system, rather than wasted.

– Smart Prosperity Institute, [2019 report](#)

Companies are also working to make the waste system more efficient through analytics solutions, such as waste bin sensors and logistics software.⁶¹ Opportunities in the circular economy, such as re-use, re-manufacturing, refurbishment, and sustainable materials offer additional market potential. The sustainable packaging market alone is expected to grow from nearly US\$225 billion in 2018 to over US\$310 billion by 2024.⁶² Demand for limited resource stocks, such as metals, biomass, minerals, and other materials, is expected to grow from 50 billion tons in 2014 to 130 billion tons by 2050.⁶³ New materials for construction, plastics, and manufacturing are also developing, from concrete that sequesters carbon dioxide, to plastics made from methane, to light-weight nano-laminate metal for applications in energy, aerospace, vehicles and construction.⁶⁴ Emerging solutions that are able to improve current unsustainable waste patterns are poised to grow in this emerging market space.

Connecting Environmental and Economic Success

Countries around the world are enacting policies that accelerate the transition to a clean economy in order to capture a share of these growing markets. For instance, at this point in time 42 national jurisdictions and 25 subnational jurisdictions have implemented or are planning to implement carbon pricing policies, which incentivize low-carbon solutions.

This includes 7 of the 10 largest economies in the world.⁶⁵ Countries are demonstrating that decoupling greenhouse gas emissions from economic growth is feasible. Since 2005, more than 30 countries have reduced their annual GHG emissions while growing their economy.⁶⁶ In fact, decoupling at the global scale was proven to be possible in 2015 and 2016, when worldwide emissions fell and the global economy continued to grow (although emissions grew again in 2017 and 2018).⁶⁷

Box 06

Examples of Decoupling in Practice (2005-2016)⁶⁸

Country	% Change GHG Emissions	% Change GDP
Canada	-4%	20%
Japan	-5%	6.71%
Ireland	-11%	55%
EU	-18%	13%
New Zealand	-5%	30%
Sweden	-21%	24.13%
UK	-30%	15%
Ontario	-22%	16%

The same trends can be seen in Canada. After introducing a carbon tax in 2008, British Columbia has decreased GHG emissions 5-15% from what would otherwise have occurred, while GDP growth outpaced the rest of the country.⁶⁹ In 2017, the four Canadian provinces with comprehensive carbon pricing in place (Alberta, British Columbia, Ontario, and Quebec) also led the country in economic growth.

#2 CANADA IS WELL POSITIONED FOR SUCCESS IN MANY SECTORS

Canada has a strong foundation to build on

Canada has many of the ingredients needed to succeed in capturing a significant share of these growing global markets: strong education, research capacity and entrepreneurship. Combined with high levels of expertise in many of the sectors seeking clean technology solutions – including electricity, oil and gas, mining, forestry, manufacturing, ICT, agriculture, and buildings – Canadians have enormous potential to develop the cleaner technologies, products, and services that will increasingly be in demand. Additionally, Canada’s highly-regarded finance industry could have a key role to play, by providing innovative financial services to companies seeking to capture the emerging clean growth opportunities.

Canada has one of the most educated populations in the OECD, ranking highly in both educational attainment and student skills. Canada also provides the highest proportion of environment-related research and development spending amongst G7 countries.⁷⁰ In 2015, Canada was responsible for 1.78% of worldwide environment-related inventions, the 9th highest in the world.⁷¹ The number of environment-related patent applications from Canada has also increased significantly since 2000, particularly for environmental management technologies and energy-related climate change mitigation technologies.⁷² Canadian academics punch above their weight in clean technology-related research as well, publishing 1.5 times as much as the U.S., relative to size.⁷³ Canada is also among the most entrepreneurial countries in the G7, with more than 18% of the population engaged in early-stage entrepreneurial activity.⁷⁴

Further, in the past few years, Canadian governments (federal, provincial and municipal) have taken great strides to stimulate clean growth. They have brought in world-class climate policies, such as the phase-out of coal power in Ontario, electric vehicle

incentives, Alberta’s cap on oil sands emissions, B.C.’s innovative approach to building codes, and Canada-wide carbon pricing, that will stimulate strong Canadian demand for clean solutions. They have also boosted green infrastructure and procurement, cut taxes on low-carbon investment by firms, and greatly expanded public investment to help grow clean technology companies – with over \$2 billion in targeted federal funding for Sustainable Development Technology Canada (SDTC), Business Development Canada (BDC) and Export Development Canada (EDC), for example.⁷⁵



Box 07

Top 10 Countries for Environmentally-Related Invention⁷⁶

United States	24%
Japan	21%
Germany	12%
South Korea	9%
China	7%
France	5%
United Kingdom	4%
Italy	3%
Canada	2%
Netherlands	1%

% of worldwide environmentally related inventions, 2015

Canada’s clean energy economy is growing faster than the rest of the economy and creating jobs across every province.

These building blocks give Canada a head start over others in capturing the opportunities of the 21st-century clean economy.

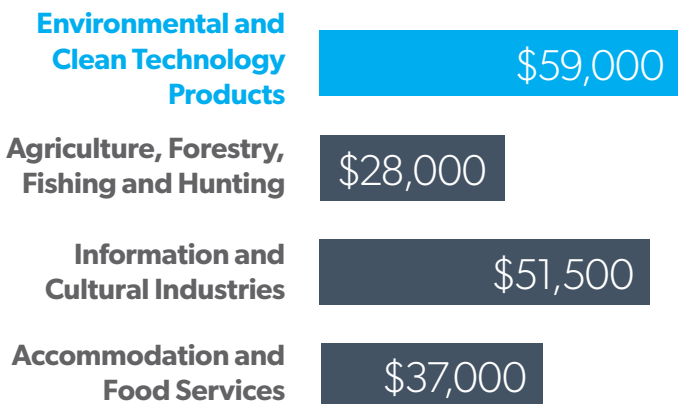
Yet Canada still has work to do to realize its potential. There is a need to strengthen domestic demand by expanding and strengthening both environmental policies and green procurement, building more private sector linkages with academic research, increasing the risk tolerance of innovation support programs, continuing to expand financing for companies to grow to scale in Canada, addressing skills gaps, and expanding international linkages to high potential export markets. The scale of opportunity is continuing to grow. By developing and producing the next generation of environmentally-friendly goods, services, and processes, Canada can drive future economic and job growth across the country. At the same time, this approach will develop technically feasible and affordable solutions to Canada’s environmental challenges that can be exported to the world.

Canada’s environmental and clean technology sector is big - and growing

Statistics are only starting to capture the breadth and depth of revenue, exports and employment generated from clean technologies. Statistics Canada developed an Environmental and Clean Technology Products Economic Account in 2017 showing GDP and employment for the sector.⁷⁸ In 2017, the sector accounted for 3.1% of Canada’s GDP, representing \$58.1 billion, which is larger than sectors such as agriculture, forestry, and fishing combined. It also accounted for about 1.9% of Canada’s exports and 1.5% of employment.⁷⁹ A recent report on the state of Canada’s clean energy economy found that it is growing faster than the rest of the economy and creating jobs across every province.* There are also tremendous opportunities (not captured in current data) for Canada’s traditional resource and manufacturing sectors in the global transition to clean growth – by being leaders in environmental performance, and providing the products and services needed for a low-carbon economy, such as key minerals for solar panels and electric vehicle batteries.

Box 08













Canada’s Environmental and Clean Technology Products Sector is a Substantial Contributor to GDP⁷⁷



Gross domestic product at basic prices

* <https://cleanenergycanada.org/report/missing-the-bigger-picture/>

Canadian Companies Listed in the Cleantech Group 2019 Global Cleantech 100 **

<p>Axine Water Technologies Vancouver, BC</p>  <p>Provides low-cost, chemical-free solution for treating high concentrations of complex, toxic organics and ammonia in industrial wastewater.</p>	<p>CarbonCure Technologies Dartmouth, NS</p>  <p>Retrofits concrete plants with a technology that recycles waste carbon dioxide to make affordable, greener concrete products.</p>	<p>Cooledge Lighting Richmond, BC</p>  <p>Provides adaptable LED lighting solutions to help the design industry integrate light into the built environment.</p>	<p>Ecobee Toronto, ON</p>  <p>Develops Wi-Fi-enabled smart thermostats for residential and commercial applications that are intuitive to use and maximize comfort and savings.</p>
<p>Enbala Toronto, ON</p>  <p>Provides distributed energy resources through a real-time energy-balancing and distributed control system to keep the grid balanced, while also creating a dispatchable load that can be bid into energy markets.</p>	<p>GaN Systems Ottawa, ON</p>  <p>Produces a range of gallium nitride power switching transistors (as a more efficient alternative to silicon) for consumer, datacenter, industrial and transportation markets.</p>	<p>Inventys Toronto, ON</p>  <p>Commercializes a low-cost and energy efficient technology for capturing post-combustion CO² from various sources, such as natural gas boilers, gas turbines, and industrial facilities.</p>	<p>Metamaterials Technologies Vancouver, BC</p>  <p>Develops smart materials and photonics to provide solutions in the field of optics for several industries, including aerospace and defence, healthcare, energy, education, and cleantech.</p>
<p>MineSense Technologies Vancouver, BC</p>  <p>Produces sensor technology for operational efficiency in the mining industry, helping to consolidate low concentration ores and reduce energy, water and chemical inputs.</p>	<p>Opus One Solutions Toronto, ON</p>  <p>Provides GridOS®, an intelligent data analytical platform for smart grids that delivers optimal energy planning and management to generate, distribute, store and consume energy in a distributed network.</p>	<p>Semios Technologies Vancouver, BC</p>  <p>Produces innovative agriculture technologies that include precision agriculture, biological pest control, and data management.</p>	<p>Terramera Vancouver, BC</p>  <p>Produces high-performance plant-based pesticide products for agriculture and consumer use.</p>

Canadian companies are already beginning to make waves. Canada ranked 4th on the 2017 Global Cleantech Innovation Index of countries set to produce the next generation of start-ups, with strong scores for emerging clean technology and early entrepreneurship.⁸⁰ The Cleantech Group included 12 Canadian firms in its 2019 list of the 100 companies most likely to make a significant market impact within the next five to ten years.⁸¹ Many of the companies poised for success have developed solutions for Canadian sectors that improve both profitability and environmental performance, and can generate exports.

Traditional resource sectors are getting in on the action

Canada is endowed with vast natural resources. And it is important to recognize that clean growth represents an opportunity not only for those sectors considered ‘cleantech’ (things like solar power, wind power and electric vehicles), but also for Canada’s traditional resource sectors. By finding more efficient, less-polluting ways of doing business, and producing the products needed for a greening global economy,

** Table adapted from the Government of Canada (2019) [Backgrounder: Canadian companies on the 2019 Global Cleantech 100 list](#).

Canadian resource companies can tap into growing global markets. Evidence of this trend can be seen across the Canadian economy, such as in mining, agriculture, and forestry.

1. Mining

Opportunities are increasing for Canada's mining sector as demand for clean technology grows. Wind turbines, solar cells, and high-density batteries all require minerals and metals — so lithium, graphite, rare earth elements, nickel, copper, and many others are in growing demand. Canada produces, or has the potential to produce, many of the minerals and metals needed for a cleaner economy — including 14 of the 19 metals and minerals used to make solar panels.⁸² Nemaska Lithium from Quebec, for example, made its first shipment of battery grade Lithium in December 2017 as part of its ground-breaking effort to mine one of the most significant spodumene lithium hard rock deposits in the world.⁸³ Canada is also home to more than half of the world's largest mining companies, and opportunities for investment are growing around the world.⁸⁴ Cobalt, for example, became the best performing commodity of 2017 as a result of growing demand for electric vehicles, leading Canadian mining companies such as Cruz Cobalt and Sherritt International to expand cobalt mining.⁸⁵



14 of the 19 metals and minerals needed for solar panels are found in Canada



US\$323 billion: Global market for organically-grown food by 2024

Vancouver-based Goldcorp (now merged with Newmont) is driving innovation in the mining industry, developing the world's first all-electric mine in Borden, Ontario, which is expected to save about \$9 million annually on diesel, propane, and electricity, and reduce the exposure of workers to air pollution.⁸⁶ MineSense Technologies, also from Vancouver, has developed another innovative solution, helping mines improve operational

efficiency while reducing energy, water, and chemical inputs. It uses innovative sensing technology to improve precision in mineral sorting has the ability to reduce costs and energy use, and improve the recovery and extraction of valuable minerals. This saves companies hundreds of millions of dollars over the life of a mine. The technology can also be used at the thousands of mine dumps around the world to recover valuable metals and reduce the risk of toxins leaching into groundwater.

2. Agriculture

In Agriculture, opportunities abound for resource and energy efficiency improvements, and the global market for organic food is expected to grow by 14%* to US\$323 billion by 2024.⁸⁷ Canada has significant potential to tap into this growth, as recognized by the Advisory Committee on Economic Growth, particularly given its global reputation for high-quality foods.⁸⁸

Increasing the farming area that produces organic products from the current 1.5% of agricultural land could have both environmental and economic benefits.⁸⁹ In 2017, Canadian organic retail sales were estimated at \$5.4 billion, with a variety of products, ranging from bulk grains to pre-packaged products.⁹⁰ The largest share of exports has gone to the United States, the European Union and Japan, with growth potential in a number of other countries.⁹¹

One example of agricultural clean innovation is Winnipeg-based Farmers Edge. The company was started in 2005 by two agronomists aiming to use technology to help farmers boost crop production, reduce waste, and improve environmental performance. The company has grown rapidly, and now has over 550 employees working with clients in Canada, the U.S., Brazil, Russia, and Australia. Unlike competitors, the company offers a fully integrated precision agriculture solution for farmers, with a combination of hardware, software, and service support.⁹² The solutions help to reduce energy use as well as inputs such as fertilizer and pesticides, saving the farmers money while reducing negative environmental impacts.

* Compound Annual Growth Rate (CAGR)



3. Forestry

With the largest forest trade balance in the world, Canada has a lot to gain from a flourishing forestry sector.⁹³ With the decline in demand for paper products, the Canadian forestry industry has had to innovate. This led to the emergence of a diversified bioproducts industry, such as the use of cellulosic waste to produce biofuels, textiles chemicals, and pharmaceuticals. The global market potential for bioproducts is expected to exceed US\$500 billion in the coming years, opening new opportunities for Canada's forest sector.⁹⁴ Forests can be a source of new materials, green chemicals, bioplastics and renewable energy. Bioproducts also help generate more value per tree while reducing waste.⁹⁵ Vancouver-based Canfor – a major world producer of lumber, pulp and paper – has emerged as a major producer of bioenergy, which it uses to power its operations, and an exporter of fuel pellets for biomass energy to customers in Europe, North America and Asia.⁹⁶



US\$500 billion: Global market potential for bioproducts in the coming years

Potential export markets for Canadian environmental solutions

The demand for products, technologies, and services that offer environmental solutions is growing in key export markets for Canada. Spurred by mounting environmental pressures and international agreements like the 2015 Paris Accord, almost all high-income countries are strengthening their climate and environmental policies, leading companies to seek innovative solutions. At the same time, emerging economies are increasingly looking to address the environmental consequences of rapid economic and population growth, and to leapfrog straight to environmentally-preferable choices such as solar electricity or sustainable transportation infrastructure.

The Conference Board of Canada prepared a list of “sweet spot” countries for Global Affairs Canada that have both high growth potential and high Canadian business potential. All of these countries also have clean growth opportunities.

Clean Growth Opportunities in Markets with High Growth Potential and High Canadian Business Potential⁹⁷

Chile
 \$940 million
 2018 Cdn
 Merchandise Exports



Export Opportunity

Clean agriculture technologies and services (e.g. lower pesticide use, greater water and energy efficiency)

Smart grids, water & wastewater technologies, public transit, green buildings, clean mining technologies, renewable energy, air pollution control, solid waste management and recycling.

Hungary
 \$84 million
 2018 Cdn
 Merchandise Exports



Export Opportunity

Electric vehicles and infrastructure, renewable energy, air pollution control, water and wastewater, solid waste management and recycling, smart grid, clean extractive sectors.

Indonesia
 \$2.1 billion
 2018 Cdn
 Merchandise Exports



Export Opportunity

Water and wastewater technologies, smart grids, renewable energy, fisheries management, biofuel processing, energy efficient technologies, clean oil and gas.

Kazakhstan
 \$90 million
 2018 Cdn
 Merchandise Exports



Export Opportunity

Clean extractive sectors (e.g. tailings management, water and energy efficient technologies).

Mexico
 \$7.8 billion
 2018 Cdn
 Merchandise Exports



Export Opportunity

Renewable energy, water and wastewater technologies, smart grid, clean agriculture technologies and services, clean extractives technologies and services, air pollution control, solid waste management and recycling.

Peru
 \$720 million
 2018 Cdn
 Merchandise Exports



Export Opportunity

Water and wastewater technologies, clean agriculture, clean extractives, renewable energy, smart grid, air pollution control, solid waste management and recycling.

South Korea
 \$5.79 billion
 2018 Cdn
 Merchandise Exports



Export Opportunity

Air pollution control, solid waste management and recycling, hazardous waste management, water and wastewater treatment, clean extractives technologies, sustainable forest products, organic food products, renewable energy, smart grid.

South Africa
 \$370 million
 2018 Cdn
 Merchandise Exports



Export Opportunity

Clean agriculture technologies, clean mining technologies, clean transportation technologies (e.g. public transit, pipelines, trucking, rail), renewable energy, smart grid, water and wastewater, solid waste management and recycling.

#3 MORE EFFICIENT USE OF RESOURCES LOWERS COSTS

By doing more with less, businesses, households and governments stand to save money while reducing vulnerability to commodity price fluctuations and resource scarcity. In the long run, investments in resource use efficiency are likely to improve economic growth and competitiveness through cost savings and the creation of new business models.

The International Energy Agency (IEA) estimates that energy efficiency investments alone have the potential to boost global cumulative economic output by US\$18 billion through 2035.⁹⁸ Existing and economically viable energy efficiency opportunities have the potential to contribute 40% of the required emissions reductions under the Paris Agreement. However, the bulk of this potential across transportation, buildings, industry and power generation sectors will be unrealized unless policies change to capture the opportunities.⁹⁹

With growing global water withdrawals and increasing scarcity, water-dependent sectors such as agriculture, extractive industries, power generation, pulp and paper, steel, chemicals, beverages, and tourism are increasingly vulnerable to water shortages and water price increases that will impact their business (even in Canada, in densely populated areas and some watersheds). Municipalities are also facing growing pressure to build or repair water treatment and distribution infrastructure in response to growing demand or deteriorating assets. For example, Halifax requires \$2.6 billion in repairs and upgrades to aging water and sewage pipes.¹⁰⁰ All of this creates a significant incentive to improve water use efficiency.



US\$1 trillion: Potential material cost savings per year of a circular approach by 2025

Growing demand for minerals, metals and other non-energy materials, combined with scarcity and commodity price vulnerability is also increasing interest in the [circular economy](#). In 2017, nearly 90 billion tons of material, metals and biomass were extracted from the Earth – three times more than in 1970. That amount stands to double again by 2050.¹⁰¹ A report by the World Economic Forum, the Ellen MacArthur Foundation and McKinsey showed potential material cost savings of a circular economy approach of over US\$1 trillion per year by 2025.¹⁰²

Businesses are increasingly seizing efficiency opportunities

Companies around the world are boosting their environmental credentials, reducing costs, and increasing resilience to resource prices and scarcity by improving resource use efficiency. Certificates for leading environmental management* were up more than 35% and adoption of energy management† practices increased almost 10 times over the last 6 years.¹⁰³ Industrial energy intensity has steadily declined since 1990.¹⁰⁴ However the pace of change needs to be accelerated, to meet the world's environmental challenges and capture growing market and financial opportunities.

Energy efficiency is a cost-effective option to help meet greenhouse gas emission targets, while reducing costs. Energy efficiency measures announced in the Pan-Canadian Framework on Clean Growth and Climate Change are expected to save consumers \$1.4 billion and save industry \$3.2 billion per year on energy expenditures.¹⁰⁵ Loblaw Companies Ltd, for example, sees energy efficiency as essential to meet its internal target of a 30% reduction in GHG emissions by 2030.¹⁰⁷ In 2016, Walmart saved nearly US\$ 1 billion by doubling the efficiency of its U.S. fleet.¹⁰⁷

* (ISO 14001)

† (ISO 5001)

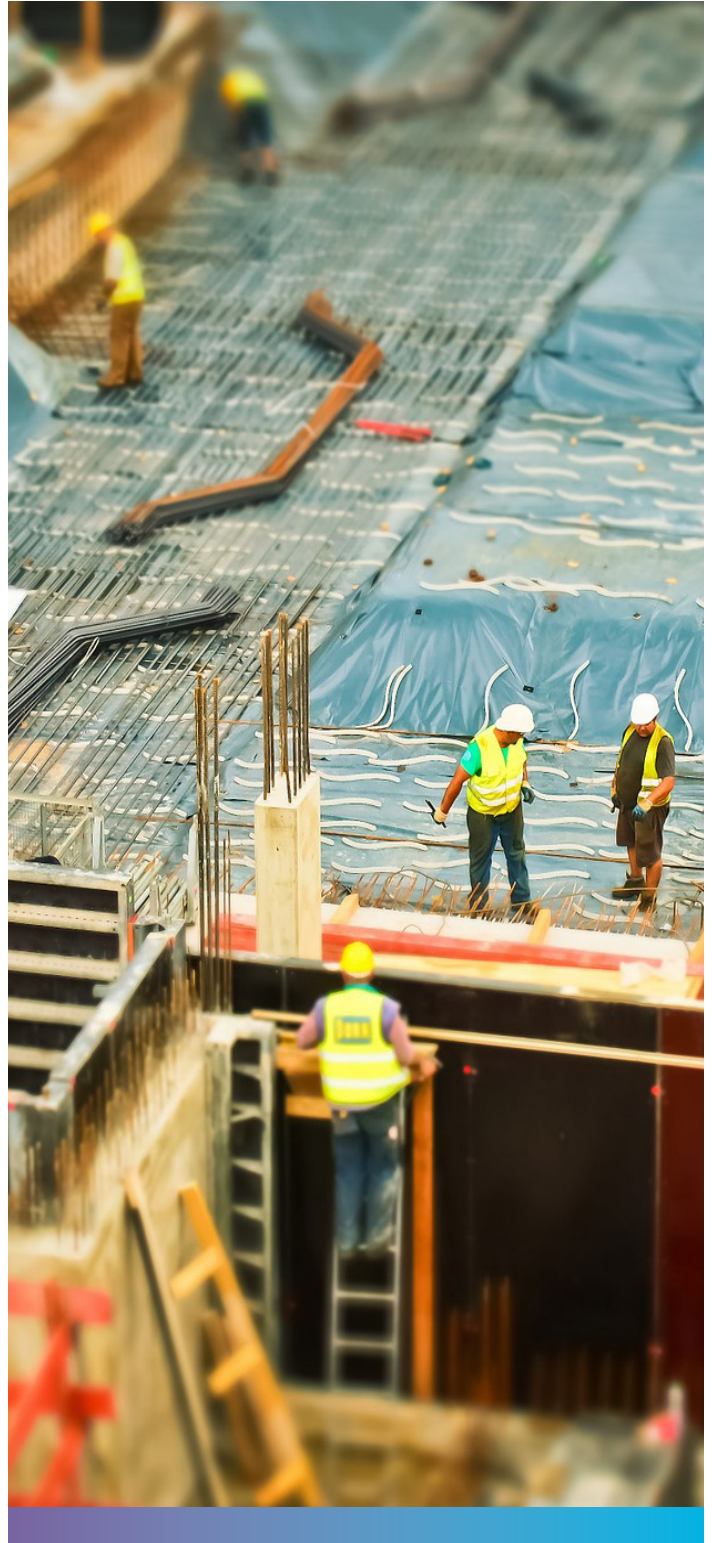
A growing number of companies are also pursuing water or waste efficiency, and achieving impressive results. For example, Ford achieved a 65% reduction in waste sent to landfill between 2011 and 2016, with all Canadian and Mexican manufacturers achieving zero waste-to-landfill status.¹⁰⁸

Despite progress being made, Canadian governments could do more to accelerate energy efficiency improvement. Supporting programs similar to those developed for energy efficiency could also help improve water and material efficiency, and move towards a circular economy. There is a lot to be learned from initiatives in other countries, and from innovative companies developing creative solutions.

Box 11

Canada's New Gold Inc. Leads the Way in Energy Management Excellence

Every year, the International Clean Energy Ministerial provides Energy Management Leadership Awards to the best examples of organizations implementing the ISO 50001 Energy Management Standard (first published in 2011). In 2016, Canada's New Gold Inc. won an award of excellence for its energy management leadership. The company's New Afton gold and copper mine in Kamloops, B.C. was the first in North America to implement the ISO 50001 standard. Facing low metal prices, and with energy as their second biggest expense after labour, the company decided to invest in maximizing energy savings. They improved their energy performance by over 11%, and cut GHGs by 2.7%, with a full-time Energy Specialist and employees helping to find a wide range of small and large opportunities. Rebates and incentives provided by BC Hydro also helped with energy studies and projects. The payback period for the initial investment was just over one year and the mine is saving over one million dollars annually in energy costs.



#4 STRONG ENVIRONMENTAL PERFORMANCE IS BECOMING A COMPETITIVE ADVANTAGE

Consumer demand is making environmental performance a core business strategy

For many Canadian businesses, environmental performance is no longer something that can be an afterthought. It is becoming a core part of competing in an increasingly globalized, low-carbon world with growing consumer preferences for environmentally-friendly products and rising community and investor concerns over environmental impacts.

What was once relegated to corporate social responsibility departments as a tangential “nice to have” activity is now becoming fundamental to business success and company brands. A global survey of CEOs found that 70% of CEOs felt that corporate responsibility will be core to everything they do within 5 years, driven by growing customer demands for relationships with organisations that have positive societal impacts and a desire to attract top talent that increasingly seeks out companies that share their values.¹¹² Almost 90% of the world’s biggest companies are now reporting on sustainability metrics.¹¹³

Company surveys done by CDP (formerly called the Carbon Disclosure Project) shows significant growth in the number of reporting companies offering low-carbon products and services (up 20% between 2016 and 2017) and companies saying that their products and services help others lower emissions (up 64% between 2016 and 2017). A growing number of firms are also setting their own internal carbon price (now at 32% of sample companies) to help drive internal change.¹¹⁴

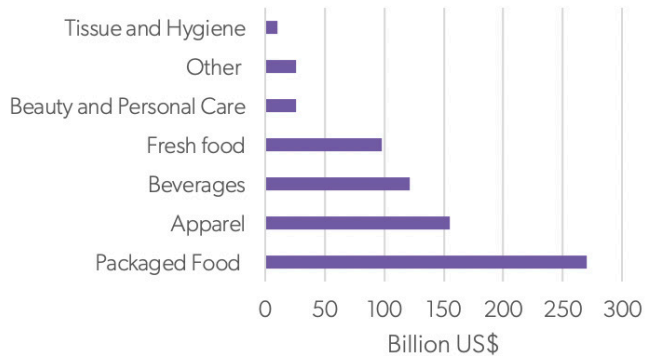
Box 12

Sustainability Can Help Market Access

The Forest Stewardship Council (FSC), founded in Toronto in 1993, represents the global standard for certification of sustainable forest management. Consumer demand for sustainable forest products grew and is now cited as the #1 reason for obtaining FSC certification.¹⁰⁹ FSC certified forests cover almost 200 million hectares worldwide, representing roughly 10% of global forest-based trade.¹¹⁰ The Canadian forestry industry was an early adopter and is now home to the largest area of third-party certified forest in the world.¹¹¹

Box 13

Potential Global Material Cost Savings per Year in Fast-Moving Consumer Goods¹¹⁵



Smart policy can attract investment and strengthen competitiveness

Not only can strong environmental performance boost appeal to consumers, but stringent environmental standards can also drive innovation and efficiency. Contrary to conventional arguments, environmental regulation need not reduce competitiveness. The idea that stringent, well-designed environmental policies will trigger innovation that reduces costs and may even improve overall productivity over time was introduced by Harvard Professor Michael Porter in 1991, and is known as the “Porter Hypothesis”. The concept is that environmental policy can: highlight resource inefficiencies and potential for technological improvement; generate greater corporate awareness; improve certainty on the value of investments; create pressure to motivate innovation and progress; and level the transitional playing field.

The Porter Hypothesis has generated a wealth of research, as well as debate. The evidence is fairly strong that stringent environmental regulations do lead to more innovation (referred to as the “weak” version of the Porter Hypothesis).¹¹⁶ The evidence is more mixed about whether they enhance overall business performance (referred to as the “strong” version of the Porter Hypothesis) – though more recent studies assessing modern environmental policies are increasingly supportive.¹¹⁷ For example, stringent environmental regulation on the Quebec manufacturing sector led to productivity increases over time that more than offset the initial costs.¹¹⁸

The net effects on productivity depend in large part on the nature of the environmental regulation (how it is designed) and the particular business and sector. In particular, most studies show that firms that are more *technologically advanced* and *globally competitive* are more likely to see productivity increases in the face of more stringent environmental policies, as they are likely better able to adapt.¹¹⁹

The challenge for governments is to select and design environmental policies and complementary measures that increase the likelihood of innovation and enhanced business performance, and therefore economic growth.

The goal of policy choice and design is to minimize negative impacts and maximize positive benefits. Fortunately, environmental policy has evolved significantly since the days of command and control regulations that dictated which technologies companies should use. It is no longer necessary to sacrifice stringency to prevent economic hardship. In fact, the policies most likely to induce cost-effective innovation are those that are *stringent, predictable, and flexible*, creating effective market incentives to improve environmental performance without slowing economic activity.¹²⁰

Market-based instruments such as cap and trade or eco-taxes are more likely to exhibit the attribute of flexibility (they do not specify where or how reductions must occur) and create cost-effective market incentives. The policies need to be carefully designed to also provide the stringency that drives innovation and the predictability that attracts longer-term investment.

Many studies show that there is generally a lag – often several years – between the introduction of stringent environmental regulations and the resulting cost savings from innovation.¹²² This has important implications for policy design. For example it suggests that, as firms adjust to new rules and invest in new technologies and processes, there may be a need for transitional support measures, such as tax incentives or free allocation of allowances (in cap & trade).

Environmental performance is increasingly a core element of business success¹²¹

Akzo Nobel (Dutch Multinational Chemicals Company):

committed to source 100% of energy from renewables by 2050, to get ahead of transition and develop new business opportunities.

Unilever (U.K. Multinational nutrition, personal care and hygiene company): “Sustainable Living” brands now represent half of total growth and are growing twice as fast as other brands.

Coca Cola (U.S. Multinational beverage company): Since 2015, it has been offsetting 100% of water used in beverages, returning it back to communities and nature through water efficiency and offset measures in order to secure community support and resilience against water scarcity.

Shell (British – Dutch Multinational oil and gas company): Set targets of cutting the carbon footprint of its energy products by 20% by 2035 and 50% by 2050, in part by doubling its investments in clean technology to \$4B per year after 2020.

Qantas (Australian airline): In January 2018, Qantas made the first biofuel powered flight from Los Angeles to Australia using fuel from a Canada-based agricultural-technology company, Agrisoma Biosciences. Qantas is working to advance biofuel use in aviation as part of efforts to reduce carbon emissions and improve fuel efficiency.

Siemens (German conglomerate industrial manufacturing company): Merged wind power business with Spanish wind company Gamesa to compete with top three global wind firms.

Caterpillar (U.S. manufacturer of heavy machinery): Expanded remanufacturing (where machinery and parts are repaired and upgraded vs. replaced) to increase profit margins.

Renault (French vehicle manufacturing company): Embraced circular economy, now generating EUR 0.5 billion per year from its recycling and manufacturing operations.

Loblaw Companies Ltd. (Canadian grocery chain): Committed to sourcing 100% of seafood products from Marine Stewardship Council certified fisheries.

General Motors (U.S. vehicle manufacturer): Plans to go all-electric, aiming to get ahead of where it believes the market is going.

#5 UNLEASHING CLEAN INNOVATION CAN CUT COSTS

Clean Innovation is needed to achieve Canada's goals at lowest cost

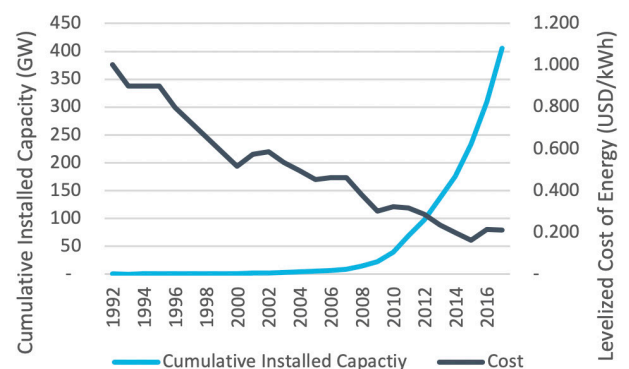
The Paris Agreement marks an unprecedented global commitment by governments to tackle climate change. It joins other pivotal agreements related to biodiversity loss, water security, air quality, and the Sustainable Development Goals, among others. These global environmental commitments also signal the growing economic imperative of addressing environmental challenges. Meeting environmental obligations requires new technologies, new products, new business practices, and new approaches to generate economic growth that put less strain on the planet.

Innovation is a critical component of achieving Canada's climate change commitments. The Pan-Canadian Framework on Clean Growth and Climate Change (PCF) projects emission reductions towards Canada's 2030 target (see figure below). The projection estimates that existing policies and those announced in the framework will achieve approximately 61% of our commitment, with the remaining 39% (or 79Mt) to come from additional measures; including through technology and innovation.¹²³

Clean innovation will not only play an important role in achieving our targets, but will also be critical for reducing the cost of achieving them. As seen in solar and wind energy, as well as electric vehicles, clean innovation has the potential to drive down costs far below those initially predicted, attract capital and accelerate adoption of new technologies. For example, the Deep Decarbonization Pathways Project found that the costs of decarbonizing the electricity sector could fall by more than 40% with technological innovation.¹²⁴

Box 15

Solar Power Installations and Costs¹²⁵

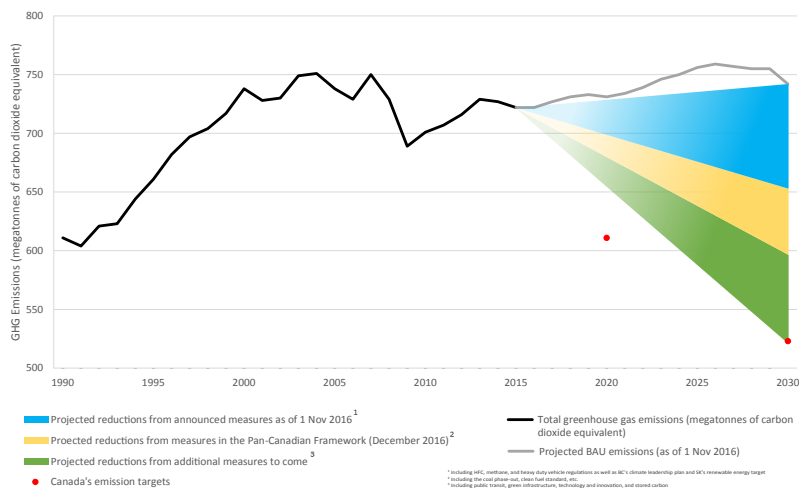


These trends can also be seen in the history of clean technologies that are now experiencing widespread adoption. As innovation helps drive down the costs of clean technologies, the markets for them are rapidly expanding. Take solar power generation for example, where costs have fallen by 70% at the same time as installed capacity has grown by more than 45 times.¹²⁶

In addition to lowering costs, clean innovation generates other valuable economic rewards, including attracting capital, increasing business competitiveness and driving job creation.

Box 16

Canada's Historic and Projected GHG Emissions



Sources: Government of Canada (2017) National Inventory Report 1990-2015: Greenhouse gas sources and sinks in Canada, Canada's Submission to the United Nations Framework Convention on Climate Change, Part 1.
First Ministers of Canada (2016) Pan-Canadian Framework on Clean Growth and Climate Change, December 9 2016.

Clean innovation is different from other types of innovation

It is increasingly recognized that well-designed policies to improve environmental performance can spur innovation in products, services and processes, which in turn can support productivity and economic growth. What is less widely understood is how clean innovation is held back by *two major market failures* – knowledge spillovers and environmental externalities – and why there is an important role for public policy to correct these failures and accelerate innovation.

Knowledge spillovers refer to the fact that when an innovator comes up with a new idea, they are not able to capture the full value of the idea, and some of that value 'spills over' to society and other innovators. This results in less investment in research and development (R&D) than is socially optimal, and has resulted in a broad consensus that government has a role to play in funding early stage R&D.

These spillovers exist for all innovations, but evidence suggests that spillover effects are greater for clean technologies.¹²⁷ This means that clean technologies tend to have wide applications that can provide larger benefits to society than so-called 'dirty' technologies (see figure below). For example, as innovations improve energy storage technology, the benefits impact a variety of markets, from electric vehicles and renewable energy to smartphones and portable electronics.

Clean innovations face an additional market failure known as **environmental externalities** – because markets generally do not reflect the true cost that environmental harm imposes on society, there is little economic reward for creating clean innovations, despite the societal benefits. This results in less demand for clean innovations and lower incentives to invest in or develop these technologies.

The impact of these two major market failures is further compounded by additional barriers that create risk and uncertainty, which discourages private investment and dampens clean innovation. For example, because demand for clean innovations is often driven by environmental regulations, uncertainty about future policy creates risk and chills investment. Additionally, network effects and infrastructure risk impede the uptake of clean innovation. For example, many people

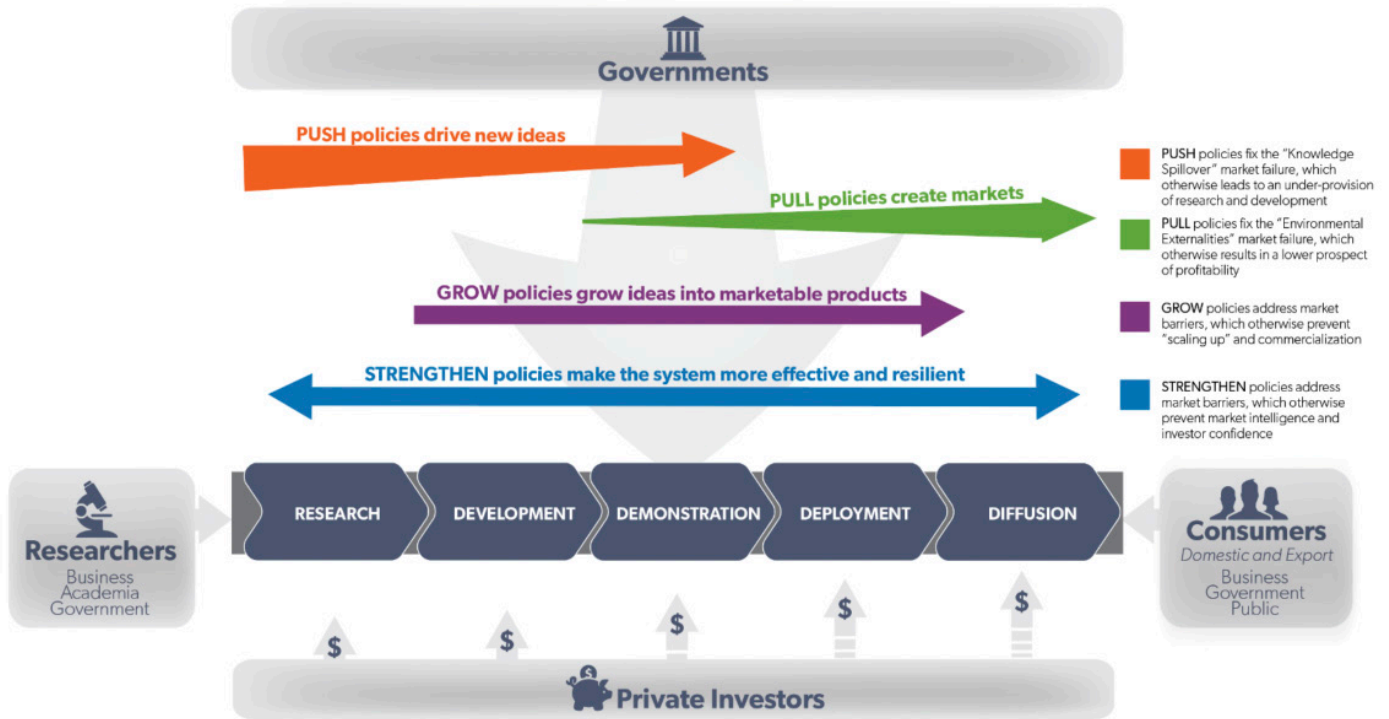
are reluctant to purchase an electric vehicle without sufficient charging infrastructure, and infrastructure is not being rapidly installed because not enough people own EVs. Other barriers, such as principal-agent problems (which misalign incentives) and future discounting also act to slow the adoption of clean innovations.

Because clean innovation faces more market failures and barriers than other types of innovation, there is a particularly important role for government to catalyze clean innovation through targeted measures that unleash private initiative and investment.

The clean innovation system is complex, with innovations having to traverse the bumpy road starting with research, development, demonstration, and ultimately commercial deployment and diffusion. Smart Prosperity Institute has identified four policy areas that must be used in combination to accelerate clean innovation in Canada:

- (1) PUSH policies that drive new ideas
- (2) PULL policies that stimulate markets
- (3) GROW policies that help ideas develop into marketable products, and
- (4) STRENGTHEN policies that make the system more effective and resilient.

The Clean Innovation System¹²⁸



For further detail on these four policy areas, and how Canada can use them to drive clean growth, see Smart Prosperity Institute's report: [Canada's Next Edge: Why Clean Innovation is Critical to Canada's Economy and How We Get It Right](#).

#6 CLIMATE-PROOFING INVESTMENTS IMPROVES RESILIENCE

Financial risk from climate change is growing

The 2019 Global Risk Report by the World Economic Forum highlighted that environmental risks are growing in importance. When considering both the likelihood of occurrence and the magnitude of impact, seven of the top eight global risks identified in the survey are environmentally-related.¹²⁹

Insured damage from extreme weather and natural disasters in Canada exceeded \$1.9 billion in 2018, the fourth highest year recorded.¹³⁰ Three of the four highest years have occurred since 2013, the highest ever recorded being the \$4.9 billion in damage claimed in 2016, driven by the Fort McMurray wildfires.¹³¹ Many of the costs associated with natural disasters are also not covered by insurance. Over the past decade, only 30% of costs were covered by insurance, leaving governments and civil society globally to manage US\$1.7 trillion in additional costs.¹³² Climate change is expected to increase the likelihood, frequency and intensity of drought, flooding and storms. Scientists are increasingly able to directly link individual extreme weather events to climate change.¹³³

Climate change is also exacerbating water risks that can disrupt supply chains, increase operating costs, and constrain growth. In 2016, large businesses spent an estimated US\$23.4 billion on projects to secure their water supply.¹³⁴

In Canada, the impacts of climate change are already being felt. It is getting hotter and wetter, with more frequent extreme events. A 2019 report shows that Canada is warming at twice the global average rate.¹³⁶ In Canada's north, temperatures are rising



\$705 million: Cost of 2018 Ontario and Quebec extreme windstorms



\$127 million: Insured losses from 2017 BC wildfires



\$3.5 billion: Insured losses from 2016 Alberta wildfires



\$850 million: Insured losses from 2013 Toronto floods



\$1.7 billion: Insured losses from 2013 Alberta floods¹³⁵

“The record damage reported in 2016 is part of an upward trend that shows no signs of stopping.”

– Don Forgeron, President and CEO, Insurance Bureau of Canada

Box 18

Top 8 Global Risks (according to the World Economic Forum)¹³⁸

- 1. Extreme weather events**
- 2. Natural disasters**
- 3. Failure of climate-change mitigation, adaptation**
4. Cyberattacks
- 5. Water crises**
- 6. Biodiversity loss and ecosystem collapse**
- 7. Large-scale involuntary migration**
- 8. Man-made environmental disasters**

Box 19

Divestment Away from Fossil Fuels¹⁴²

- Republic of Ireland
- Norway's sovereign wealth fund (proposed)
- New York City
- City of Oslo
- Rockefeller Family Fund
- World Council of Churches
- Canadian Medical Association
- California State Teachers' Retirement System (coal)
- Lloyd's of London (coal)
- Swiss Re (coal)

even faster, almost three times the global rate, leading to loss of sea ice and permafrost.¹³⁷ Northern infrastructure depends on stable permafrost, and degradation is causing costly damage and isolation of remote communities.

Changes in temperature and precipitation are also making wildfire seasons longer, and sea level rise is increasing the frequency and height of storm surges. British Columbia experienced its biggest wildfire season ever in 2017, breaking the previous record of burned area by over 40%; it then surpassed that new record in 2018.¹³⁹ The federal government has spent more on recovering from large-scale natural disasters in the last six years than the previous 40 years combined.¹⁴⁰ In addition to creating devastating effects on individuals' lives, impacts are creating financial risks for companies and governments, in terms of disruption or damage of operations, disruption of supply chains and trade, and increased infrastructure repair and maintenance.¹⁴¹ These impacts are expected to increase in severity over time.

In response to the risks of climate change, water stress, air pollution, biodiversity loss, waste accumulation, and other environmental challenges, governments around the world are increasingly implementing policies to mitigate damage. Businesses can capitalize on this shift by being early-movers in pursuing sustainable ways of doing business or may face a financial risk by failing to act. A 2018 study by Moody's found around US\$2.2 trillion in rated debt exposed to environmental concerns such as the carbon transition impacting the coal industry.¹⁴³

In some cases, decisions by a foreign government can also have major implications at home. For example, when China — the largest importer of recyclable materials — banned imports of 24 categories of recyclables and solid waste in 2017 for environmental reasons, governments dependent on that market were forced to review their current waste management practices.¹⁴⁴ Many Canadian municipalities have been scrambling to find alternative partners or to adjust to China's new stricter standards. Following the lead of the European Union in 2019, Canada announced the ban of single-use plastics starting in 2021.¹⁴⁵ Challenges such as these may lead to greater calls for producer responsibility, where businesses are required to manage products through to the end of their lives.

Pressure from investors and insurance companies will continue to mount

It is becoming clear that companies, and governments, will not be able to continue ignoring these risks. Investors and insurance companies increasingly insist that environmental risks are tracked, publicly reported, and reflected in business plans. In 2017, Norway's US\$1 trillion sovereign wealth fund proposed an exit from nearly US\$35 billion in oil and gas stocks.¹⁴⁶ As the world's largest equity investor, the proposal caused stocks in oil and gas companies to fall. In 2019 the fund initiated the sale of 20% of its oil and gas stocks, amounting to US\$7.5 billion in 134 companies. The fund has also sold off most of its coal stocks.¹⁴⁷ Other jurisdictions and organizations are also divesting from fossil fuels, including New York City and the Republic of Ireland. And the market for sustainable investments continues to grow, as can be seen in the high demand for green bonds (see box).

Moody's, which issues credit ratings, has given notice to coastal communities that they need to start preparing for climate change or risk higher interest rates. Moody's is now asking questions about what cities are doing to mitigate exposure to climate risks, and is taking the response into consideration in determining credit ratings.¹⁴⁸ It is also exploring applying disaster forecasting in calculating grades given to government debt and to companies in industries such as insurance and construction. Islands identified as particularly susceptible to climate change may also receive poor ratings.¹⁴⁹

Box 20

Green Bonds – Investing in Clean Growth

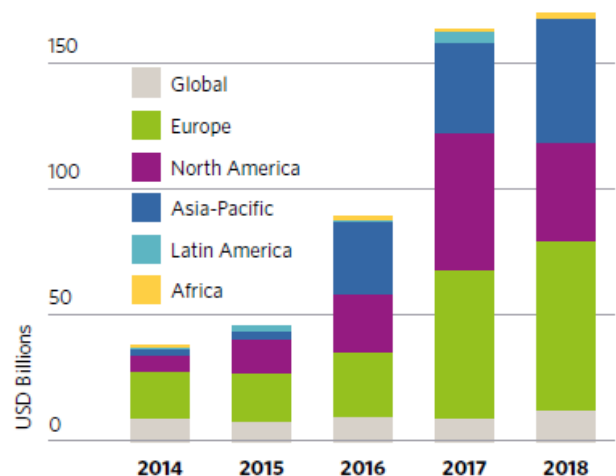
In 2018, the global market for green bonds exceeded US\$165 billion, a more than threefold increase since 2015.¹⁵³ Increasingly, investors are recognizing the market opportunity for clean technologies, and by investing in a portfolio, green bonds can help mitigate the risk associated with individual cleantech investments. In Canada, green bonds continue to grow in popularity, and have been issued by companies (Telus), banks (RBC), federal agencies (Export Development Canada), provinces (Ontario, Quebec) municipalities (Ottawa), individual investors (through CoPower) and recently major institutional investors (Canada Pension Plan Investment Board). Demand continues to outpace supply. In 2018, Ontario issued its largest bond to date, \$1 billion, after the originally planned issuance of \$500 million was oversubscribed by 360%.¹⁵⁴ Canada Pension Plan Investment Board's (CPPIB) record-setting green bond issuance from 2018 was also oversubscribed, by an estimated 80%, and subsequently issued a €1 billion bond in early 2019.¹⁵⁵

Considering climate change in credit ratings may not always be negative, however. S&P found that 44% of the time it resulted in an upgrade.¹⁵⁰ Lithium producers, for example, are anticipated to see higher revenue from greater electric car battery demand. Similar forecasting of low-carbon economic risks and opportunities should inform government's planning, investments and policies.

Insurance companies and governments are also grappling with the challenge of how best to manage the growing cost of natural disasters. For example, insurers have in some cases refused insurance to certain properties in flood-prone areas. Others offer flood insurance with higher premiums. Many homeowners and businesses in Canada are not aware of their flood risk or whether they are insured. In the United Kingdom, homeowners and businesses can determine flood risk by entering the postal code of a property on a website, and access a nationally pooled system of insurers backed by the government.^{151,152}

There are many opportunities to improve resiliency and reduce risk

Businesses can build resiliency to environmental and policy risks through a number of strategies, including: improved resource efficiency; diversification into alternative energy or material inputs; development of new product or service lines; and



adjustments to long-lived infrastructure investments. Shadow prices for carbon and water use can be used to ensure that investments will withstand potential future policy changes.

Consideration of various future scenarios may offer insight into potential blind spots. Using available information on anticipated local climate change impacts in terms of rainfall, temperature, and flood risk can inform the design and location of infrastructure. And effective reporting and disclosure can identify additional risks and opportunities. The companies that start thinking, planning, and innovating for the future are the ones that will thrive in the transition. Those that ignore trends may be left with stranded assets and greater costs.

Governments at all levels will also need to adjust.

Unprecedented levels of infrastructure investment are planned over the coming decades: an estimated US\$57 trillion worldwide by 2030*, including C\$180 billion over that time by the Canadian federal government, which will leverage even more from other levels of government and the private sector.¹⁵⁶ Much of the infrastructure will be long-lived, lasting 20-50 years or more. If it is not built to withstand the future impacts of climate change, or to anticipate the needs of a low-carbon economy (energy, transportation, etc.), future taxpayers will bear the financial burden of costly rebuilds and upgrades.

Government operations can also present risks and opportunities, particularly in terms of buildings, vehicles and energy use. Governments can use tools such as cost-benefit analysis (incorporating environmental valuation), internal carbon or water pricing, triple bottom line accounting, greening government strategies, and other approaches to improve the resilience of investments and better manage long-lived assets. A broader, strategic view will also be important, such as the Resilience Strategies being promoted by the 100 Resilient Cities initiative (see box).

Requiring greater financial disclosure of environmental risks and opportunities will help everyone better understand the adjustments that should be made. Other countries are moving in this direction, and Canada would be better placed ahead of the curve than behind it. In 2017, eight countries established a *Network of Central Banks and Supervisors for Greening the Financial System* to exchange experiences, share best practices, contribute to the development of environment and climate risk management in the financial sector, and to mobilize mainstream finance to support the transition toward a sustainable economy.¹⁵⁸ The group has grown to include more than 35

* *Infrastructure productivity: How to save \$1 trillion a year*, McKinsey Global Institute, January 2013. <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/infrastructure-productivity>

Box 21

100 Resilient Cities Initiative¹⁵⁷

In 2013, the Rockefeller Foundation launched the 100 Resilient Cities initiative, which helps cities around the world become more resilient to the physical, social and economic challenges that are a growing part of the 21st century. The challenges include shocks, such as floods and fires, as well as stresses that weaken the fabric of the city such as inefficient transportation, high unemployment and water scarcity.

The Foundation provides resources to develop a roadmap to resilience that includes naming a new Chief Resilience Officer, developing a Resilience Strategy, identifying partners and service providers that can help develop and implement strategies, and being part of a network of member cities that can learn from and help each other.

Out of over 1000 applications, four Canadian cities were selected: Calgary, Montreal, Toronto, and Vancouver. A panel of expert judges sought innovative mayors, a recent catalyst for change, a history of building partnerships and an ability to work with a wide range of stakeholders.

members, including Canada.¹⁵⁹ And in 2019, Canada's Expert Panel on Sustainable Finance released their final report, which [included 15 recommendations](#) for Canada to leverage its strong financial sector to accelerate clean growth, including disclosure of climate-related financial risks and opportunities.¹⁶⁰

Environmental risks and opportunities will also need to be increasingly integrated into economic and social strategies. For example, are there ways to promote greater economic diversity or support industries with lower environmental risks and greater environmental opportunities? Are tax systems and labour market policies supporting a smooth transition? Do education and training policies adequately reflect the skills and knowledge that will be needed in the future? Policy alignment will be of growing importance, given the interconnectedness of issues and the desire to ensure the best possible economic, social, and environmental outcomes.

#7

CONSERVING AND PROTECTING NATURAL CAPITAL IS CRITICAL TO GROWTH

Natural capital is a foundation of Canada's economy

Most sectors of Canada's economy rely in some way on our vast natural capital, whether it is industries that extract and refine natural resources from the ground such as oil or potash, industries that rely on healthy ecosystems such as agriculture and fisheries, or tourism and recreational industries that depend on natural areas.

Canada has a vast wealth of natural capital, with the world's longest coastline, the second largest land mass, the third largest supply of fresh water, the largest amount of intact forest area, 36 wetlands of international importance, and some of the world's largest populations of many species, such as bears, wolves, caribou, migratory songbirds and beluga whales. Canada also has the third largest oil reserves and fourth largest uranium reserves.¹⁶¹

The value of some natural capital resources, including minerals, energy and timber, is in part measurable through commodity prices. But the true value of natural capital to current and future generations is often invisible until it is lost. A 2014 study estimated that the Earth's ecosystems provide "free" support or services to the global economy that are worth around US\$125 trillion per year (more than annual global GDP).¹⁶²

Box 22

Efforts at Valuing Canada's Natural Capital¹⁶³



Boreal Forest - \$700 billion in ecosystem services each year



Water - \$15.5 to \$43.7 billion to the economy per year



Ontario Greenbelt - \$2.6 billion in ecosystem services per year



B.C. Lower Mainland natural capital - \$5.4 billion per year



Value of honeybee population - \$2 billion

There have been efforts to measure the value of some parts of Canada's natural capital (see box), and Statistics Canada maintains natural resource asset accounts using market prices. However, there is no consistent and comprehensive metric to track the non-market value of Canada's natural capital and the ecosystem services it provides.

Costs of failing to conserve natural capital are high

The global cost of ecosystem degradation is projected to increase to \$28 trillion per year by 2050 without additional action.¹⁶⁴ We are already seeing some of the costs from past failures to protect natural capital, with billions of dollars in liabilities relating to contaminated sites. The infamous collapse of the cod fishery on the east coast of Newfoundland was also an important lesson in the importance of sustainably managing resources.

Canada is on track for more losses in natural capital without significant action. Wetlands, for example, are one of Canada's most valuable ecosystems, in terms of the number of species they support, and the services they provide such as purifying water, removing pollutants, buffering water flows during times of flood or drought, and capturing and storing carbon from the atmosphere. Canada has roughly one-quarter of the world's wetlands, which cover 13% of our territory.¹⁶⁵ Unfortunately, many of them are declining in extent due to conversion to agriculture and other development.¹⁶⁶ Around urban areas, over 80% of original wetland habitat has been converted to other uses.¹⁶⁷

“Often the value of natural capital goes unrecognized until it needs to be restored, replaced or substituted for.”

Forests are also a critical resource in Canada, not only for our forestry sector, but also by providing other services of even greater value, including carbon storage, air filtration, water filtration, flood control, and soil formation, as well as habitat for thousands of species.¹⁶⁸ Canada has 9% of the world's forests, which cover around 40% of our territory.¹⁶⁹ Overall deforestation in Canada is low, but the conversion of old growth forests to managed forests can lead to significant losses of stored carbon, biodiversity (e.g. woodland caribou) and other ecosystem services.¹⁷⁰

Canada faces challenges in terms of both water quantity and quality in certain regions. The St. Lawrence River and Great Lakes Region, home to 60% of Canadians, has the highest proportion of sites with poor or marginal water quality and has experienced declining quality in several major rivers over recent years.¹⁷¹ Water availability is also a concern in dry years in the Okanagan Valley in B.C., southwestern Manitoba, southern Saskatchewan, southern Alberta and southern Ontario. In 2015, 12% of Canada's fish stocks were assessed as being in critical condition.¹⁷²

Box 23

Spallumcheen: High Costs of Contamination¹⁷³

Residents of Spallumcheen, B.C. (population 5,106) that have their water sourced from the local Hullcar Aquifer have been under a water quality advisory since 2014 due to high levels of nitrate. High levels of nitrate can reduce the amount of oxygen that can be carried in the blood, which is particularly problematic for babies, pregnant women, and those with pre-existing health conditions.

The source of the nitrate is believed to be from the spreading of liquid manure on nearby dairy farms. In response, the province issued pollution abatement and prevention orders to the farms, ordered a review of regulation of agriculture waste management, and pledged \$950,000 to help the local water utility find alternative drinking water sources. The township of Spallumcheen is also developing a long-term sustainability plan for its water systems.

Marine pollution is a growing issue around the world, as well as in Canada. It is estimated that 90% of sea birds consume plastic and over 8 million tons of new plastic trash enter the oceans every year.¹⁷⁴ Almost 700 species have been documented as having ingested or become entangled in marine litter.¹⁷⁵ Along the coast of Newfoundland, researchers were shocked by the accumulation of garbage, including vinyl siding, windows, carpet, flooring, fridges, stoves, washers, barbecues and bicycles, completely obscuring the natural ocean floor in some places.¹⁷⁶



A landmark study by the United Nations on biodiversity released this year warns of the unprecedented acceleration in biodiversity loss we are experiencing, with around 1 million plant and animal species threatened with extinction, driven by humans altering land and sea-use, exploiting organisms, and creating pollution-causing climate change.¹⁷⁷ A 2017 report by the World Wildlife Fund found that half of the vertebrate species assessed in Canada had experienced an average decline of 83% between 1970 and 2014. Habitat loss was the most significant factor, in addition to climate change, pollution, invasive species and unsustainable fishing practices.¹⁷⁸



\$4 billion: Cost of collapse of Canada's cod fishery in 1990s

Real savings in managing natural assets

Investing in nature and the ecosystem services it provides can create concrete savings for Canadian communities. Take for example, the burgeoning interest around municipal natural asset management.*

Canadian municipalities are facing significant challenges in maintaining aging infrastructure. While much of this infrastructure is necessarily engineered (such as roads, bridges, and water distribution pipes), in some cases natural assets can also perform essential services (such as stormwater management, water filtration, and flood protection). There is a growing recognition that natural assets can perform some of these services and be managed in the same way as engineered assets, with ongoing investment to ensure that they continue to provide the same level of service.¹⁷⁹ This can lead to cost savings while at the same time protecting natural assets.

For example, Gibsons, B.C. calculated that maintaining natural ponds that manage stormwater in the town's White Tower Park costs about \$15,000 every three years, which is significantly lower than the estimated \$4 million required to provide the same services through engineered stormwater solutions. Integrating nature into the town's financial and operational planning is actually saving money.¹⁸⁰

By taking steps to manage natural assets in the same ways as built infrastructure assets, Canadian communities can take advantage of the services provided by natural assets and the economic benefits they deliver.

* For more information, see the Municipal Natural Assets Initiative <http://mnai.ca>

#8

A CLEAN ECONOMY IMPROVES HEALTH AND QUALITY OF LIFE

The benefits of seizing the clean economy opportunity extend beyond environmental and economic outcomes. By reducing pollution in our air and waterways or reducing congestion on our streets, for example, we can also improve the quality of life for Canadians while making Canada a more desirable destination for businesses and talent. While these quality of life improvements can be hard to quantify, there are some measures for how economic outcomes will improve by reducing the pollution released into our ecosystems.

Pollution costs Canadians in more ways than one

While the appeal of clean air and water may seem obvious, there are real economic benefits. Pollution creates costs in many ways: air pollution affects human health and burdens the medical care system, pollution degrades crops and soil affecting the cost of food, and pollution in waterways harms fisheries and decreases the value of land, to name just a few. However we are only just starting to understand the full magnitude of these costs.

Globally, pollution has been estimated to cost US\$4.6 trillion annually, representing 6.2% of global GDP.¹⁸¹ According to a report by the Lancet Commission on Pollution and Health, diseases caused by land, air and water pollution were responsible for over 9 million premature deaths in 2015.¹⁸² In Canada, the human health impacts of air pollution alone — the costs of smog on the health and well-being of Canadians — amounted to at least \$36 billion and caused over 7,500 deaths in 2015.¹⁸³

Taking steps to reduce pollution can help avoid these costs. Investment in pollution reduction is estimated to provide an overall return on investment of 30:1, in terms of health benefits and cost savings.¹⁸⁴ A 2016 study found that a phase-out of coal across Canada before 2030 would result in 1,008 fewer premature deaths, 871 fewer emergency room visits, and improved health outcomes valued at nearly \$5 billion between 2015 and 2035.¹⁸⁵ These benefits, as well as reduced greenhouse gas emissions, are a large part of the reason Canada and other countries around the world are phasing out coal-fired electricity generation.

Similarly, when waterways become polluted with sewage, agricultural run-off and other forms of waste, it disrupts the functioning of aquatic ecosystems. For example, nutrient runoff into Lake Erie resulted in massive algal blooms that led to the Great Lake being labelled as 'dead' in the 1960's and 1970s.¹⁸⁶



\$36 billion: Cost of human health impacts of air pollution in 2015



30:1 Return on investment from reducing pollution



1,008: Fewer premature deaths in Canada from phasing out coal-fired power by 2030

While reducing phosphorus discharge from sewage that caused the blooms led to a recovery in the 1990s, the lake faces new threats. Warmer waters from climate change and the proliferation of invasive zebra mussels have weakened the ecosystem and led to the proliferation of algal blooms once again. It is estimated that in 2015, algal blooms in Lake Erie resulted in a \$4 billion loss in value of the goods and service provided by the lake, and houses along the shoreline lost a combined \$700 million in property value.¹⁸⁷ Situations like this are not unique to Lake Erie, and can be seen across the country.

Sustainable cities can be more liveable cities

Over 80% of Canadians live in large and medium-sized cities. These cities are expected to continue to grow into the future. How they grow will influence both their environmental impacts and their livability. Continued urban sprawl, for example, will increase the financial burden on municipalities for supporting infrastructure (e.g. roads, utilities) and lead to more traffic congestion and pollution. Accommodating a growing population will require creative innovations to maintain and expand green space, efficiently move people and products, and provide attractive, affordable places to live and work.

Many of the solutions to these challenges can also support clean economy. Companies are realizing that trees and green spaces can help attract top talent and improve worker productivity. Amazon's Seattle headquarters has 40,000 plants. Samsung's San Jose office space has a garden on every second floor. Alibaba is aiming for all employees in Hangzhou to be no more than a one-minute walk from an outdoor green space.¹⁸⁸ Urban gardens are being used in vulnerable neighbourhoods to provide healthy food and employment for those in need.¹⁸⁹ Alberta is investing in wildlife overpasses and sensors to limit traffic accidents on busy highways.¹⁹⁰

Urban mobility is also important. Reducing traffic congestion can result in environmental, economic and quality of life improvements. Congestion is a major headache for many commuters. It also increases air pollution from vehicles and causes lost time in the movement of people and goods

throughout Canada, reducing the efficiency of the economy. The Toronto Regional Board of Trade estimates that traffic congestion and delay in the Toronto-Waterloo corridor results in Canadians paying \$500-650 million per year in higher prices for goods

and services.¹⁹¹ The C.D. Howe Institute estimates the direct and indirect costs congestion in the Greater Toronto and Hamilton Area could be as high as \$11 billion every year.¹⁹² Innovative policies to address this challenge such as congestion pricing have proven successful in places like London and Stockholm.¹⁹³ Expanded bike lane networks and pedestrian-centered areas are making active transportation easier, safer and more attractive. Research from McGill University shows that safe biking infrastructure can significantly increase ridership and reduce vehicle emissions by offering commuters an attractive alternative.¹⁹⁴ Changing the way Canadians move can also promote health benefits and reduce health care costs. Canadian physical activity guidelines recommend at least 150 minutes of moderate to vigorous physical activity each week.¹⁹⁵ Active and pollution-free forms of commuting such as cycling or walking could meet this guideline based simply on a 30-minute commute every day during the workweek.

“Canada’s top 20 most congested traffic bottlenecks cost drivers over 11.5 million hours and drain an extra 22 million litres of fuel per year.”

— Canadian Automobile Association

Increases in ride-sharing, bike-sharing, electric vehicles and eventually autonomous vehicles will change how people and products move around cities. Technology is enabling innovative approaches to mobility pricing to help manage traffic and pollution. Charges can now be aimed at specific zones of a city, highway lanes or even per-kilometer driving.¹⁹⁶ The Internet of Things is being used to develop hyperlocal air pollution data that can be used to identify problem areas in a city.¹⁹⁷ Combining the two could eventually lead to increased driving charges in high-pollution zones. Public transit is also set to get more efficient with technological advances such as automation, face recognition, cloud-based management, automatic fares and real-time data. Numerous opportunities exist for governments to guide cities towards a future where urban areas are cleaner, more attractive, more livable and more efficient.

CONCLUSION

There is a growing global recognition that a clean economy – shifting toward a low-pollution, innovative, resource-efficient economy – is the opportunity of the century. Leading countries are moving quickly to position themselves to capitalize on this opportunity. The pursuit of a clean economy aims to simultaneously boost economic growth, by capturing growing clean market opportunities, and improve environmental performance, through innovation, efficiency and smart policies and investments – which together lead to better quality of life.

Evidence for the magnitude of the opportunity can be seen in growing global markets for clean technologies and increasing emphasis on sustainability across all sectors. This shift offers an opportunity for Canada, across all economic sectors, to utilize existing expertise and resources to punch above its weight in these emerging markets.

The race is on and the stakes are clear: a share of the growing markets for sustainable goods and services, increased energy and resource productivity, an innovative and resilient economy, healthy ecosystems, and more liveable communities.

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