Écotech at the frontiers of the new green economy[1]

Painting 1: Global Green Economy (Painting by Ekaterina Turkina)

It was a beautiful crisp morning and downtown Montréal looked particularly bright and fresh under the beams of early spring sun. Denis Leclerc was enjoying his organic fair trade coffee at MELK Bar à Café and browsing through the morning press. In half an hour he was supposed to meet his Écotech team to discuss new trends and challenges in the current economy and how Écotech could keep up with some important developments at the industry and macro-economic

[1] IGC research assistants: Meaghan Girard, Andriana Hnatykiw, Bazhena Ivanova; IGC linguistic editor: Meaghan Girard

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levels. In fact, Écotech's team needed to evaluate how emerging clean technologies and further advancement of the global green economy would affect Écotech's strategy.

Since 2009, Denis Leclerc has been President and CEO of Écotech Québec, and association that represents the Québec cleantech cluster. He is also the chairman of the International Cleantech Network, a global network of cleantech clusters with headquarters in Copenhagen (Denmark), and the chairman of the CanadaCleantech Alliance. Given all these high-level positions, his colleagues say that Denis is "the king of cleantech." In the past Mr. Leclerc also held several senior management positions, including Vice-President of Sustainability and Environment for AbitibiBowater, a global forest products corporation. Mr. Leclerc has been involved in many projects and strategic decisions for companies with operations in Canada, the United States, Europe and Asia. He has proven experience in issues management, public affairs, sustainable development and in relations with investors, socio-economic players, governments and the media. Highly involved in the community, Mr. Leclerc also sits on the Board of Directors of Ecofuel, the Québec Cleantech Accelerator, and of COOP Carbone; on the Executive Committee of SWITCH, the Alliance for a Green Economy; on the Community Advisory Board of Aéroports de Montréal, and on the Québec Advisory Committee of the Minister of Sustainable Development, Environment and the Fight against Climate Change. [2]

Photo 1: Denis Leclerc, President and CEO of Écotech Québec

[2]Information taken from: http://www.ecotechquebec.com/en/about-us/team/

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Denis put aside the newspaper he was reading and took some time to reflect upon the development of the global and local green economy, current political trends in Quebec, and Écotech's goals to further advance the local green economy and become the world's leading cleantech cluster.

At the global level, the whole range of activities related to clean technologies, pollution mitigation and management occupies an enormous place. According to infoDev (2014), the size of this sector is similar to that of the construction sector. In 2011-12, the total value of low-carbon environmental goods and services was $5.5 trillion (DBIS, 2013: 13). Global growth in the recent years was significantly higher than the rest of the economy (DBIS, 2013: 16). Therefore, it was high time for Écotech to think about a strategy to become a local and a global leader.

Écotech

In a sustainable development perspective, Écotech Québec is a cleantech cluster association (cleantech sector of the economy), which mobilizes key players of the green economy to create the most favourable conditions for the development and growth of companies, and encourages end-users to increase the deployment of clean technologies.

Écotech brings together all of Québec's industry stakeholders from across the province, including innovative companies, R&D and technology transfer centres, major end-user companies, the financial community, educational and training institutions, labour confederations and associations working in the clean technology sector.[3] Its vision is a more competitive, greener and healthier Québec, with an emphasis on sustained growth of the cleantech sector. In order to quickly offer concrete benefits to its members, Écotech Québec develops tools and activities that respond to their needs.

Écotech Québec receives financial support from the private sector and all three levels of government (city, provincial and federal).

Écotech's 4 main lines of actions are:

- **KNOWLEDGE:** Grow specialized knowledge and expertise about needs and trends in both the national and international realms
- **NETWORKING:** Increase the breadth of networking amongst industry players in order to generate more opportunities and partnerships
- **POSITIONING:** Boost recognition of Québec's cleantech, both here at home and abroad
- **PUBLIC POLICY:** Encourage industry leaders to take action in order to accelerate development and facilitate the commercialisation of clean technologies in Québec

[3] See more at: http://www.ecotechquebec.com/en/about-us/#sthash.CRDDILSc.dpuf; Écotech website: http://www.ecotechquebec.com/en/

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Écotech Québec is the first cleantech cluster association in North America to receive a certification of Cluster Management Excellence. It is a member of the CanadaCleantech Alliance and International Cleantech Network (ICN), an exclusive network of cleantech clusters in the world's leading cleantech regions, aiming to generate new business opportunities, enhance competitive advantages and create value for companies, knowledge institutions and local authorities across cluster regions.[4]

Appendix A gives detailed information about Écotech's activities.

Écotech's work is organized into 5 task forces: regulatory framework and taxation; financing; innovation and commercialization; branding and internationalization; skills and expertise. For more information, visit: http://www.ecotechquebec.com/en/task-forces/

Important global trends: green industry and green economy

In the last few years, the United Nations Development Organization coined the concept ***Green Industry*** to place sustainable industrial development in the context of new global sustainable development challenges.[5] **"Green industry"** is a term that can be used for industrial businesses that use environmentally-friendly practices, develop clean technologies or those that produce eco-conscious products.[6] In the 21st century, increased awareness and education about global warming, climate change, and the impending exhaustion of natural resources has created a significant level of demand for green economy.[7] Governments interested in improving environmental practices may sometimes choose to offer incentives, such as tax breaks or support programs, in order to foster the development of green businesses and clean technologies.[8]

Greening of Industry is a method to attain sustainable economic growth and promote sustainable economies. It includes policymaking, improved industrial production processes and resource-efficient productivity.

Many different aspects of the industrial world now contain an element of green technology. Nearly any type of product, from cars to lightbulbs to coffee mugs, have at least one alternative produced with advanced environmental standards.[9] Business and economic experts have cited

[4] http://internationalcleantechnetwork.com/members/ecotech-quebec/

[5] http://www.unido.org/greenindustry/green-industry-initiative.html

[6] https://www.franchisehelp.com/industry-reports/green-industry-report/

[7] Iwan Setiawan, Agribisnis Kreatif, 2012

[8] http://www.unido.org/greenindustry/green-industry-initiative.html

[9] http://www.wisegeek.com/what-is-green-industry.htm

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the trending industry as due for enormous growth throughout the next century, in part due to necessity, but also due to changing levels of demand.

Green industry is deeply enmeshed in the production and development of alternative energy. Solar, wind, hydrothermal, and even nuclear power plants are often considered to be environmentally-friendly forms of energy production as they are either renewable or sustainable and provide little to no pollution or greenhouse gas emissions. Industrial pursuits in this area include the research and development of new alternative energy technologies, the implementation of alternative energy systems, and the same maintenance and work that goes on in traditional power plants.

Green products, often popularized by celebrities and notable figures, have created a thriving system of green industry.[10] Recycling, organic and sustainable growing practices, and even eco-conscious packaging are all major elements in the green product industry. Toilet paper made from recycled notebooks, organic cotton t-shirts and shopping bags, appliances built to save energy, and even houses built from low-emission materials all contribute to this segment of green industry.[11]

Sustainable and environmentally safe food is also a growing segment of the green industry. In addition to organic food grown without pesticides, green farming pursuits manage livestock and crops to prevent damage to watersheds and topsoil. By rotating crops or grazing animals through different pastures each season, the green farming industry helps preserve nutrient-rich topsoil that allows growing to become a renewable procedure.[12]

Green-produced products have become quite popular throughout the industrialized world. While this may seem like a good thing for the environment, it also opens the door to scams and advertising fake-outs that try to capitalize on the popularity of green industry. Be wary of products that claim to be green but provide no evidence of certification; an “all natural” tomato may still be covered in pesticides unless it has been certified by a governing body as organic. [13]

Green Industry is considered to be a pathway for protecting communities, vital ecosystems and the global climate from escalating environmental risks and emerging scarcities of natural resources.[14] It transforms manufacturing and allied industry sectors so that they contribute

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[10] http://www.wisegeek.com/what-is-green-industry.htm

[11] ibid

[12] Info in the paragraph taken from http://www.wisegeek.com/what-is-green-industry.htm

[13] Info in the paragraph taken from http://www.wisegeek.com/what-is-green-industry.htm

[14] http://www.unido.org/fileadmin/media/documents/pdf/Energy_Environment/Green_Industry/Green%20Industry%20Initiative%20for%20Sustainable%20Industrial%20Development.pdf

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more effectively to sustainable industrial development. Green Industry is thereby the sector-strategy for the realization of Green Economy and Green Growth in the industry sector.[15]

At its best, Green Industry unleashes the business and innovation potential arising from a process of continuous improvement in natural resource use efficiency, minimizing waste and reducing emissions.[16] The realization of Green Industry is central to resolving today's most pressing environmental challenges, including mitigation of greenhouse gas (GHG) emissions and adaptation to climate change, the environmentally sound management of chemicals and wastes, and the security of supply of water, energy and other natural resources. It is possible to realize Green Industry in tandem with income and job creation in developing countries, and to secure net contributions to poverty alleviation and sustainable industrial development.[17]

The green industry involves two strategies to create a system that does not require the eternal increase of the natural resources consumption and the pollution as a source of development and expansion of organizations, namely:[18]

* Greening the existing industries: facilitating and supporting industries in any sector in order to green the operations, processes and products through more efficient use of resources; transformation of energy systems into ecological systems and expansion of renewable energy use; elimination of toxic substances and improvement of health and safety at work.

* Creation of new green industries: providing ecological goods and services on the market creates new green industries which help reduce the negative environmental impact and resource consumption. These include: materials recovery, recycling, treatment and management of garbage and industrial waste and the use of alternative energy.

According to Staniskis et al. (2012), the central idea to greening industries and sustainable economic growth is the "decoupling" of resource use and pollution from industrial development.[19] Decoupling occurs when the growth rate of an environmental pressure is less than that of its economic driving force, e.g. GDP over a given period. Another important issue of the concept is an emerging school of thoughts that goes beyond life cycle assessment. In order to redesign technological processes and minimize negative impacts, a new "cradle to cradle" approach is evolving that considers waste from one process as a resource for another process. This systems approach has resulted in the way the policies and supporting infrastructures are

[15] UNIDO GREEN INDUSTRY INITIATIVE for Sustainable Industrial Development, 2013

[16] Speech by Prof. Balkenende, UNIDO Unido project, Promote Inclusive Green Industrial Growth, Sept. 3st Xinjiang, Urumqi.

[17] UNIDO GREEN INDUSTRY INITIATIVE for Sustainable Industrial Development, 2013

[18] https://www.questia.com/library/journal/1P3-3868356091/sustainable-development-the-green-industry-contribution

[19] *Staniskis, J. K., Stasiskiene, Z., Kliopova, I., Varzinskas, V., 2012. Sustainable Innovations in Lithuanian Industry: Development and Implementation.*

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designed and how science is conducted. Such change is characterized by a multi-disciplinary approach with a shift in focus towards ways of production and use.[20]

Green economy generally means economy striving for a more sustainable pathway of growth, by undertaking green public investments and implementing public policy initiatives that encourage environmentally responsible private investments. The International Chamber of Commerce (ICC) representing global business defines green economy as "an economy in which economic growth and environmental responsibility work together in a mutually reinforcing fashion while supporting progress on social development". [21]

Karl Burkart defines a green economy as based on six main sectors:[22]

- Renewable energy
- Green buildings
- Sustainable transport
- Water management
- Waste management
- Land management

Importance of green economy for economic growth

A study conducted by Deloitte for Écotech Québec analyzed the cleantech sector **(Appendix B)** to assess the strengths and weaknesses of the different fields of activity and evaluate which ones show potential for growth.

Overall, it is expected that the greening of industries will become a core determinant of economic competitiveness and sustainable growth. Besides that the concept also plays a role in poverty alleviation, by promoting energy security, health and safety, jobs, and reducing costs through increased productivity. The concept of green growth emphasizes the fact that environmental protection is compatible with economic growth and can even enhance it. This concept brings together a diverse set of benefits: avoiding the economic cost of environmental degradation, green comparative advantage, green Keynesian stimulus, etc.[23] Recently, green

[20] http://erem.ktu.lt/index.php/erem/article/view/388/376

[21] https://www.coursehero.com/file/13320556/Emerging-trends-in-global-business-environmentpptx/

[22] *"How do you define the 'green' economy?". MNN - Mother Nature Network. 2009-01-09. Retrieved 2013-11-09.*

[23] http://www.iddri.org/Publications/Les-espoirs-de-la-revolution-industrielle-verte-une-perspective-historique

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growth has been associated with the strong belief that green technology may be able to trigger a new "wave" of productivity gains, and thus growth, comparable or superior to that generated by the steam engine, the railways or electricity.

What are the main drivers that sustain this hope of a "green industrial revolution"? How can we analyze this concept in the historical perspective of technological breakthroughs and of economic growth? The history of the industrial revolution and economic growth is much richer than that of technology: it is accompanied by drastic changes in the organization of work and business, of social compromise, or of consumers' behavior. Clean technologies are central in the new green economy. They do not merely allow business as usual at a lower cost, but they often enable things to be done in a completely different way.[24]

What is cleantech?

Cleantech is an industry term used to describe products or services that improve operational performance, productivity, or efficiency while reducing costs, inputs, energy consumption, waste, or environmental pollution. Its origin is the increased consumer, regulatory, and industry interest in clean forms of energy generation—specifically, perhaps, the rise in awareness of global warming, climate change, and the impact on the natural environment from the burning of fossil fuels.[25]

According to Clean Edge, a leading clean tech market research firm, clean tech refers to *"a diverse range of products, services, and processes that harness renewable materials and energy sources, dramatically reduce the use of natural resources, and significantly cut or eliminate emissions and wastes."*[26] This broad definition suggests that clean tech has the potential to be embodied in almost any industry. While there is agreement that all industries could be operated with less impact on the environment, experts say clean tech-specific industries have a primary focus on doing "more good" versus just "less bad."

Understandably, there is a wide gray area between these two distinctions, which is what makes the cleantech cluster so difficult to quantify. Cleantech is a dynamic, evolving set of industries. As more industries become 'cleaner' the distinguishing properties will continue to shift and there will be a need to refine and update how cleantech is quantified.

The idea of cleantech first emerged among a group of emerging technologies and industries, based on principles of biology, resource efficiency, and second-generation production concepts in basic industries. Examples include: energy efficiency, selective catalytic reduction, non-

[24] http://www.iddri.org/Publications/Collections/Idees-pour-le-debat/WP1113EN.pdf

[25] http://www.navitasholdings.co.za/ourspace/cleantech/tabid/390/Default.aspx

[26] http://ts-1.eee.hku.hk/ccst9015sp12/greentech1/green-technologies-new-trend-of-development/

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toxic materials, water purification, solar energy, wind energy, and new paradigms in energy conservation.[27] Since the 1990s, interest in these technologies has increased with two trends: a decline in the relative cost of these technologies and a growing understanding of the link between industrial design used in the 19th century and early 20th century, such as fossil fuel power plants, the internal combustion engine, and chemical manufacturing, and an emerging understanding of human-caused impact on earth systems resulting from their use (see articles: ozone hole, acid rain, desertification, climate change and global warming).

In 2008, clean technology venture investments in North America, Europe, China, and India totaled a record $8.4 billion.[28] Cleantech Venture Capital firms include NTEC, Cleantech Ventures, and Foundation Capital. China is seen as a major growth market for cleantech investments currently, with a focus on renewable energy technologies.[29] In 2014 (the most recent available), Israel, Finland and the US were leading the Global Cleantech Innovation Index out of 40 countries assessed. Canada placed 7th, behind Sweden, Denmark and the UK.

According to the published research, the top clean technology sectors at the global level are solar, biofuels, transportation and wind. In 2009, Solar accounted for almost 40% of total clean technology investment dollars, followed by biofuels at 11%.[30] The more recent investment trends, however, are becoming more diversified, with more focus on waste management.

The 2009 United Nations Climate Change Conference in Copenhagen, Denmark, was expected to create a framework that would eventually place limits on greenhouse gas emissions. Many proponents of the cleantech industry hoped for an agreement to be reached in order to replace the Kyoto Protocol. As this treaty was expected, scholars had suggested a profound and inevitable shift from "business as usual."[31] However, the participating States failed to provide a global framework for clean technologies. The outburst of the 2008 economic crisis then hampered private investments in clean technologies, which were back at their 2007 level only in 2014. At the same time, the figures for 2014-2017 represent steady growth in venture investing in cleantech industry, widely recognized as a leading indicator of overall investment patterns. Cleantech is officially recognized as one of the fastest growing industries globally.

Figure 1 depicts major cleantech sectors.

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[27] http://hulseyiplaw.com/green-sustainable-technologies/

[28] http://www.businesswire.com/news/home/20090106005584/en/Clean-Technology-Venture-Investment-Reaches-Record-8.4

[29] http://www.globalmidwestalliance.org/PROGRAM_Clean_Technology.html

[30] http://www.sustainablebusiness.com/year-end-reports-on-cleantech-vc-funding-44162/

[31] *"Climate Change Congress". University of Copenhagen. 2009-12-03.*

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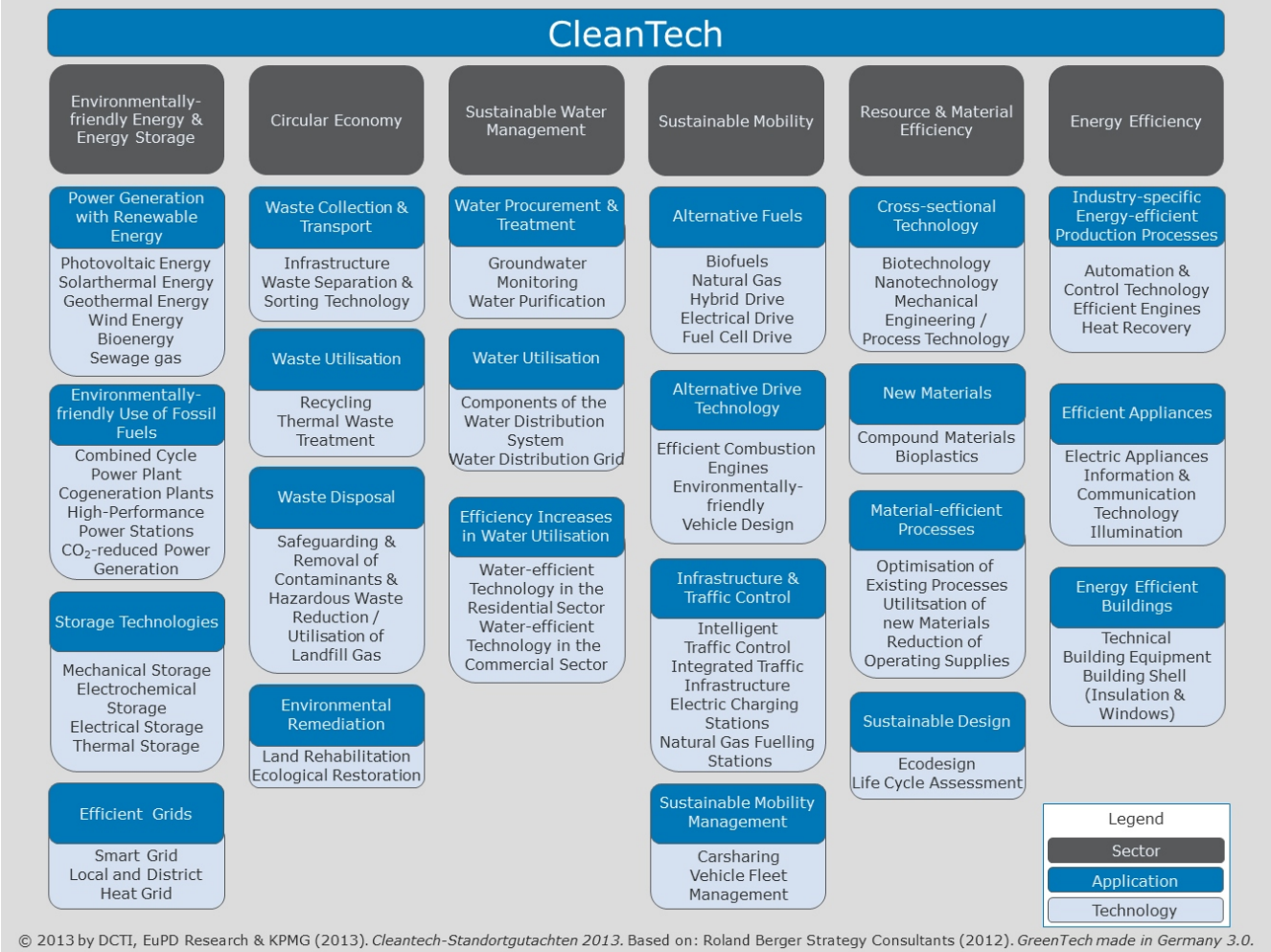

Figure 1: Major cleantech sectors

Cleantech is Green, But Not All Green is Cleantech

An important distinction should be made between "cleantech" and "green," and between jobs and industries. The definition for cleantech industries differs from the definition for green jobs. Cleantech industries have a strong focus on reducing environmental impact or addressing environmental issues as part of their core functions. Green jobs can exist in any industry or company that attempts to conduct their operations in a more sustainable or environmentally-friendly manner. In most instances, the difference is clear. For example, Starbucks has corporate goals for operating its business more efficiently and sustainably. Its sustainability manager has a green job, but their industry is coffee. A biofuels company, on the other hand,

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has a specific focus on providing a product that increases the availability of a renewable source of energy. Not every industry, however, can be neatly filed into either cleantech or green. For example, building-related industries, such as architecture, construction and engineering, have design, construction, operation and maintenance of buildings and facilities as their main focus. However, due to the large impact buildings have on the usage of energy, water and other resources, 'green building' has become an important segment of cleantech.

Quebec's economic, political and environmental/cleanteach outlook

As far as Québec's economy is concerned, it has evolved through different phases. A predominantly rural social economy existed until the end of the nineteen century. In the first half of the twentieth century, it moved toward a co-operative movement inspired mainly by corporatism and the social doctrines of the Church. During the period from 1945 to 1960, the province specialized in consumer goods industries and its economic growth was fueled by investments in Québec's natural resources (the majority of which came from the United States).

The next twenty years was a period of intense socio-political and socio-cultural change in Québec. The province experienced effective secularization of society, the creation of a welfare state (in which the state plays a key role in the protection and promotion of the economic and social well-being of its citizens), and the realignment of politics into federalist and sovereigntist factions. The public sector's involvement in Québec's economic activities increased through creation of government corporations and massive public investments in infrastructure, housing and social services. In the meantime, co-operatives, mutual insurance companies and associations adjusted to this Quiet Revolution and took part in economic nationalism that emphasized domestic control of the economy, labour, and capital formation and imposed tariffs and other restrictions on the movement of labour, goods and capital. When Québec suffered a backlash in the 1980s due to its restrictive policy, the Québec government made massive investments in public capital projects (buildings and roads) and new technologies. The 1990s were characterized by struggles against inflation and rising interest rates. Québec's ramp-up in public spending and booming export (thanks to the decline in the Canadian dollar and upticks in U.S. economic growth) helped boost the economy.

At the beginning of 2000s, Québec first experienced the bursting of the technology bubble and then a North American recession. In the 2010s, the era of knowledge-based economy, Québec is expected to see an economic boom thanks to its abundant and accessible natural resources, world-class universities, its cultural wealth and creativity, and outstanding quality of life. Quacquarelli Symonds (QS), the global higher education analyst, has recently named Montréal the world's number-one student city.[32] "Montréal jumped from last year's seventh place to overtake the reigning champion Paris, now the world's second-place student city after four years in the top spot. Montréal's improvement in the QS Best Student Cities ranking reflects

[32] http://publications.mcgill.ca/reporter/2017/02/qs-to-release-top-cities-for-students-rankings/

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gains in two of QS's five traditional composite indicators—Affordability and Employer Activity... The Employer Activity score reflects Montréal's recent economic progress, which is outpacing that of Canada as a whole."[33]

As far as economic progress goes, Montréal is doing very well in the service sector, as well as high-tech sectors such as aerospace, biomedicine, clean technologies, information technology, life sciences with its world-class clusters such as AeroMontréal and Écotech. Montréal has also developed a concentration of expertise in the area of artificial intelligence. Such tech giants as Google and Microsoft open their artificial intelligence labs in Montréal and make considerable investments in research institutions such as MILA (Montréal Institute for Learning Algorithms).[34] Element AI, conceived as the world's largest applied artificial intelligence lab, thrives in Montréal.

As far as the cleantech sector is concerned, it is very vibrant in Québec: there are approximately a thousand organizations linked to cleantech, including 500 innovative companies and 200 public research groups. 94% are SMEs and 70% are active on international markets.[35] They provide over 30,000 jobs and totaled revenues of $10.7 billion in 2011.[36]

The Québec cleantech ecosystem is essentially composed of the eight key categories of a green economy (Figure 2):

[33] http://publications.mcgill.ca/reporter/2017/02/qs-to-release-top-cities-for-students-rankings/

[34] http://www.cbc.ca/news/canada/montreal/montreal-institute-learning-algorithms-1.3859460

[35] www.ecotechquebec.com

[36] ibid

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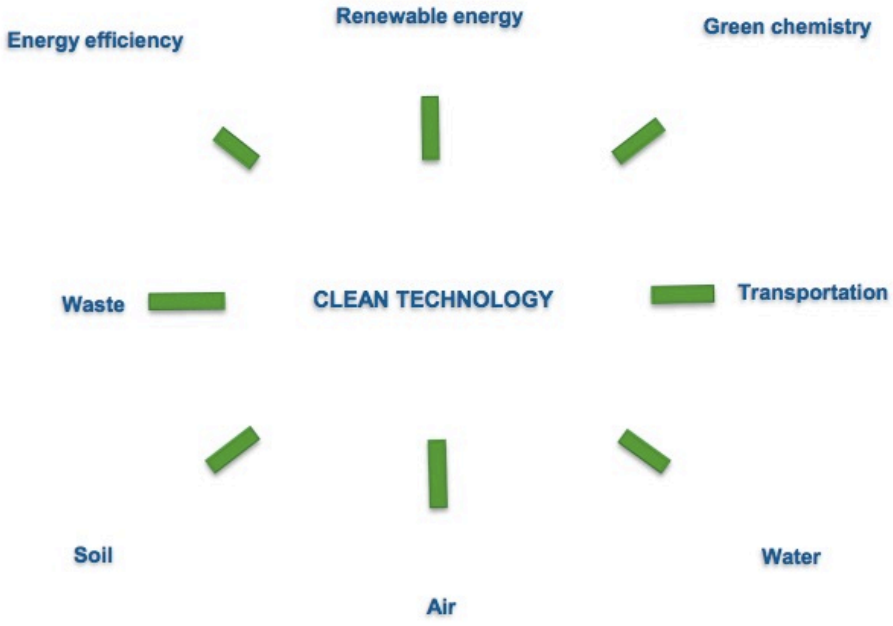

Figure 2: The categories of Québec's green economy

Québec particular areas of expertise:

- Water management: drinking water and waste water, municipal (including isolated residences) and industrial waters
- Residual waste management: sorting equipment and processing of recyclables
- Treatment of ambient air and atmospheric emissions
- GHG reduction technologies
- Measurement and control equipment
- Soil and groundwater treatment, remediation of contaminated sites
- Life cycle analysis
- Energy efficiency
- Biomass treatment and energy recovery (municipal and paper mill sludge, manure, biogas)

With these assets, Québec can become a leader in cleantech:

- A large territory rich in natural resources
- Leadership in the battle against climate change
- Dynamic R&D
- A solid, growing core of innovative businesses

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- Enlightened energy choices
- Concrete initiatives to encourage sustainable mobility
- A motivated community of investors

Challenges for cleantech companies: global, Canadian and Quebec outlook

On the global scale, clean technology exporters face challenges such as barriers to trade and excessive dependence on public policy. Indeed, tariff barriers remain high at the global level, with average tariff barriers for environmental goods and services sitting at 8.7%, while the average for all commodities is 3% (UNEP et al., 2012). On the other hand, demand for clean technologies is still too closely tied to public policy and the regulation of importing countries—this holds particularly true for developing countries (infoDev, 2014). Indeed, the commercial viability of several clean technology innovations initially depends on government legislation or programs (infoDev, 2014). Any change in the political contexts of countries will have important consequences for firms that export these technologies.

As far as Canada is concerned, its clean technology industry has been growing at four times the rate of the country's overall economy. It is a very R&D-intensive industry. Currently, it has 774 firms—compare that to the aerospace industry's 700 firms and the automotive industry's 450—and employs more Canadians than the forestry, pharmaceutical or medical device industry.[37] Though the industry has experienced a growth rate of 10% in the recent years, it's expected to slow to 5% between now and 2020. There are a number of factors contributing to that decline, but observers and leaders in the industry says financing is the chief hurdle right now. Analytica's report identifies Canadian financial institutions "not rising to the challenge" of supporting cleantech companies, and charging too much for debt financing as a major issue facing the industry.[38] Kate Ballotta, spokesperson for the Canadian Bankers Association, says the clean technology sector presents specific challenges for Canadian banks. "As the report notes, it can be challenging to provide debt financing to firms who do not yet have balance sheets that banks can use as security, or the cash flow to be suitable for traditional debt financing," she says. "These companies are typically in the early stage of the business life cycle and are more suitable for equity financing—a market which banks do not actively finance."[39]

[37] http://www.canadianbusiness.com/innovation/canadas-cleantech-industry-is-bigger-than-you-think/

[38] http://www.canadianbusiness.com/innovation/canadas-cleantech-industry-is-bigger-than-you-think/

[39] http://www.canadianbusiness.com/innovation/canadas-cleantech-industry-is-bigger-than-you-think/

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Another important issue with financing is related to government policies and subsidies. According to the CEOs of cleantech companies, the innovation system in Canada in the cleantech sector needs to be improved, as in its current form it is not very helpful for small- and medium-sized enterprises to grow domestically. The government spends a lot of money in R&D, but largely earmarks it for universities and auxiliary agencies, which are really good at developing ideas, but not building businesses. In contrast, Europe has been doing much more for its cleantech companies in terms of cleantech-friendly policies, subsidies to companies, and all sorts of programs with different services, from affordable business plans and to helping companies with marketing strategies.

Another important issue is that 43% of Canada's cleantech revenues are domestic. The remaining 57% are international—34% from the U.S., and 23% from the rest of the world, even though the industry is mostly represented by small- and medium-sized enterprises.[40] These figures show "how hungry these companies are to do well internationally—but also that they're struggling to find a market domestically."[41] Audrey Mascarenhas, the CEO of Questor Technology Inc., identifies 50% of her company's revenue as coming from outside of Canada. For Daryl Wilson, CEO of hydrogen-generator company Hyrdogenics, it's 95%.[42] "We're anticipating in the near future that we'll see growth in our business in Canada, but for our 20-year history most of our business has developed outside of the country," he explains. "Most of our business is focused in Europe, where historically there has always been a much higher focus on renewable energy and reduction of climate change impact." Wilson says he recognizes the growing shift to recognize climate change in Canada, but adds that it's an ongoing process. "We end up creating companies that spend more of their time being successful outside the country, and that leads eventually to companies getting acquired, because the market conditions are too difficult domestically," says Bak. "If we do that for all of our companies, then we will have missed the opportunity to build them at home."[43] "There's a number of positive policy initiatives that could help our growth," agrees Wilson. "One of them would be spending on infrastructure in Canada that purposefully supports innovation and builds on Canadian and clean technology solutions." CEOs of cleantech companies also want to see a culture-shift in how Canadians go about marketing their own cleantech solutions. According to Wilson, Canadians are naturally somewhat risk-averse: Wilson's company has successfully sold hydrogen fuel cell rail technology in Germany, but Canadian buyers show a lot of opposition questioning the riskiness and the novelty of the product. Wilson argues: "We need to tell our own story better than we do," he says. "It's not Canadian to be self-promotional, but we need to promote ourselves much more strongly, because elsewhere in the world we are recognized

[40] http://www.canadianbusiness.com/innovation/canadas-cleantech-industry-is-bigger-than-you-think/

[41] http://www.canadianbusiness.com/innovation/canadas-cleantech-industry-is-bigger-than-you-think/

[42] http://www.canadianbusiness.com/innovation/canadas-cleantech-industry-is-bigger-than-you-think/

[43] http://www.canadianbusiness.com/innovation/canadas-cleantech-industry-is-bigger-than-you-think/

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as innovators and leaders, but on our home soil we don't promote our solutions to the degree that we should."[44]

As far as Quebec is concerned, even though Quebec cleantech sector is well positioned with strong assets, high levels of human capital, and strong expertise in many cleantech sub-sectors, there are several important challenges facing Quebec cleantech companies. As far as the current politico-economic situation is concerned, since the Liberal government took office in 2014, it has pursued austerity measures and budget cuts. Bruno Massé, the coordinator of the Network of Quebec Environmental Groups (RQGE), argues that these austerity measures resulted in less money for environmental protection, greater difficulty enforcing environmental rules, and reduced capacity to respond to crises.[45] Massé emphasized that budget shortfalls are used to justify investments in extractive projects such as mining, fracking, and oil drilling in order to boost provincial revenues. Last April, for example, the Liberal government announced a subsidy of $100 million for a Chinese mining company to continue a mining operation on Inuit land in northern Quebec.[46] At the same time, transferring to cleaner technologies is something very important for Canada, as its emissions per capita from burning fossil fuels is among the highest in the world (Figures 3 and 4).

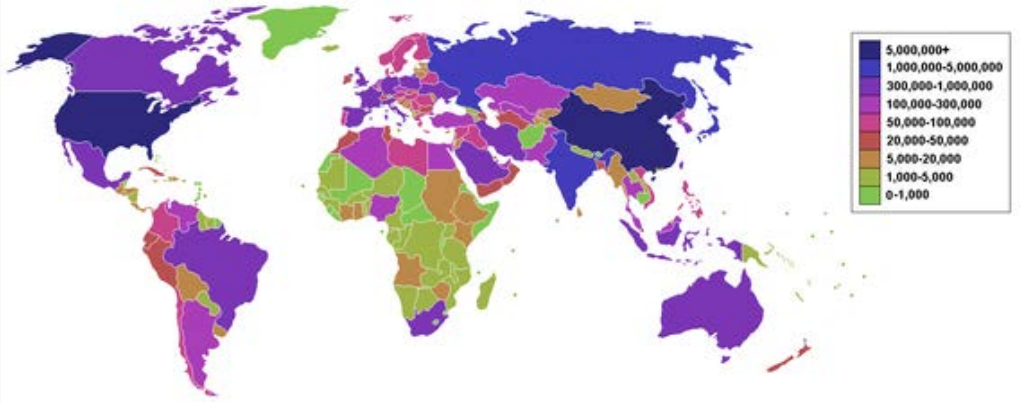

Figure 3: Countries by carbon dioxide emissions in thousands of tonnes per annum, via the burning of fossil fuels (blue the highest and green the lowest).

[44] ibid

[45] https://briarpatchmagazine.com/articles/view/quebecs-movement-for-economic-and-environmental-justice

[46] https://briarpatchmagazine.com/articles/view/quebecs-movement-for-economic-and-environmental-justice

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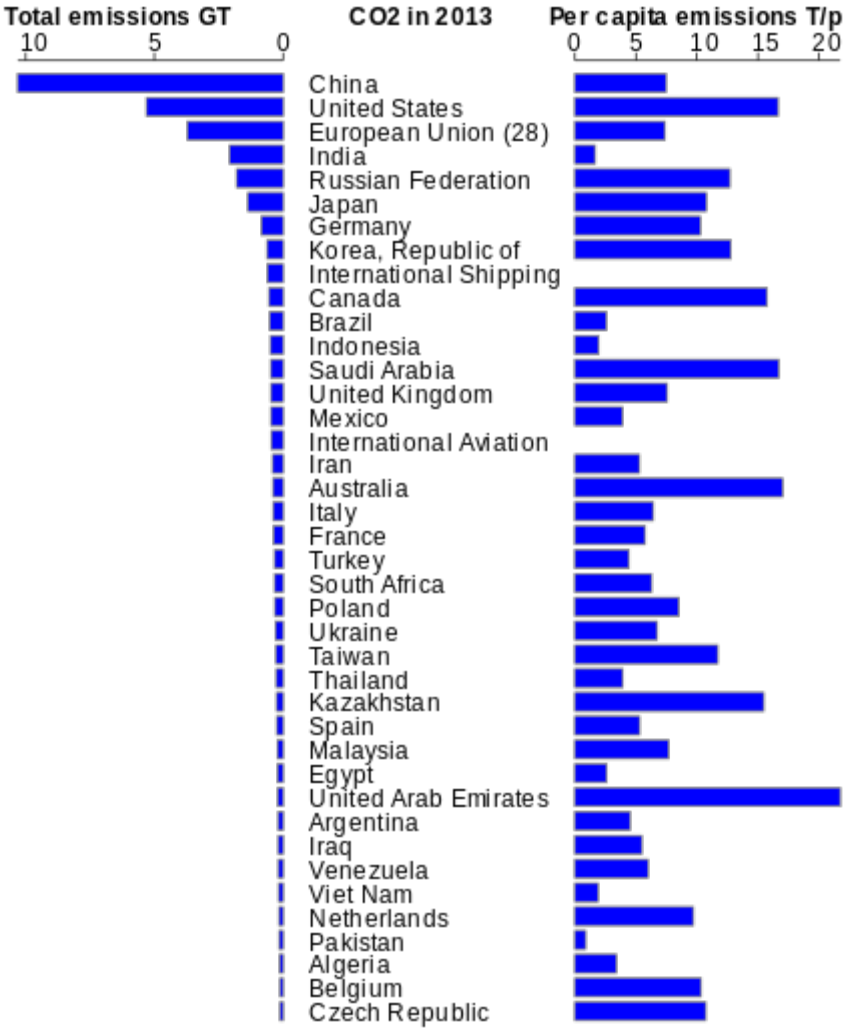

Figure 4: emissions per capita

At the same time, it is important to note that even though public commons and several environmental programs have been affected by the liberal government's policies (which did affect many companies working in the cleantech sector), Écotech's budget (as a cluster association) has not been affected much. Additionally, since Écotech worked for some time in the mode of limited human resources (vacancies for three full-time positions), it managed to save on the salaries.

In general, the government is aware of the difficulties faced by Canadian companies, so it has decided to encourage the development of so-called super clusters: tech business hubs that will also attract anchor companies from around the world.

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The 2017 budget proposes:[47]

- $950 million over five years (provided through competition) to support the superclusters.
- $400 million over three years to be made available through the Business Development Bank, a new Venture Capital Catalyst Initiative to increase last-stage venture capital available to Canadian entrepreneurs who submit proposals.
- $14 million over two years for Futurpreneur Canada—a non-profit organization—to match investments with funding from departments and private sector.

At the same time, Écotech decided not to apply for a supercluster, but rather integrate its companies in other superclusters (e.g. facilitate partnerships between Écotech companies and companies in oil and gas supercluster).

Major stakeholders in the green economy and the role of Écotech

The industry is split up into multiple institutions working in the different sectors and technological applications such as electronic energy storage, alternative fuels, and energy efficient buildings. The four main traditional groups of stakeholders in the green economy mentioned in the literature are: governments, consumers, investors and companies.[48]

1. Government at all levels initiates innovation and investment in the green economy by setting regulatory frameworks and economic incentives. Integration of new green technologies and approaches with economic and environmental policies is vital. Government also has an important role in fostering linkages between companies and consumers at the regional, national, and global levels.

2. Consumers—individuals as well as businesses—judge and choose companies and products for their compliance with ecological and sustainable standards.

3. The finance industry sees sustainability as an important criterion for investment decisions.

4. Companies have to reply to the demands of politicians, customers, and investors by being resource-efficient, producing low emissions, and being nonpolluting.

[47] http://www.cbc.ca/news/canada/ottawa/federal-budget-2017-ottawa-1.4035656

[48] **Source:** "Going GREEN and Clean: Finding Clean Technology Information"

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At the same time, with growing competition, globalization and a rapid advancement of knowledge, new technologies and innovations have a wide variety of sources—most of them outside the direct control of enterprises and industries. Therefore, researchers have started to mention other important stakeholders: other institutions than government involved in the innovation process, such as universities, technical institutions, private and public research laboratories, and most importantly, industrial cluster organizations like Écotech. Cleantech cluster associations play an important role not only in the innovation process (e.g. generating ideas for the development of new technologies), but are also critical for mediating and strengthening the relationship between industry, a variety of institutions and the government. Strong relationships and multiple interactions among diverse stakeholders are necessary as modern science systems need to be broad based, with the ability to work across and beyond usual disciplines and ability to collaborate with different actors. **Appendix A** gives a comprehensive overview of Écotech's different interventions.

By supporting SME development, cluster organizations have successfully promoted SME internationalization, thus increasing exports and generating regional growth in their home regions.[49]

***Écotech and global cluster organizations*:**

Écotech figures in the Global CleanTech Cluster Association (GCCA), whose vision is to "drive sustainable regional economic development, on a global scale." GCCA is harvesting the power of networking disparate local Cleantech clusters in a global market environment. Its focus is on creating a global cluster collaboration system to drive sustainable regional economic development that is open, larger and more effective than what we have seen as of today.

GCCA develops customized services benefitting two target groups:

A) Cluster member companies: access to capital, corporates and markets to drive global technology deployment

B) Cluster managers: Access to the best clusters and meta cluster insights (peer-to-peer, benchmarking) to drive cluster business excellence

As serial entrepreneurs, they embrace and value constant innovation. GCCA focuses on business modelling and finance innovation, based the meta-cluster insights. One goal is to create a scalable, new financial mechanism that allows Cleantech clusters and companies to

[49] http://internationalcleantechnetwork.com/about/recognitions/

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engage with institutional investors, e.g. pension funds. GCCA is a fully independent, not-for-profit initiative of a private consortium, based in Zurich, Switzerland. As an umbrella foundation, it is monitored by the Swiss Federal Supervisory Board of Foundations.

Écotech is also the member of International Cleantech Network (ICN) (http://internationalcleantechnetwork.com/), an exclusive network of cleantech clusters from the world's leading cleantech regions that aims to generate new business opportunities, enhance competitive advantages and create value for companies, knowledge institutions and local authorities across cluster regions. ICN's vision is to be the leading global network of the best performing cleantech cluster organizations from around the world. ICN's mission is to create direct value for stakeholders belonging to the clusters, such as companies, knowledge institutions and local authorities, by using international cooperation to enhance their competitive advantages in the global market. ICN is governed by a Board of Directors and Steering Committee. As mentioned above, the president of the Board is Denis Leclerc, who is President and CEO of Écotech Quebec. ICN has a Secretariat, which is responsible for the daily operation of the organization according to the strategic direction set by the Board of Directors and was established in its current form on January 1, 2016, in Copenhagen, Denmark. The Secretariat develops and implement strategies in order to improve cluster collaborations, expand the network and add value for the members of ICN.

What are the major clusters and countries?

During the last decade, the development of the clean technology sector was driven by private or strategic corporate investments in venture-grade companies, or by investment in projects underpinned by renewable energy targets and carbon markets. Researchers and policymakers have started to argue that the low-carbon economy has now gone mainstream. Local, regional and countrywide economic development groups, business organizations, corporate partners, investors and centres of R&D are coalescing in clusters aimed at accelerating the path to market for cleantech innovations. From Europe to the Asia Pacific, via North America, dozens of clusters have been launched, often in conjunction with major cleantech investment events.

Whether as incubators of clean-tech growth companies, or business services and partnerships for later stage innovators, these clusters represent and attract a portfolio of companies characteristic of their mandate (whether job promotion, green procurement, economic development, or achieving high-value exits for investors) and local business culture.[50] Cleantech

50

http://www-personal.umich.edu/~adriaens/CleanTechInnovation/Clusters_and_Network_Optimization_files/Top%20Capital%20Article%20041112.docx.

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clusters are fast becoming the driving force behind the acceleration of developments and innovations in energy, water, waste, clean fuels, green materials and green buildings.

According to the Global Cleantech Cluster Association, there are 50 prominent cleantech clusters in the world**:** **http://www.globalcleantech.org/en/custom/cluster/directory/map**

The top 5 countries and clusters are listed below with their main focus and slogan.

a) **Denmark (2):**
   - **a.** CLEAN Copenhagen (Copenhagen): Green solutions spur growth
   - **b.** Climate Circle (Holstebro): Promoting Cleantech success in Holstebro

b) **Belgium (2):**
   - **a.** Flanders Cleantech Association (Berchem): Supporting Flemish cleantech companies
   - **b.** I-Cleantechvlaanderen (Houthalen-Helchteren): Enabling the Future

c) **France (3)**
   - **a.** CD2e (Loos-En-Gohelle): Driving the Eco Transition
   - **b.** French CleanTech (Lyon): From innovation to connection
   - **c.** IAR- Pole Industries and Agro resources (Laon): Competitiveness Cluster Industries and Agro-Resources

d) **United States (18 Clusters)**

1. ACCA- Arkansas Cleantech Cluster (Little Rock, United States): Focus in regional and global technology deployment
2. Akron Global Business Accelerator (Akron): Driving Technology, reviving the economy
3. CAMA- CleanTech Alliance Mid-Atlantic (Philadelphia): Growing Green Business Opportunities
4. CCIA- Colorado CleanTech Industry Association (Denver): Business-Innovation-Impact
5. Clean Energy Trust (Chicago): The innovation ecosystem in the Midwest
6. Clean Tech Center Syracuse (Syracuse): Integrated incubation infrastructure
7. CleanTech Alliance Washington (Seattle): The DNA for game changing developments
8. CleanTech San Diego (San Diego): Innovate. Educate. Advocate. Collaborate.
9. CleanTech LA (Los Angeles): The Greenest Big City in the US
10. CTSI- Clean Technology and Sustainable Industries (Austin): Commercializing Emerging Clean Technologies
11. Energy Accelerator (Honolulu): Start up paradise for energy innovation
12. Energy Florida (Cape Canaveral)
13. NCSEA-NC Sustainable Energy Association (Raleigh): A clean energy ecosystem for North Carolina

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14. NECEC- New England Clean Energy Council (Boston): Accelerating the clean energy economy
15. Next Energy (Detroit): driving Technology demonstration and commercialization
16. NYC ACRE
17. Portland Development Commission (Portland): Competitive advantages for clean tech industries
18. RTCC: Research Triangle Cleantech Cluster (Raleigh): Transformation through collaboration

e) Canada (3)

- **a.** Écotech Québec (Montréal): Cohesion and synergy for the cleantech industry
- **b.** GreenTech Exchange (Vancouver): Cultivate, Collaborate, Grow
- **c.** MaRS Discovery District (Toronto): Advanced Energy Center

Figure 5: Gobal distribution of cleantech clusters

Green economy and companies

As mentioned above, the cleantech sector is represented mostly by small- and medium-sized enterprises. The GCCA gives an annual award to top 10 Company Winners and their respective nominating clusters. The companies and clusters that received awards in 2016 are: Fluidsolids, Bioenergy/Biomaterials (swisscleantech), GreenSynch, Energy Storage/Smart Grid (Australia), Magrow, Food/Urban Ag. (Green Way, Ireland, Enervalis), Lighting/Energy Efficiency (Flanders), M-Field Energy, Energy Storage/Smart Grid (Taiwan), CleanSpark -Energy Sorage/Smart Grid (San Diego), SmartWires, Energy Storage/Smart Grid (San Diego), Wirepas,

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Bioenergy./biomaterials (NIA – Cleantech Finland), WaterTectonics – Water (Washington, US), Azuri Technologies, Solar/wind (Cambridge Cleantech).

A full list of the 2016 Later Stage Award Top 30 Finalists and all nominees can be found at www.globalcleantech.org/en/custom/company/directory.

Companies from Écotech traditionally appear in the finalist list and frequently figure in the top 10. For instance, in 2011 Newalta from Brossard, QC, was in the top 10. It specializes in industrial waste management and environmental services. In 2012, Biothermica Carbon, Inc from Écotech was in the top 10. It develops, finances, builds and operates carbon and energy infrastructure projects based on the destruction and utilization of landfill gas and coal mine methane. The company owns a 25 MW landfill gas power plant located on the city of Montréal's landfill, in Canada, and also developed the first coal mine ventilation air methane destruction project at an active mine in the U.S. (Alabama). In 2014, Sonitec-Vortisand Inc. from Écotech was in the top 10. The company specializes in water filtration, serving the recreational, municipal, industrial water markets since 1986. The award-winning Vortisand vertical & horizontal units are considered high performance Cross Flow Microsand Submicron Filtration Systems. It is a high capacity, high flow automatic backwashable media filter that combines cross flow dynamics with microsand media to achieve submicron filtration at speeds up to 5 times faster than traditional multimedia filters. A large production plant with over 2,500 installations worldwide, Vortisand has become a global leader in filtration for various industries including: pharmaceutical, petroleum refining, biotechnology, pulp and paper, automotive, general HVAC and more. Common applications include HVAC, cooling towers, data centres, process/manufacturing, water reuse, pre- & post-membrane filtration, reverse osmosis, aquatic/recreational centers and more. Écotech's companies receive other prestigious awards. For instance, the companies Pyrowave and PureSphera, both members of Écotech Québec, are among the top 10 of their own category ("Special Prize Start-up" and "Recycling & Resources") at the GreenTec Awards 2017.

Conclusion

Denis Leclerc put aside the newspaper he was reading and took some time to reflect upon the development of the global and local green economy, current political, economic, and industry trends in Canada and Québec, and Écotech's goals to further advance the local green economy and become the leading cleantech cluster in the world. While the current global and local landscape comes its fair share of challenges, Denis believes that at the same time, it presents many exciting opportunities. He feels that Écotech needs to be very strategic to seize these opportunities.

Task:

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1. Reflect on and discuss the current cleantech sector landscape (global, Canadian and Québec) and the impact of important trends of the new green economy.
2. Propose a strategic plan for Écotech that would allow it to become a leading cleantech cluster in the world.

Appendix A: Detailed Examples of activities

Participation in Public Consultations:

Écotech Québec, a key player in the positioning of Québec's clean technologies sector, is frequently asked to participate in public consultations prior to the development of several public policies. Speaking on issues directly related to the ecosystem and the business conditions of the sector, Écotech Québec presents some capacity-building proposals.

For example, Écotech Québec participated in the development of the Government Sustainable Development Strategy, where the government wanted to provide greater incentives for clean technologies. As part of its brief to the government, Écotech Québec proposed elements that would help to support the government in the implementation of its strategy. Not only can the clean technology sector contribute to the achievement of government objectives but also the strategy itself can have a real impact on the growth and competitiveness of this sector. In October, the new strategy was unveiled and thanks to Écotech, included several measures to increase the use of clean technologies.

As another example, last March, Écotech Québec was invited to present its proposals to the Advisory Committee on regulatory and administrative relief led by the Minister for Small and Medium Enterprises, Regulatory Relief and Regional Economic Development. The mandate of this committee is to advise the government on the measures to be taken to alleviate the regulatory and administrative burden on businesses, to identify problems and needs, and to suggest priority regulatory and administrative areas.

Écotech Québec was also invited by the Committee on Transportation and the Environment to submit its recommendations on the green paper entitled Modernizing the Environmental Approval Scheme of the Environment Quality Act. The objective is to provide Québec with a clear, predictable and effective environmental regime. Écotech Québec participated in the special consultations and presented recommendations to the Committee on how to increase the contribution of innovative companies to help Québec meet the emissions reduction target by 2030.

Finally, Écotech Québec made recommendations to the Québec Taxation Review Committee. Volume 1 on the current Québec's tax reform recommends, among other things, the introduction of fiscal measures to support the commercialization of research and development for SMEs. This was one of the flagship measures introduced by Écotech Québec.

A Sustained Commitment:

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Écotech Québec, through its President and Chief Executive Officer, is a member of the Climate Change Advisory Committee of the Minister of Sustainable Development, Environment and Climate Change, whose mandate is to advise the government on the guidelines and the most promising actions in the fight against climate change.

In addition, as a founding member of the Alliance for a Green Economy (SWITCH), Écotech Québec continues contributing to making the shift to a green economy. Écotech and SWITCH actively participated in the organization of the Canadian Round Table on the Green Economy. The event brought together nearly 200 decision makers from Canada's economic, associative, financial and environmental communities, who discussed the key elements to accelerate the shift to green economy.

Finally, the Vice-President of Écotech Québec was invited to sit on the independent commission mandated by the Council of the Communauté métropolitaine de Montréal for public consultations on the draft of the Metropolitan Management Plan 2015-2020.

Business activities:

Écotech Québec organizes events, called Rendez-Vous, to showcase the potential of new markets. For instance, knowing that the City of Hong Kong, an excellent gateway to penetrate the Asian market, has to invest several billion dollars in the green economy (waste treatment, green building, energy efficiency, water treatment), Écotech Québec jumped on the opportunity when Hong Kong stakeholders were passing through Montréal. Last June, a Rendez-Vous was organized for Québec and Hong Kong company representatives in collaboration with the Hong Kong Canada Trade Association (ACHKC). The objective was to explore business opportunities and meet partners to help companies start or accelerate their efforts in this region of the world. The speakers shared the secrets to entering the Hong Kong market and exchanged with participants during the mesh activity.

In anticipation of a mission led by Prime Minister Philippe Couillard to Mexico and a second mission to Colombia led by the Minister of Economy, Innovation and Exports, Jacques Daoust, Écotech Québec organized the Rendez-Vous for participants from Québec, Mexico City, and Bogota. The meeting, organized in collaboration with Export Québec, provided an opportunity to better identify priorities and opportunities for Québec's cleantech companies in Mexico City and Bogota. Successful advice to support the process abroad was presented by Export Development Canada (EDC).

International Mesh:

Écotech Québec collaborates intensely with the International Cleantech Network (ICN), an exclusive network that brings together clusters of clean technologies located in Asia, Africa, Europe and North America with headquarters in Copenhagen. This international collaboration aims to generate new business opportunities and improve the competitive advantage of each by creating synergies between companies, research centers and local authorities in each of the regions concerned. As mentioned above, the President and Chief Executive Officer of Écotech

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Québec, Denis Leclerc, is the Chairman of the Board of Directors of the ICN, which helps Écotech Québec to be at the centre of different international activities.

Building on the initiative of Écotech Québec, members of the ICN held their annual meetings in Montréal in March. The objective of the meeting was to define the CCM's action plan, which also includes strategic vision and the exchange of good practices for cluster management. As part of the 20th edition of the Salon d'Americana, Écotech Québec also organized a technical briefing for members of the ICN with representatives of the Communauté métropolitaine de Montréal and the Government of Québec to give them an overview of the context and business opportunities in Québec. Écotech Québec has helped develop the ICN Passport, which provides cluster members with international membership (access to all the cleanteach clusters-members of ICN), including the provision of temporary office space and the linking of relevant organizations to each region. Finally, an agreement with the grouping of megacities, the C40, was announced at the COP21 now offering privileged access to companies wishing to propose their innovations to large metropolises.

A Remarkable Presence at COP21:

The Conference on Climate in Paris (December 2 to 9, 2015) was the perfect opportunity for Écotech Québec to actively promote Québec's innovations, particularly at the Solutions Gallery, with a view to reducing the impact of professional activities on climate. The presence of political and economic players from around the world has given Écotech Québec the opportunity to forge links with high-level stakeholders, including Morocco, Denmark, Brazil, Israel and the United Arab Emirates.

The President of Écotech Québec hosted a press conference during which the Prime Minister of Québec, Philippe Couillard, announced a package of measures totaling $25.5 million to support actions to combat climate change. In addition, he acted as moderator of the panel on "Integrating climate issues into public policy," which included the Minister of Sustainable Development, the Environment and the Fight Against Climate Change, David Heurtel.

Missions in Japan and China:

In an effort to propel Québec companies internationally, Écotech Québec has been involved in two trade missions organized by the Board of Trade of Metropolitan Montréal and the World Trade Center. During the mission to Japan in February, participants had the opportunity to participate in the Kansai-Canada Greentech Forum in Osaka to present and showcase their expertise to potential partners. The mission then traveled to Tokyo to participate in the World Smart Energy Week, a world-renowned fair. The second mission, led by the Mayor of Montréal, Denis Coderre, took place in China in November. Écotech Québec offered companies a special clean technology program that included a day at Eco Expo Asia (Asia's largest trade fair for environmental technologies and green buildings), which led to personalized and organized meetings by the Consulate of Canada. In addition, thanks to its partnership with the China Yixing Industrial Park for Environmental Science and Technology, Écotech Québec has offered companies the opportunity to meet potential partners. Dagua Technologies seized this

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opportunity to find a great business partner. For more information on this innovative Québec company, please go here: http://www.dagua.com/.

INNO+:

INNO + is another important initiative designed and created by Écotech Québec. It is a simple and effective formula for the emergence of more business opportunities between Québec's technology-based SMEs and potential users of innovative solutions. As part of this initiative, in partnership with the Québec Association for Energy Management (AQME), the Québec Council for Environmental Technology Enterprises (CETEQ) and Réseau Environnement, Écotech Québec organized a series of workshops. The objective of these workshops is to present the solutions of innovative SMEs to an audience composed mainly of representatives of the municipal sector. Écotech Québec was selected as part of the PRAM-Est program of the City of Montréal, funded by the Ministry of Municipal Affairs and Land Occupancy. Three INNO + workshops were organized on the topics of soil decontamination, energy efficiency and process optimization. These workshops were conducted in partnership with local chambers of commerce, industry associations and local development centers. Nearly 200 participants attended the workshops. In addition, a microsite has been developed to allow those who have not been able to attend the workshops to have access to the innovations that were presented.

Collaboration with different industry players:

Écotech Québec successfully collaborated with the MISA Group (Mining Expertise Network) in order to better inform the mining industry about innovative solutions contributing to its vitality and sustainability. Solutions were presented in relation to the various challenges and challenges in the mining environment.

Knowledge and Networking:

Écotech's ConneXion activities provide targeted information and training, as well as opportunities for networking for Québec companies. The activities focus on such topics as market identification and prioritization, uses and benefits of liquefied natural gas, investor presentations, lobbyists registry, tax credits, commercial and technological positioning, etc. In total, more than 800 participants participated in various Écotech Québec networking events.

Supporting Start-up Development:

With the objective of increasing the presence of start-up companies, Écotech Québec continues its collaboration with the Ecofuel accelerator. In addition to receiving a free annual membership, Québec start-ups are invited, through ConneXion, to make a presentation on their technology and discuss the next steps in their business plan. In addition, through its communication tools, Écotech Québec promotes calls for applications from the accelerator and also disseminates the “wins” of Ecofuel's companies.

From School Benches:

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The Écotech Challenge is a competition in which teams of university students offer solutions to a real strategic challenge of a real clean technology company. In March, Idénergie sought student assistance to prioritize opportunities for the commercialization phase of its small river hydro turbine. The winning team presented a very comprehensive action plan addressing both the marketing challenge of reaching the target clientele and penetrating new markets. The second place winner presented a detailed marketing plan that includes a very elaborate web campaign. Other clean technology companies attended the team presentations and met with potential trainees. The Écotech Challenge with Idénergie's participation resulted in the offer of three summer internships and one permanent position within the company.

A second edition of the Challenge took place in November with the Brio Group, which asked students to help them position themselves with a strong brand image in order to develop a relationship with their customers and potential partners. The winning team presented an array of innovative ideas and the second-place team offered the Brio Group a marketing plan in four areas: developing a sense of ownership through the creation of tools, developing partnerships with specific companies, rethinking traditional sites and promoting on-screen activities. Idénergie also attended the presentations and offered two winter internships and two summer internships. Québec also recruited two trainees.

Green Innovation:

In order to increase the growth of green innovations in Québec and its partners, Écotech Québec implements a strategy targeting social media. Thus, Écotech Québec offers, twice a week, Ecominute, the green innovation of the day. A total of 98 blogs have been published and disseminated on a range of social media. More than 6,500 people follow Ecominute on Twitter, LinkedIn and Facebook. These blogs are also a source of information for traditional media. Web traffic continued to grow strongly this year, particularly in terms of number of users and number of visits. Indeed, in 2015, more than 50,000 different visitors visited the website, an increase of 64% compared to 2014. In addition, Denis Leclerc participates as a columnist on the Silver Channel, where he introduces and popularizes Québec innovations in clean technologies.

Green and Clean Creativity:

A flagship event for creativity and innovation, C2MTL brings together important players active on a global scale. The event aims to stimulate visionary managers by offering an environment that encourages collaboration and the emergence of new approaches. The activity presented by Écotech Québec, inspired by the INNO + workshops, allowed four companies to present their solution to a wide and varied audience. In addition, a workshop was organized to stimulate creativity in order to find ways to increase the socio-economic acceptability of projects related to wind and energy recovery.

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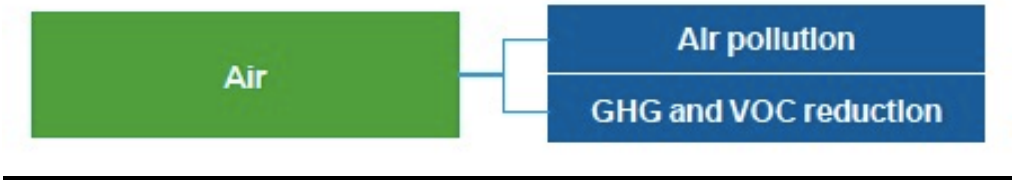
Appendix B

Impact on Québec's economy:

Deloitte's study of the cleantech sector revealed that energy efficiency, waste, biomass and hydroelectricity are in a promising position internationally. Other categories and subcategories have significant assets in their respective niches: water treatment, transport, soil rehabilitation, green chemistry, wind energy and solar energy.

Air:



Clean technologies in the Air sector can, among other functions, reduce atmospheric pollution, volatile organic compounds (VOC) and greenhouse gases (GHG). Air cleantech also quantifies GHG reduction efforts in order to convert them into carbon credits trade on local and international markets.

Québec has a highly specialized air treatment industry. Made up essentially of mature companies, this Québec sector is expected to experience expanded business opportunities (principally in the subcategories of GHG and VOC reduction and the field of pollution**)** with the launch of the regulated carbon in 2013 and Québec's target of reducing GHG by 20% compared to 1990 emission levels. With the market characterized by major players, small specialized companies have chosen to enter the market via niche segments such as intelligent odour management, biogas purification and carbon capture.

Several research institutions stand out in the air sector: UQAM, McGill University, Université Laval, Université Sherbrooke and the INRS Carbon Capture and Storage (CSS).

Green Chemistry:

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A new branch of chemistry, green chemistry, is stirring a lot of interest in Québec. It refers to biocomposites, bioplastics and ecomaterials as well as bioproducts and bioprocesses. Renewable resources like cellulose, lignin and fatty acids are transformed into ecomaterials that can be integrated into biocomposites. Green chemistry offers new processes that enable renewable raw materials to be used in the production of chemical products and materials as well as adapted production techniques that minimize waste with traditional processes.

As many countries embrace green growth, green chemistry is becoming a necessity. Having become a priority for the chemical industry, green chemistry is a promising market for Québec. According to the Centre québécois de valorisation des biotechnologies (CQVB), Québec will be, per capita, the "Canadian leader in green chemistry." Several local and international leaders stand out in the nanotechnologies and materials sector, including the world's first nanocrystalline cellulose (NCC) demonstration plant. Stimulated by innovation, it is working to meet global challenges by increasing the design, manufacture and use of cleaner chemical processes and products. Although industrial bioprocesses and biomaterials seem to offer great potential, biomass is another path towards sustainability. However, it must be said that there is very little special activity in this field in Québec. The province does, however, have significant assets at its disposal when it comes to expertise, which could help it make its mark. With the help of highly specialized workers currently active in declining sectors, this expertise could easily be transferred to the green chemistry sector.

Québec is known for its large number of chemical product formulators and R&D organizations (e.g. CQVB, CRIBIQ, Centre in Green Chemistry and Catalysis, Centre Québécois sur les Matériaux Fonctionnels and IMI). As it works to increase the province's capacity for developing world-class technologies, the Québec government has committed to supporting specific projects related to green chemistry. Nonetheless, despite the government's willingness to stimulate this industry, Québec's regulatory framework appears deficient. In fact, there are no strategies or policies in place to encourage the emergence of green chemistry and some environmental processes could discourage the chemical industry from setting up shop in Québec.

Water:

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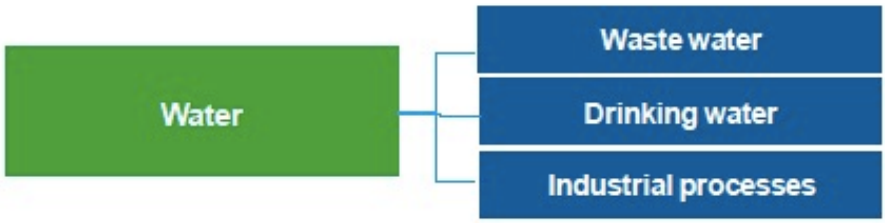
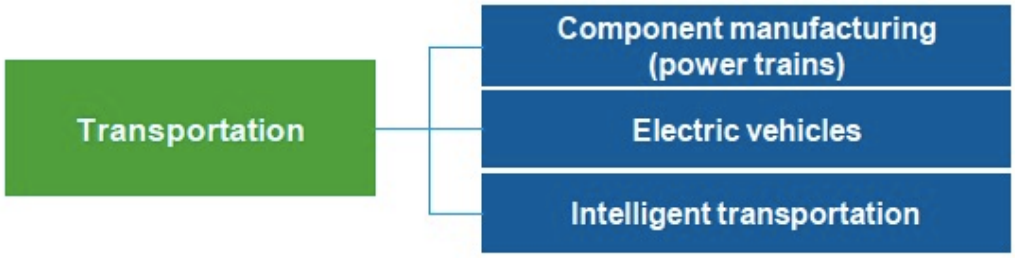


The water sector includes drinking water and wastewater treatment. It refers to water generation (e.g. desalination), treatment (e.g. filtration, decontamination), transport, control and efficiency (e.g. intelligent irrigation), and industrial processes requiring water. Although this eco-industry appears somewhat fragmented with companies working primarily in local markets, some Québec SMEs are active in foreign markets.

Freshwater covers 10% of the territory of Québec. With 4,500 rivers and half a million lakes, Québec holds 3% of Earth's renewable freshwater reserves, 40% of which is concentrated in the St. Lawrence River watershed. Unfortunately, the abundance of this resource has not guaranteed that public authorities closely manage it. The water sector, along with its water treatment sub-sector, is one of the largest in Québec. The Government of Québec provides a regulatory framework that favours clean technologies of the water sector. Québec appears well positioned in this sector, compared to international competitors, particularly in the segment of decentralized treatment systems. In this mature market, the innovations being explored primarily target water treatment processes like filtration membranes, ultraviolet rays, ozone disinfection and other new disinfection systems.

Québec's water treatment sector is well supported in terms of research facilities (e.g. CREDEAU, ERDAT, Centre des technologies de l'eau).

Eco-mobility/Transportation:



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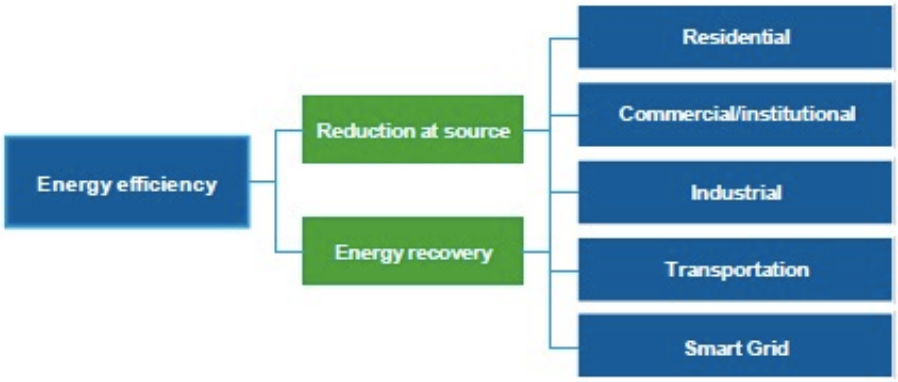
Eco-mobility refers to intelligent transportation, electric vehicles, as well as power train component manufacturing electrification. Intelligent transportation systems (ITS) use electronics, communications and information processing technology to improve all aspects of transport, including public transit. With the help of new technologies, ITS can improve the management and operations of road, rail, air and marine transportation networks, as well as service to users. Québec can rely on its strengths in mathematical modelling and operational research applicable to flow management software.

Electric vehicles are gaining ground in Québec's transportation sector, notably in public transit. Québec enjoys numerous advantages that could drive its expansion into the electric vehicle market. Québec's position on the global stage could also be enhanced by the strength of its research and development in the field of component manufacturing, particularly in the niche markets of batteries and charging stations. The IREQ (Hydro-Québec's research institute) holds several patents on battery materials.

Finally, Québec is home to no less than 30 university research centres and college technology transfer centres in various fields related to road transport.

Energy Efficiency:



Energy efficiency relies on managing (energy recovery) and reducing energy demand at the source. The market is extremely broad: it includes smart grid, transportation, industrial, commercial/institutional and residential uses. In addition, there are great disparities in terms of the maturity of these various market segments. It would appear that, in Québec, the commercial

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and institutional market has peaked. Furthermore, the low cost of electricity could limit the number of local opportunities. The market for wood fibre-based insulation (carbon-neutral), the management of integrating renewable energy sources and the growing influence of information and communication technologies in managing energy efficiency (smart grids) also present a number of opportunities. Moreover, truck fleet operators show a keen interest in improving energy efficiency.

Conversely, the industrial, transportation and residential markets do offer some development opportunities given the emergence of leaders, how the market is organized and the increased demand for eco-innovations in these segments. As for smart grid, this market is still in its infancy. According to data from 2010, the building trade accounted for nearly 60% of energy efficiency expenditures, followed by the industrial sector with 25%, and transportation, with 15%.

At this time, when meaningful, efficient energy management must accompany sustainable energy savings, countries like Japan, Denmark, Hong Kong, Ireland and Israel have successfully done just that and stood out from their competitors.

With a global market worth nearly $300 billion (2010), the energy efficiency sector is becoming predominant on the institutional market. Although the trucking industry has already shown a keen interest in improving energy efficiency, many other market segments have yet to be explored. Both small- and medium-size businesses and the residential market are very likely to be the scene of numerous technological initiatives.

Certain niche markets stand out, such as refrigeration industrial processes and equipment for transportation applications. The economic fabric of Québec, which is predominantly manufacturing, combined with the province's weather, gives it a comparative advantage on the international market when it comes to energy efficiency project development and testing and industrial process optimization.

Québec has the enviable position of being able to count on several research chairs in energy efficiency (e.g. Chair in Industrial Energy Efficiency-Sherbrooke, Industrial Research Chair T3E-ÉTS), research centres in GHG reduction and energy consumption (e.g. CanmetENERGY-Varennes), renewable energy integration (e.g, NGTC-Boucherville) and industrial process optimization (e.g. INO, Optech).

Renewable Energy:

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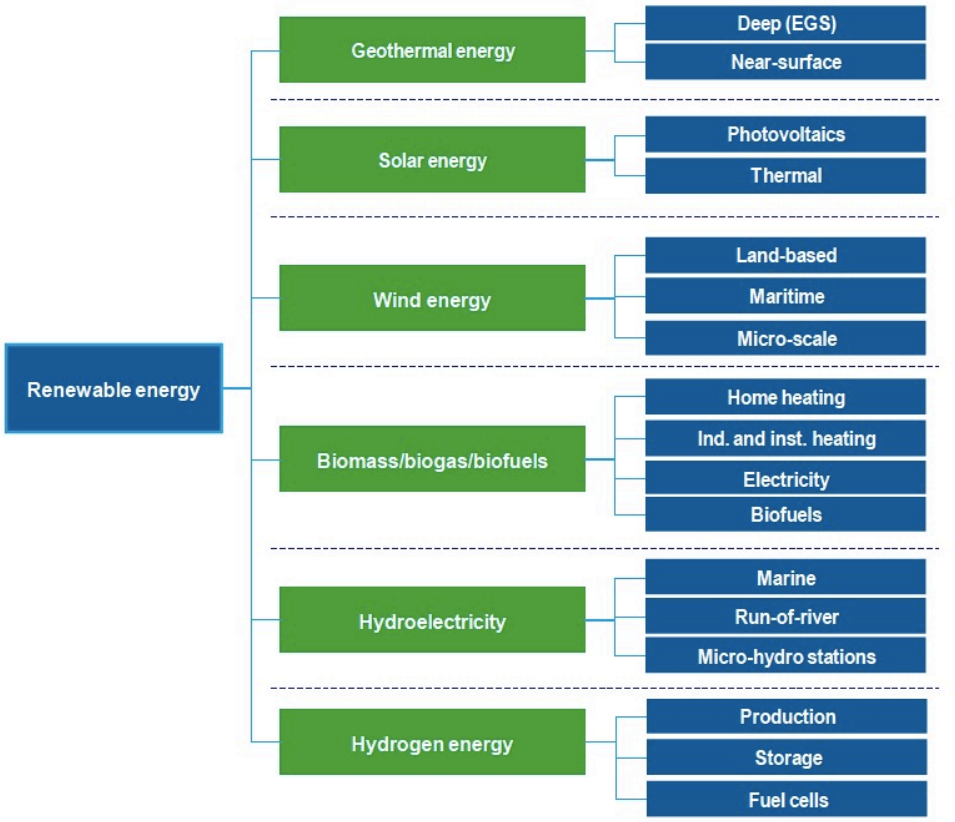

The primary forms of renewable energy, i.e. solar power, wind energy, energy from biomass / biogas / biofuels, geothermal energy, hydroelectricity and hydrogen energy, represent one of largest growing markets in the world. In addition to helping improve the sustainability of energy production, renewable energy offers environmental benefits.

Although Québec is privileged to be able to count on hydroelectricity, other forms of renewable energy are emerging: biomass, wind and solar energy. Though the Secretary General of the World Energy Council has noted, "Québec is a leader among countries in terms of renewable energy," hydrogen energy, biofuels and 3rd generation solar power are alternative energies that remain challenging.

- **Hydroelectricity**

Hydroelectricity, a highly promising market for Québec, has earned recognition both here and abroad, thanks to Québec's unique expertise and engineering skills. Exporting their talents to international markets, Québec engineering consulting firms are creating and developing hydropower projects. Using the driving force of water to produce renewable energy, Québec has developed a solid reputation on the world stage. Hydroelectricity has earned recognition both

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here at home and abroad, thanks to Québec's unique expertise and engineering skills. Some niche markets, like mini-hydroelectric power stations, river-run micro-hydro stations and marine turbines are starting to stand out. Research centres like IREQ, LTE and GRANIT and industrial research chairs like the NSERC/Hydro-Québec TransÉnergie and NSERC/Hydro-Québec can be counted on to develop solutions in the fields associated with the transport of electrical energy and the management of water systems and to use government-sponsored measures to extend the scope of this sector.

- **Biomass**

Québec is holding its own vis-à-vis international competition in the field of biomass harvesting. In fact, biomass as a generator of electricity is well developed in Québec. Though biofuels, biogas, forestry residues and marine biotechnology are less prominent and still at the early stages, they are beginning to penetrate the market and Québec is well positioned in them. These new forms of renewable energy are currently attracting new investment and several projects have been launched to explore the possibilities offered by these new energy sources. With the help of a large forest industry and low electricity costs, the biomass market in Québec is developing rapidly and catching up to international niche markets (first and second generation biofuels and energy pellets). Biomass energy relies largely on R&D, and organizations like CRIP-Biorefinery, CRIBIQ, FP Innovations and FORAC research consortium are contributing to forge ahead in this promising sector.

- **Wind**

With the best wind energy potential in North America—ahead of Ontario, the Maritimes and the United States—Québec can boast of having invented numerous electronic control interfaces in the field of wind energy. Although the technology for land-based turbines is relatively mature, certain niches (like offshore wind turbines, on-board wind turbines, autonomous wind turbines and micro-scale wind turbines) are poised to expand. The Québec wind energy sector is flying high after having reduced its dependence on foreign intellectual property (IP). Many Québec companies can boast of having developed an expertise on specific parts of turbines and on electronic control interfaces. Québec is home to several specialized centres like the TechnoCentre Éolien, which hosts the wind energy niche of excellence, as well as the Canada Research Chair on Nordic Environment Aerodynamics of Wind Turbines (ÉTS), the Anti-Icing Materials International Laboratory (UQAC) and the Wind Energy Research Laboratory (UQAR).

- **Solar**

While promising on the international stage, the solar energy market in Québec is still not very developed and remains costly. Given the global competition it faces from countries active in this sector, Québec does not enjoy a strong position because of weak development in solar manufacturing, despite the fact that some Québec companies produce the polysilicon used in photovoltaic solar panels. Two of the leading global participants in the solar thermal niche are in

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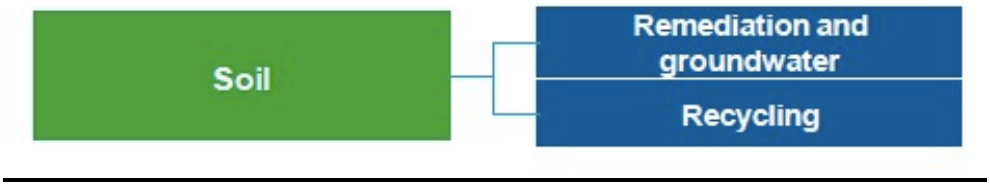
business in Québec. Québec can take advantage of research chairs in solar building (e.g. Concordia University and Polytechnique) to acquire cutting-edge expertise.

Soil & Groundwater:



The treatment, remediation and recycling of soil and groundwater represent a mature market, technologically speaking. The business environment is composed primarily of local SMEs. However, there are several major engineering consulting firms active internationally.

The biggest driver for the development of this sector in Québec will be the mining industry soil that needs to be decontaminated. A number of SMEs have also developed expertise in the assessment and biological treatment of contaminated sites. Some are also active in R&D.

The École Polytechnique, INRS, Concordia University and the ÉTS with its Canada Research Chair in Characterization of Contaminated Sites are particularly active in the field.

Waste Management:

Waste management is one of Québec's largest and most promising sectors. In fact, Québec can be a leader in waste-to-energy technologies (biomethanation and biofuels), recycling and waste collection (sorting and disposal).

Québec companies specialize in the brokerage and recycling of plastic and the innovative production of plastic from recycled resin. Québec possesses expertise in managing the complete cycle of waste recovery/reuse, collection, treatment, sorting and processing. Thermal plasma for waste destruction and energy recovery and optical sorting are some examples of promising niches. Moreover, it is worth noting that Québec truck manufacturers and vehicle equipment manufacturers for sorting centres are particularly active in R&D and known internationally. With stricter government requirements concerning subsurface containment, the implementation of the Québec Residual Materials Management Policy, the emergence of a range of government programs designed to support technological waste reclamation initiatives and the new legislative

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framework with regard to reducing greenhouse gas emissions, it is highly likely that Québec could maintain its strengths in certain niches and improve its R&D performance.

Québec university research chairs (e.g. INRS, Polytechnique, UQAT, McGill), as well as organizations like the Centre technologique des résidus industriels and the Centre de transfert de technologies en écologie industrielle, have developed important expertise in the field of residual waste.

Enabling Technologies:

Enabling technologies are new processes and techniques used to develop and improve existing technologies. Among other things, they can optimize the development and use of clean technology. Information and communications technologies (ICT), nanotechnologies and optics-photonics are examples of enabling technologies.

Information and communications technologies (ICT) are used to produce, process, transmit, communicate, interpret, save and dematerialize information. By helping us reduce travel, material resources and energy use and encouraging the use of energy-efficient goods and services, the ICT industry plays an important supporting role in the entire cleantech sector.

Optics-photonics refers to all the knowledge and practices associated with the generation, manipulation, detection and use of light. Technological developments in optics-photonics are used in the detection and monitoring of gases and other pollutants, solvent-free chemical analysis, device energy optimization, wind turbine/solar panel performance improvements, traffic measurement/management and more efficient waste sorting.

Nanotechnologies involve manipulating and controlling matter with at least one dimension on the nanoscale (nm, or one-thousandth of a metre), to create materials with amazing qualities: resistance to UV degradation, impact, scratches and corrosion, as well as lightness, sturdiness, conductivity, and antibacterial and antireflective properties vastly superior to those of traditional materials. A major benefit of these breakthroughs is the possibility of obtaining materials or configurations in systems with tailor-made functionalities. In terms of the environment and energy efficiency, the enhanced reactivity of some nanoparticles makes them promising candidates for fixing pollutants and developing new-generation processes.

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