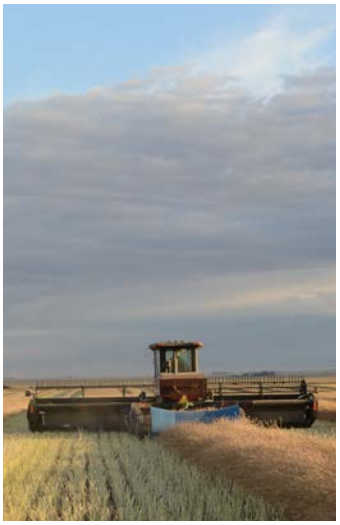

FORGING **A CLEANER AND MORE INNOVATIVE ECONOMY** IN CANADA

The challenges of the financing chain to foster innovation and growth in the cleantech sector

Conducted by **Gilles Duruflé** in collaboration with **Louis Carbonneau**
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A study produced jointly by

CYCLE CAPITAL MANAGEMENT

SUSTAINABLE DEVELOPMENT TECHNOLOGY CANADA
TECHNOLOGIES DU DÉVELOPPEMENT DURABLE CANADA

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BACKGROUND

The March 2016 Vancouver Declaration commits Canada's First Ministers to work together on the development of a Pan-Canadian Framework on Clean Growth and Climate Change. To this end, First Ministers directed the creation of Working Groups in four areas, including Clean Technology, Innovation and, Jobs.

Innovation is a fundamental part of the knowledge-based economy since it is, directly or indirectly, the key driver of labour productivity growth and, thus, the main source of national prosperity. It is in the context of the cleantech sector that it is here analyzed.

The Working Groups released their reports to the public on December 2nd, 2016. Our study is a contribution to the ongoing discussions about climate change and growing a greener economy in Canada, bringing valuable data and information to this important reflexion.

The present report prepared by Cycle Capital and SDTC intends to shed some light on the issues and provide some of the answers to questions addressed by the Working Group.

METHODOLOGY

The report focuses on the key stages (or segments) of the financing chain for innovative cleantech companies: deal flow generation initiated by patenting for commercialization purposes; seed and early stage financing and scale up financing; and analyzes Canada's strengths and weaknesses for each of these stages (or segments).

Canada's relative strengths and weaknesses are derived from an analysis of databases on scientific publications (Scopus), patents (Orbit) and venture capital investment and investors activity (Pitchbook, Cleantech Group), and comparing Canada to the US and to other leading countries in cleantech innovation. The report also uses proprietary information from Cycle's and SDTC's deal flow.

DATA SUMMARY

Research and Patents

The OECD uses the number of patents filed as a measure of innovation and, thus intellectual property also serves as an indicator of a country's technological growth.

Table 1 provides a summary of the number of publications and patents as a percentage of global totals for several countries, including Canada and the US.

Over the 2000-2016 period, cleantech related research is strong in Canada: the number of Canadian scientific publications is 15% of US scientific publications, which is 1.5 times greater than expected based on the size of relative economies or populations i.e., 10% expected on that basis.

A majority, 72%, of all Canadian publications in cleantech are concentrated in transportation and ecomobility (35%), advanced materials (16%), nuclear (14%) and air (7%). The order is the same in the US.

The number of clean technology academic patents per 1000 publications is, on average, smaller in Canada than in the US. As a result, the number of academic patents in Canada is only 7% of what it is in the US, which is less than expected on a per capita basis.

For industrial patents in this space, Canada represents 9% of the US, which is nearly at par relative to the size of the economies. However, in most sectors, the majority of the top 15 assignees are non-Canadian multinationals.

TABLE 1

NUMBER OF PUBLICATIONS AND PATENTS AS A PERCENTAGE OF GLOBAL TOTALS

	NUMBERS		
	Publications	Academic Patents	Industrial Patents
Canada	3.1%	0.7%	1.1%
US	20.1%	10.4%	12.4%
China	19.7%	65.3%	43.3%
Germany	5.6%	10%	4.8%
France	4.0%	0.4%	1.3%
UK	4.8%	1.5%	1.0%

Source of data: Questel Consulting based on Scopus and Orbit Venture Capital Financing

Venture Capital Financing

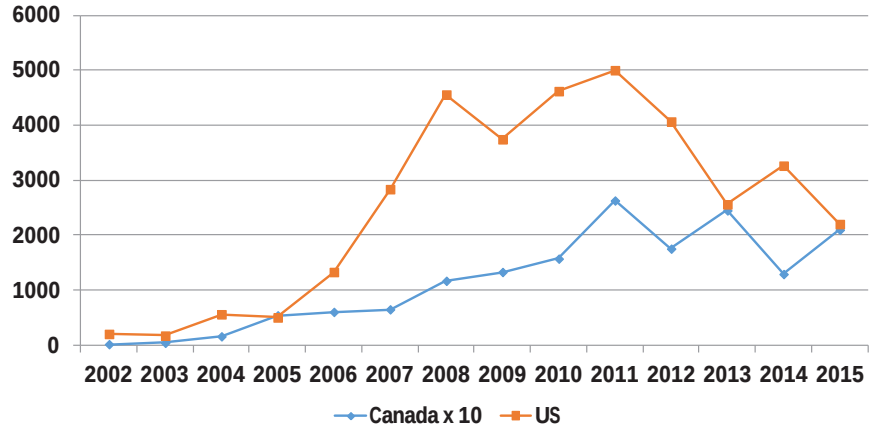
In Canada as in the US, the number of venture capital (VC) rounds in cleantech has increased by more than a factor of 10 between 2002-03 and 2013-14.

In the US, the size of rounds doubled between 2002-03 and 2012 but has strongly declined since. The decline was primarily seen in the renewable energy sectors. Investment in other sectors (cleantech IT, environmental technologies) was more stable. Overall, US VC investment in cleantech sectors grew from $206M in 2002 to $5B (25 times more) in 2011, before dropping to $2.2B in 2015. Even after the decline in investment recorded over the last three years, total investment in 2015 was still 11 times that of 2002 levels.

The relative trends were similar in Canada, even though the total amount of investment, on a per capita basis, was markedly lower (Figure 1).

FIGURE 1

VC CLEAN TECH INVESTMENT IN CANADA (X10) AND THE US ($M, 2002-2015)



Source of data: Pitchbook

Relative to the size of the economies, the number of VC rounds in Canada is comparable to that in the US (9.8%), but the relative size of investment per round is 56%, and, consequently, the total investment is about half of what it should be on a per capita basis (5.5%). The gap in round sizes further widens for late stage investments, at 45% in relative size of investment per round (see Table 2).

In Canada, there were only 17 VC rounds larger than $15M since 2010 vs. 406 in the US (14 times more). Five Canadian companies raised more than $50M VC equity vs. 183 companies did so in the US (39 times more).

The 20 companies that raised the most VC equity in the US raised between $326M and $1.2B. 90% of their VC investors were American, with an average amount invested per investor of $28M.

In Canada, the 20 top companies raised between $20M and $292M. 40% of their investors are foreigners, with an average amount invested per investor at $7.5M.

Debt Financing

Debt plays an important role in cleantech, especially in those sectors that require very significant capex and depend on large amounts of financing for the industrial scale up phase.

Overall, debt raised by Canadian cleantech companies as a percentage of the US appears to be very similar to the VC situation: the number of rounds (8.0%) is slightly below where expected on a per capita basis, while the average round size is significantly smaller in Canada (65%). Consequently, the total amount of debt raised is about half of what it is in the US on a per capita basis (5.2%).

TABLE 2

CLEANTECH DEBT AND VC INVESTMENTS (2010-H1 2016) CANADA VS. THE US

	CANADA / US %		
	Number of rounds	$ invested	Average size
Venture Capital	9.8%	5.5%	56.1%
Early stage	8.7%	6.7%	77%
Late Stage	11.1%	5.0%	45%
Debt	8.0%	5.2%	64.8%

Source of data: Pitchbook

Very large players are involved at this stage in the U.S., including government agencies, large banks and specialized venture debt funds. A Canadian-based vehicle as a source of similar large-scale debt financing is needed to help Canadian companies in the early to middle stages of commercialization.

Conclusions

- While Canada is strong in producing cleantech research, as measured by the number of scientific publications on a per capita basis, Canada lags behind the US in translating this research into patents. This highlights a gap in translating research into innovation and start-up companies that can commercialize said research and compete head-on on a global basis.
- Further, Canada has lagged behind the US on a per capita basis in both venture capital and debt financing; both critical components in helping companies innovate, scale up their operations and commercialize their technologies.

1. CONTEXT OF THE REPORT AND METHODOLOGY

1.1. CONTEXT AND OBJECTIVE OF THE REPORT

The March 2016 Vancouver Declaration commits Canada's First Ministers to work together on the development of a Pan-Canadian Framework on Clean Growth and Climate Change. To this end, First Ministers directed the creation of Working Groups in four areas:

- Clean Technology, Innovation and Jobs;
- Carbon Pricing Mechanisms;
- Specific Mitigation Opportunities; and
- Adaptation and Climate Resilience.

The Working Group on Clean Technology, Innovation and Jobs has been mandated to develop a report with options on how to stimulate economic growth, create jobs, and drive innovation across all sectors to transition to a low-carbon economy, while leveraging regional strengths. This Working Group has been directed to consider a range of policy tools to bring new and emerging technology and innovations to market, sustain a competitive economy, reduce greenhouse gas (GHG) emissions, encourage growth and investment, and increase exports of clean technologies, services, and expertise.

The present report is a contribution to this Working Group prepared by Cycle Capital and SDTC. In particular, it builds on Cycle's and SDTC's experience as sources of financing for innovative and high-growth cleantech companies and it intends to provide some of the answers to questions addressed by the Working Group.

1.2. METHODOLOGY AND ORGANIZATION OF THE REPORT

In order to build on the experience and knowledge of Cycle Capital and SDTC, the report focuses on the key components of the financing chain for innovative cleantech companies: deal flow generation initiated by patenting for commercialization purposes; seed and early stage financing; and scale up financing.

The objective of the report is to analyze Canada's strengths and weaknesses for each of these components and make recommendations on how to build on strengths and mitigate weaknesses.

Canada's relative strengths and weaknesses are derived from an analysis of databases on scientific publications (Scopus), patents (Orbit) and venture capital investment and investors (Pitchbook, Cleantech Group), comparing Canada first to the US and to other countries leading in cleantech. The report also uses proprietary information from Cycle's and SDTC's deal flow. Note that deal flow generation stems mainly from inventions that have been patented for the intent of commercialization, hence our use of patents statistics in this analysis.

The report also draws on academic literature regarding venture capital characteristics and success factors.

2. OPPORTUNITIES AND CHALLENGES RELATED TO CLEANTECH

2.1. GLOBAL CONTEXT[1]

The global cleantech market is already very large and growing fast.

The main drivers of that growth are here to stay and will, in fact, intensify.

The fastest growing markets will be in emerging countries, especially China.

The most sophisticated markets are where the regulation is most binding: Europe, California and a few other American states and, increasingly, China.

2.2. CANADIAN CHALLENGES

The Canadian economy is largely based on natural resources and fossil fuels and its environmental performance is lagging, placing it in the bottom group of comparable countries[2]. This represents a particular challenge for Canada at a time when Canadian governments (federally and in most of the provinces) together with many other countries have made the transition towards a greener economy a priority.

The cleantech sector is a sizable sector in Canada. According to one source, 775 companies generated $11.6B in revenues, $6.6B in exports and more than 55,000 jobs[3] .

According to the Global Cleantech Innovation Index, Canada is among the leaders for the general innovation drivers (3rd), but for the cleantech-focused drivers (government policies, R&D expenditure and infrastructure), it is among the laggards (18th). It is in a better position (10th) for the evidence of emerging cleantech innovation (patents, startups, early stage financing) than for the evidence of commercialized innovation (14th)[4] .

Overall, between 2005 and 2014, global trade in clean technology exports doubled, growing at a CAGR of 8% and Canada's market share of manufactured environmental good declined by 41% from 2.2% to 1.3%. Among the top 24 exporters, Canada's ranking fell from 14th to 19th[5].

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1 This paragraph is a summary that draws on the following sources: Goldman Sachs, "The Low Carbon Economy", November 30, 2015; Bloomberg New Energy Finance, "New Energy Outlook 2016"; McKinsey&Company, "Myths and realities of clean technologies", April 2014. More detailed information is to be found in Appendix 2.

2 Source: "New Thinking - Canada's Roadmap to Smart Prosperity", Smart Prosperity, February 2016. More detailed information is to be found in Appendix 2.

3 Source: Analytica Advisors, "2016 Canadian Clean Technology Industry Report";

4 Source: Cleantech Group, "The Global Cleantech Innovation Index 2014"

5 Source: Analytica Advisors

3. THE ROLE OF VENTURE CAPITAL TO FINANCE TECHNOLOGY COMPANIES AND SPECIFIC CHALLENGES RELATED TO THE FINANCING OF SCALING UP CLEANTECH COMPANIES

3.1. THE ROLE OF VENTURE CAPITAL TO FINANCE TECHNOLOGY COMPANIES

Venture capital is the instrument of choice for financing technology startups and to help them grow because it brings together financial resources, expertise and networks ("smart money") around the entrepreneurs it supports, thus mitigating the specific risks related to the financing of tech companies. The key success factors of venture capital funds are the experience and expertise of their managers (operational experience and industry expertise), the quality of their networks (networks of co-investors and networks in the industry) and their ability to select and work with serial entrepreneurs. In addition, these funds must be structured according to the industry best practices (decision making processes and alignment of interests)[6] .

3.2. CANADIAN EFFORTS TO BUILD A PERFORMING VC INDUSTRY

For the last decade or more, Canada has been working hard to build a performing venture capital industry made up of specialized private independent funds. Due to their limits in terms of size and experience, the strategy of the leading Canadian VC funds has been to build relationships with the top US funds and attract them into their investments in order to benefit from their financial resources, experience, network, and access to the American market.

Such a strategy has contributed to the success of many Canadian companies and elevated the expertise and performance of the Canadian VC industry. However, it may also have contributed to the migration of these companies to south of the border and their acquisition by foreign firms.

Having contributed strongly to entrepreneurship and developing a deal flow of tech startups, the present challenge of the Canadian VC industry is to take a larger share in later stage rounds while continuing to support the scaling up of independent tech companies to create a Canadian cleantech industry. This role requires larger and more experienced funds able to take meaningful positions in financing syndicates.

[6] For a review of these arguments: Josh Lerner, "The Architecture of Innovation – The Economics of Creative Organizations", Harvard Business Review Press, 2012, Chapter 3 and Paul Gompers, Will Gornall, Steven Kaplan, Ilya Strebulaev, "How do Venture Capitalists Make Decision", June 2016.

This objective is now widely accepted. One can witness a progressive increase in size and sophistication of Canadian funds, some of them developing an increased number of later stage investment strategies:

- **iNovia Capital**: IT, Montreal, Calgary, New-York, San Francisco, 2015 fund, **$175M**
- **Georgian Partners**: Big data and applied analytics, Toronto, fund II (2013), **$200M**
- **Lumira Capital**: Life sciences, Toronto, Montreal, fund II (2012), **$111M**
- **Relay Ventures**: IT, mobile technologies, Toronto, Menlo Park, fund III (2015), **$106M**
- **XPV Water**: Water, Toronto, fund II, (2013), **$245M**
- **Tandem Expansion**: IT, technology, growth capital, Montreal, Toronto, fund I, (2009), **$300M**
- **Cycle Capital**: Cleantech, Montreal, Toronto, New-York, Seattle, fund III (2012), **$108M**

Despite their growth, the size of these funds remains limited, especially when compared to their American counterparts. To feed their knowledge of the deal flow and the market, diversify their portfolio and build credibility with foreign co-investors whose participation remain necessary, these funds need to strengthen their international position, mainly in the US. Until this happens, building larger funds managed by experienced teams will remain a challenge for the Canadian VC industry.

3.3. SPECIFIC CHALLENGES RELATED TO THE FINANCING OF SCALING UP CLEANTECH COMPANIES

The cleantech sector is made of a large number of sub sectors and different technologies (see classifications in appendix 1). From a financing perspective, it is important to note that these technologies differ strongly in their capital intensity, their risk profile, and their exit perspective.

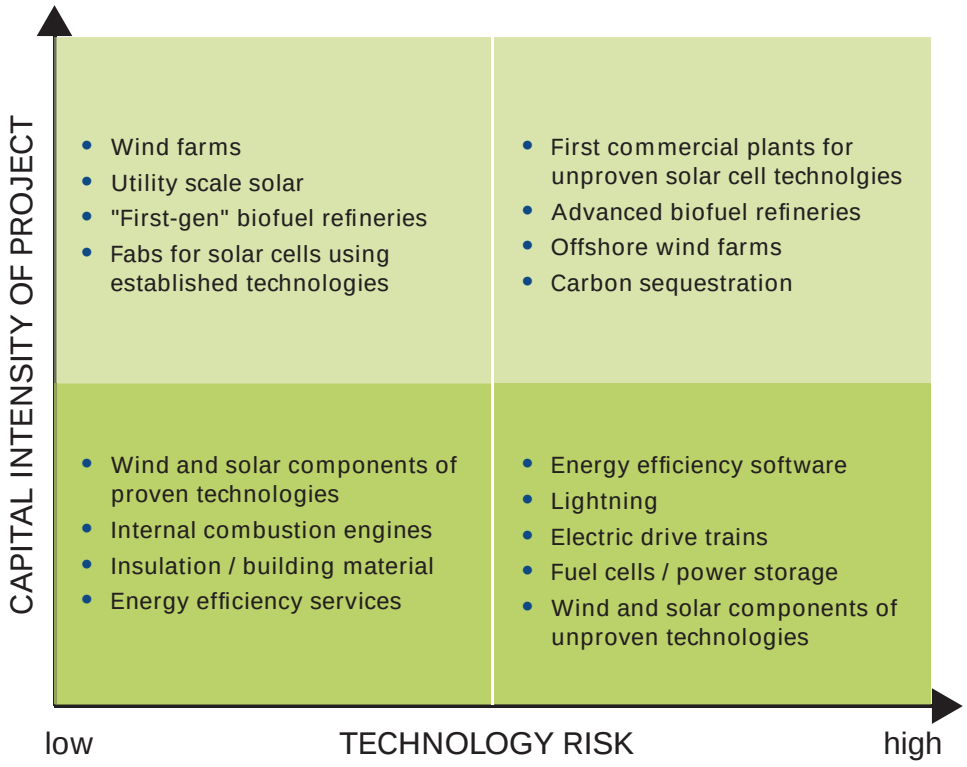
On one hand, there are technologies characterized by low or moderate capital intensity, technological risk concentrated at the start up phases (validation of the product) and whose exit happens mostly by acquisition by a large company once product and market validations have occurred. These technologies are largely software based. Their financing needs and risk profile are similar to IT, as is their investor profile.

On the other hand, there are more industrial technologies (renewable energies, biofuels, green chemistry, waste management, etc.). The risk associated with these technologies goes beyond product validation and includes industrial scale up, which implies building a plant, hence much higher capital intensity. Additionally, in many cases, incumbents are not interested in buying these technologies and therefore have to be financed for a longer period of time before public markets or other types of financing can take over. As well, financing needs are more significant, risk profiles are different, as is the type of expertise required for the industrial scale up.

The graph below visualizes how technologies within clean energy rank according to their capital intensity and technology risk. Setting up the right mix of investors (equity, debt, grants) to finance companies that are in the upper right quadrant of the graph is a challenge in all countries[7]. Nevertheless, the US seems to be more advanced than Canada in this regard and there may be lessons to be learned for Canada (see sections 4.5 to 4.8).

[7] The Natural Gas Biofuels Fund led by SDTC was created to support the scale up of liquid biofuel technologies.

SUB-SECTORS WITHIN CLEAN ENERGY



Source: Shikhar Gosh et Ramana Nanda[8]

[8] Source : Shikhar Ghosh et Ramana Nanda, "Venture Capital Investment in the Clean Energy Sector", Harvard Business School, Working Paper 11-020

4. STRENGTHS AND WEAKNESSES OF THE CANADIAN CLEANTECH STARTUP CHAIN

In order to highlight the strengths and weaknesses of the Canadian cleantech startup chain, we have analyzed:

- Scientific publications;
- Academic patents;
- Industrial patents;
- Venture capital investment by stage, including venture debt and grants received by venture backed companies; and
- The size and profile of venture capital and venture debt providers.

The analysis has been conducted by cleantech subsector using classifications that are largely inspired by the classification of the Cleantech Group (Appendix 1).

The main point of comparison to assess Canada's strengths and weaknesses is the US market due to the many similarities in our academic and economic systems. The Canadian economy is approximately 10% of the US and this is the overall benchmark. When a Canada/US ratio is above 10%, it is a Canadian relative strength, when it is below, it is a Canadian relative weakness.

For publications and patents, we have enlarged some comparisons to the world, China, and some European countries.

4.1. PUBLICATIONS: CANADA ABOVE ITS WEIGHT

Scientific publications over the 2000–2016 period have been retrieved by Questel[9], using the Scopus database. Scopus is the largest abstract and citation database of peer-reviewed literature and includes scientific journals, books, and conference proceedings.

Main findings of the analysis are the following:

- Cleantech related research is strong in Canada: the number of Canadian scientific publications is 15% of the US, which is 1.5 times its relative weight;
- 72% of all Canadian publications in cleantech are concentrated on transportation and eco-mobility (35%), advanced materials (16%), nuclear (14%) and air (7%) - the order is the same in the US; and
- The Canada/US ratio is significantly above 10% in all sectors, except in solar.

4.2. ACADEMIC PATENTS: A LOW RATE OF CONVERSION FROM PUBLICATIONS TO PATENTS

Worldwide patents and patent applications over the 2000–2016 period have been retrieved using the Orbit database. This database provides access to one of the largest global collections of patents (80+ million patent documents from worldwide offices) with many advanced search and analytics features[10].

As many Canadian universities and research centres file their patents abroad directly, our methodology considers as Canadian (i), those patents from any university and research center first filed in Canada and (ii), patents from any university, research center and academic inventor and applicant based in Canada that are filed first outside of Canada.

The main findings of the analysis are the following:

- The number of academic patents per 1000 publications is, on average, 2.3 times smaller in Canada than in the US. As a result, the number of academic patents in Canada is only 7% of what it is in the US;
- This conversion rate from publications to patents varies considerably according to sectors but the gap between Canada and the US is wide in all sectors;
- In Canada, the main sectors of concentration for academic patents are: biofuels & biochemicals (30%), advanced materials (23%), energy storage (9%), fuel cells and hydrogen (8%), energy efficiency (8%), and solar (7%); and
- In the US, they are: advanced materials (24%), biofuels & biochemicals (22%), energy storage (11%), solar (9%), energy efficiency (9%), and fuel cells and hydrogen (8%).

9 Source: Questel Consulting, "Landscape & Benchmark Analysis – Phase 1 Canada's Cleantech Sectors", August 2016

10 Source: idem

4.3. INDUSTRIAL PATENTS: CANADA NEARLY AT PAR WITH THE US, THANKS TO MULTINATIONALS

Main findings:

- For industrial patents, over the 2000–2016 period, Canada represents 9% of the US, which is nearly at par relative to the size of the economies. However, in most sectors, the majority of the top 15 assignees are non-Canadian multinationals;
- 76% of all Canadian industrial patents are concentrated on advanced materials (20%), energy efficiency (16%), energy storage (13%), biofuels & biochemicals (11%), fuel cells & hydrogen (8%), and transportation 8%;
- The situation is somewhat similar in the US. One notes, however, a stronger position in transportation (11%) and a weaker position for fuel cells & hydrogen (5%); and
- The Canada/US ratio is greater than 10% for recycling and waste (15%), water & wastewater (13%), air (14%), fuel cells & hydrogen (14%), agriculture (12%), smart grid (11%), and geothermal (10%).

4.4. PATENTS AND PUBLICATIONS: THE GROWING WEIGHT OF CHINA

Table 1 presents the number of publications and patents and the conversion rate from academic publications to academic patents in various countries and for the world.

The conversion rate in China (a world-leading 239 academic patents per 1000 academic publications) is in a different category than all other countries. Canada's rate (16) is smaller than the US (37) and the UK (23), but larger than Germany (13) and France (6).

TABLE 1

NUMBER OF CLEANTECH PUBLICATIONS AND PATENTS (2000-2015) AND CONVERSION RATES

	NUMBERS			
	Publications	Academic Patents	Industrial Patents	Academic Patents per 1000 publications
Canada	140 057	2 288	20 246	16
US	907 175	33 933	226 077	37
China	889 507	212 813	787 848	239
Germany	254 624	3 283	86 532	13
France	181 026	1 173	24 304	6
UK	214 705	4 876	18 149	23
World	4 510 100	325 787	1 818 473	72

Source of data: Questel Consulting based on Scopus and Orbit

Table 2 presents ratios related to the number of publications and patents for various countries. The world share of China is similar to the US for publications (20%) and well above for academic patents (65%) and (43%). This may denote a different behaviour regarding publications and patenting than in Western countries, but it also denotes the growing importance of China in cleantech.

Apart from China, Germany stands out for its relative weight in industrial patents (40% of the US).

TABLE 2

NUMBER OF CLEANTECH PUBLICATIONS AND PATENTS AS A PERCENTAGE OF THE WORLD (2000-2015)

	NUMBERS		
	Publications	Academic Patents	Industrial Patents
Canada	3.1%	0.7%	1.1%
US	20.1%	10.4%	12.4%
China	19.7%	65.3%	43.3%
Germany	5.6%	1.0%	4.8%
France	4.0%	0.4%	1.3%
UK	4.8%	1.5%	1.0%
World	100%	100%	100%

Source of data: Questel Consulting based on Scopus and Orbit

Table 3 presents the relative weight of Canada compared to other countries.

As already mentioned, compared to the US, Canada is above its weight for publications (15%), below for academic patents and nearly at par for industrial patents.

The Canadian economy is about 60% the size of the French and British economies and 40% the size of the German economy. Canada is:

- above its weight vs. all three European countries for publications;
- above Germany and France, but below the UK, for academic patents; and
- above France and the UK for industrial patents but far below Germany.

TABLE 3

NUMBER OF CANADIAN CLEANTECH PUBLICATIONS AND PATENTS COMPARED TO OTHER COUNTRIES (2000-2015)

	NUMBERS			Relative size of the economies
	Publications	Academic Patents	Industrial Patents	
Can/US	15.4%	6.7%	9.0%	10%
Can/Germany	55%	70%	23%	40%
Can/France	77%	195%	83%	60%
Can/UK	65%	47%	112%	60%

Source of data: Questel Consulting based on Scopus and Orbit

4.5. VC: CANADA'S WEAKNESS IN LARGE DEALS

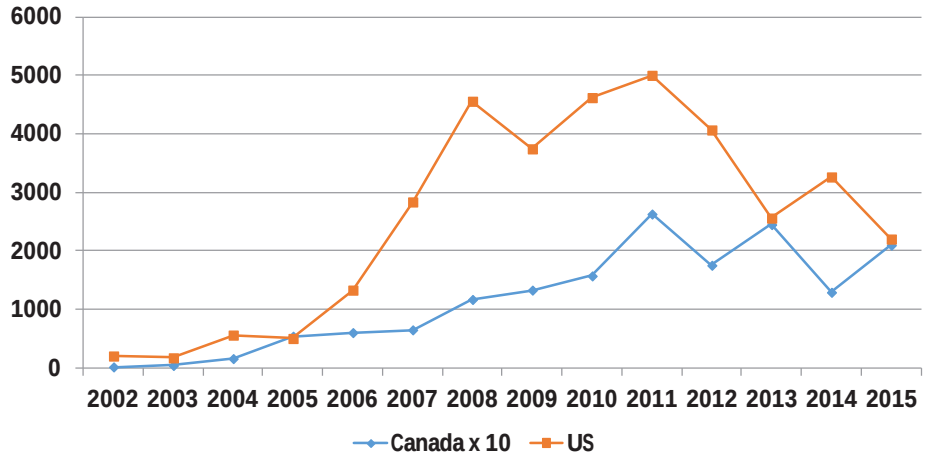
The following analysis regarding venture capital and venture debt received by VC-backed companies was conducted using the Pitchbook database. While Pitchbook has a cleantech category, there are no cleantech sectors in the database so the attribution of companies by cleantech sector was done manually by the Cycle Capital team.

The cleantech sector has witnessed a spectacular growth since the beginning of the century.

- In Canada as in the US, the number of venture capital rounds in cleantech has been multiplied by more than 10 between 2002–03 and 2013–14 but then registered a recent decline.
- In the US, the size of rounds has doubled between 2002–03 and 2007-12 and strongly declined since. This decline affected the new energy sectors particularly. Other sectors (cleantech IT, environmental technologies) are more stable. Overall, VC amounts invested in the US in cleantech sectors grew from $206M in 2002 to $5B (25 times more) in 2011 and scaled back to $2.2B in 2015, which is still 11 times that of the 2002 level.
- The situation is somewhat similar in Canada.

TABLE 4

VC CLEANTECH INVESTMENT IN CANADA (X10) AND THE US ($M, 2002-2015)



Source of data: Pitchbook

It is worth noting on the above graph that the gap between Canada and the US has diminished since 2011.

The rest of the analysis focuses on the most recent period (2010-2016).

Relative to the US, cleantech VC investment in Canada is similar in numbers of financing rounds but much smaller in dollar amounts invested.

Relative to the size of the economies, the number of VC rounds in Canada is comparable to that in the US (9.8%), but round size is about half (56%) so that total amount invested is about half as well (5.5%). The gap in round sizes is larger in late stage (Table 5).

TABLE 5

CLEANTECH VC INVESTMENTS (2010-H1 2016): CANADA VS. US

STAGE	CANADA / US %		
	Number of rounds	$ invested	Average size
ALL VC	9.8%	5.5%	56%
Seed & ES VC	8.7%	6.7%	77%
Later Stage VC	11.1%	5.0%	45%

Source of data: Pitchbook

Strong sectors in Canada compared to the US are biofuels & biochemicals, advanced materials and, to a lesser extent, water & wastewater and energy efficiency. Sectors in which Canada is particularly weak compared to the US are energy storage, transportation and, to a lesser extent, solar.

Canada lags in large rounds.

In Canada, there were only 17 VC rounds larger than $15M since 2010 vs. 406 in the US (14 times more) and 7 companies raised more than $50M VC equity vs. 183 in the US (26 times more).

The 20 companies that raised the most VC equity in the US raised between $326M and $1.2B. 90% of their VC investors are American and the average amount invested per investor is $ 28M.

In Canada, the 20 top companies raised between $20M and $292M. 40% of their investors are foreigners and the average amount invested per investor is $7.5M. For the list of the top 20 companies that raised the most VC equity in Canada and the US, see Appendix 3.

4.6. FUNDS' SIZE AND THE ROLE OF FOREIGN VC INVESTORS IN CANADIAN LARGE ROUNDS

Leading US funds investing in cleantech are large scale funds.

The list of most active US VC funds in cleantech is composed of large multi-sector funds such as Kleiner Perkins, Khosla Ventures, Draper Fisher Jurvetson and NEA and a small group of specialized cleantech funds such as Braemar Energy Ventures, DBL Partners, the Westly Group, and Rockport capital partners.

These fund managers manage a series of funds with an average size between $200M and $1.8B, most of them well beyond $300M which explains how they can be investors in rounds whose average size is between $15M and $64M or, in the top 20 US companies that, on average, raised $28M per investor.

Canadian funds are much smaller

Only a small number of specialized cleantech funds exist in Canada and their size is relatively limited, well below $300M with the exception of XPV Water which specializes in technologies related to water treatment.

TABLE 6

CANADA BASED CLEANTECH FUNDS (2008-2016)

- **Arctern Ventures**, **CAD$30M** (2012), Toronto, cleantech
- **BDC Industrial**, Clean and Energy Technologies Venture Fund, **CAD$152M** (2011)
- **Chrysalix Energy Ventures III**, **US$128M** (2008), Vancouver, Energy, fully invested, (fund registered in the US)
- **Cycle Capital Fund III**, **CAD$109M**, (2013), Montreal, Toronto, New York, Seattle, cleantech
- **Cycle-C3E**, **CAD$42M**, (2011), Montreal, Toronto, New York, Seattle, cleantech, seed fund
- **Cycle capital Fund I**, **CAD$81M** (2009), Montreal, Toronto, New York, Seattle, cleantech
- **Emerald Cleantech Fund III**, **€100M** (2012), Zurich, Toronto (European fund)
- **Enertech Capital Partners IV, US$125M** (2012), Philadelphia, Toronto, Montreal, Calgary, cleantech (US fund)
- **Pangaea Ventures III**, **US$50M** (2012), Vancouver, New materials, (fund registered in the US)
- **XPV Water Fund II**, **US$245M** (2013), Toronto, Water technologies, (fund registered in the US)
- **XPV Waterfund Limited Partnership**, **US$126M** (2010), Toronto, Water technologies, (fund registered in the US)

In terms of assets under management, the largest teams focused primarily on cleantech are XPV Capital (US$371M) and Cycle Capital ($232M). Table 8 presents the number of cleantech companies in which these funds invested and Table 9, the total number of companies in their portfolio.

In addition to these specialized venture capital funds, one has to add Evok Innovations, a partnership of Cenovus Energy, Suncor Energy and BC Cleantech CEO Alliance to fund and accelerate the development and commercialization of transformative energy solutions (2015) and also more generalist teams such as EDC, Investeco, the Fonds de solidarité, Desjardins and Fondaction, business angel groups, family offices and a few funds in IT (Rho Canada) or AgTech (Avrio) that occasionally invest in cleantech.

Over the 2010-2016 period, the most active funds in cleantech were Cycle-C3E (17 companies), BDC Industrial, clean and energy technology venture fund (13 companies) and Cycle Capital funds I and III (12 companies). Overall, the funds listed in Table 8 have invested in 58 Canadian and 36 foreign cleantech companies. Table 9 represents all investments of these same companies, including cleantech companies and companies active in other sectors.

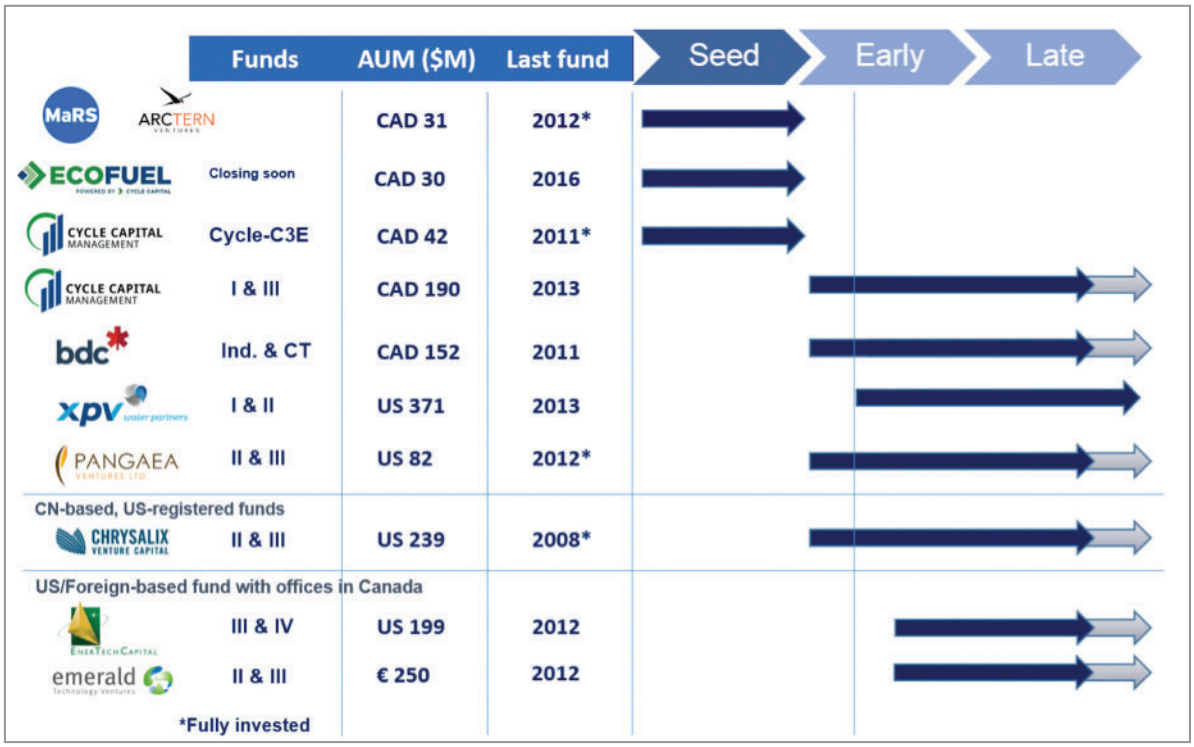
These funds have limited resources to address the double challenge of scaling up companies and the particular risk profile of more capital intensive technologies that include both technology risk and industrial scale up[11] .

[11] Another important link of the financing chain for cleantech startups that is not reflected by the databases we have analyzed are the specialized cleantech accelerators and the seed funds that are linked to them :

- Accelerators : Ecofuel, powered by the Cycle Capital platform (Quebec and Atlantic Canada), MaRS Innovation cleantech branch, powered by MaRS (Ontario), Foresight Cleantech Accelerator Centre (B-C); and
- Seed funds : Cycle-C3E and its successor Ecofuel Fund around Ecofuel, Arctern Ventures around MaRS

TABLE 7

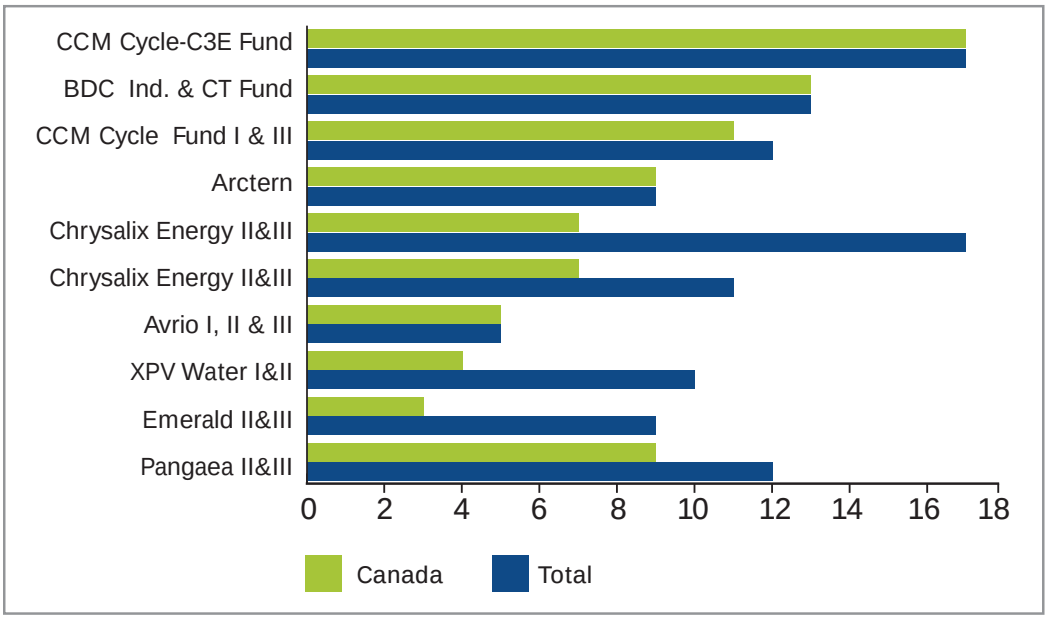
CANADIAN SPECIALIZED CLEANTECH VENTURE CAPITAL FUNDS ACTIVE SINCE 2010 – ASSETS UNDER MANAGEMENT AND INVESTMENT STAGE



Source of data: CVCA Infobase, Pitchbook, Cycle Capital

TABLE 8

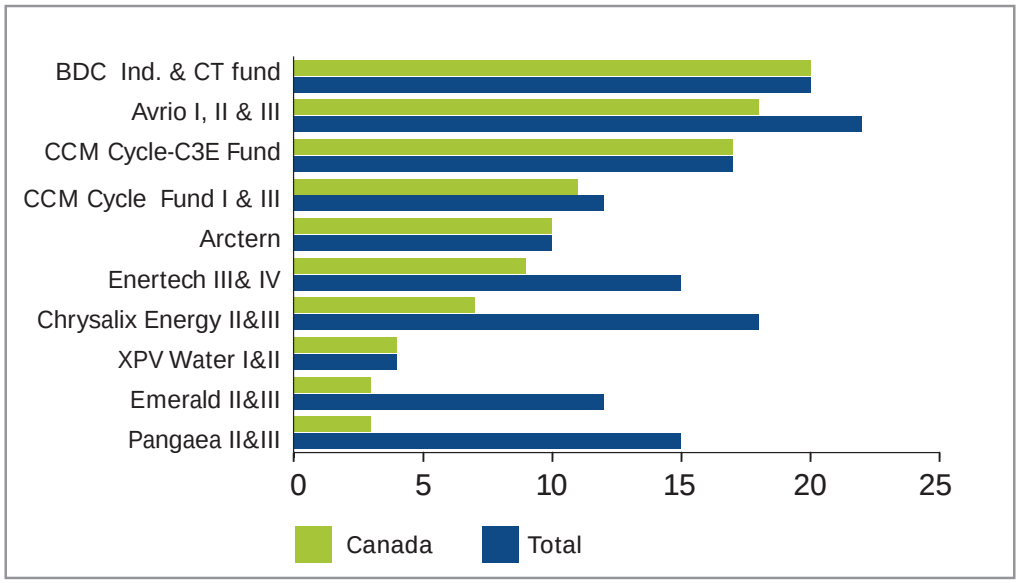
CANADIAN SPECIALIZED CLEANTECH VC FUNDS
AND FUNDS WITH ACTIVITIES IN CLEANTECH
NUMBER OF COMPANIES (CLEANTECH) FINANCED SINCE 2010



Source of data: CVCA Infobase, Pitchbook, Cycle Capital

TABLE 9

CANADIAN SPECIALIZED CLEANTECH VC FUNDS
AND FUNDS WITH ACTIVITIES IN CLEANTECH
NUMBER OF COMPANIES (ALL SECTORS) FINANCED SINCE 2010



Source of data: CVCA Infobase, Pitchbook, Cycle Capital

Foreign investors play a leading role in most large rounds in Canada.

Canadian cleantech funds, like their counterparts in other sectors, look to syndicate their investments with larger US funds in rounds B and beyond in order to address their particular challenges. They also rely on their networks of corporates which, through their corporate venture arms or directly from their balance sheet, play a more important role in cleantech than in other sectors, especially at the industrial scale up phase. Given the importance of synergies with corporates, many cleantech VCs such as Chrysalix and Cycle Capital have attracted corporates as LPs in their funds[12]. In some cases, they will also rely on government financing support (grants, special loans) for industrial scale up.

Table 10 below presents the list of investors in cleantech companies that closed deals over $15M since 2010[13]. They include many foreign funds (in red) and corporates.

12 Chrysalix counts among its LPs Fortum, Robeco, Mitsubishi, Shell and Total and Cycle Capital counts Brookfield, Cascades, Groupe M3, Gaz Métro, Rio Tinto, Lonza, Systemex, Hydro Québec and Aluminerie Alouette.

13 Some of these companies closed several rounds larger than $15M over the period.

TABLE 10

EQUITY INVESTORS IN CANADIAN CLEANTECH COMPANIES
THAT CLOSED ROUNDS OVER $15M (2010-H1 2016)

COMPANY	INVESTORS
Agrisoma	BDC Capital, Cycle Capital Management, Lune Rouge
Anaergia Inc.	EDC Equity, **Global H2O Investments LLC**, Macquarie Capital, Tandem Expansion Fund
BioAmber Inc.	**AquaRIMCO, Avrio Capital, Lanxess, Mitsui Global Investment, NAXAMBER S.A, Naxos Capital Partners, Parametric Clifton, Samsung Venture Investment, Siclanova S.A.S., Sofinnova Partners, Unigrains**
Delta-Q Technologies Corp.	Tandem Expansion Fund
Distech Controls, Inc.	Caisse de dépôt et placement du Québec, **EnerTech Capital Partners**, Fonds de solidarité FTQ, Investissements W2, **Lior Investissements, Samsung Venture Investment**
Ecobee, Inc.	**Amazon.com**, Carrier Corporation, Export Development Canada, JLA Ventures, **Just Energy Group**, Ontario Capital Growth Corporation, Relay Ventures, Tech Capital Partners, **Thomvest Ventures**
Enerkem Inc.	Alberta Energy, **ATEL Ventures**, BDR Capital, **Braemar Energy Ventures**, Cycle Capital Management, Fondaction, Fonds de solidarité FTQ, Innovatech Quebec et Chaudiere-Appalaches, Investissement Quebec, **Quince Associates, Rho Ventures, The Westly Group, Valero Energy, Waste Management**
GaN Systems Inc.	BDC Capital, BDC Industrial, Clean and Energy Technology Venture Fund, Chrysalix Energy Venture Capital, Cycle Capital Management, **RockPort Capital, Tsing Capital**
General Fusion Inc.	BDC Capital Inc., **Braemar Energy Ventures**, Cenovus Energy Inc., Chrysalix Energy Venture Capital, **Entrepreneurs Fund Management LLP, Explore Holdings LLC, Khazanah Nasional Berhad, Minor Capital (VCC) Ltd., Intl private investors**
Morgan Solar Inc.	ArcTern Ventures, Enbridge, **EnerTech Holding Company, Iberdrola, Kuwait Investment Authority, Nypro, PERSEO, The Frost Group, Turnstone Capital**
Nexterra Systems Corp.	ARC Financial Corp., Tandem Expansion Fund
Potentia Solar Inc.	Conundrum Capital Corporation, MacKinnon, Bennett & Company Inc. (MKB), Victoria Square Ventures Inc.
Sulvaris Inc.	Avrio Ventures Management Corp., Other investors

Source : CVCA Infobase, Pitchbook, Cycle Capital

Corporate venture funds and corporations are very active in large rounds. In Canada, they are mostly foreign.

In the US, corporate investors (corporate VC groups or corporations) play an important role in 16 of the top 20 companies that raised the most capital.

In Canada, corporate investors (corporate VC groups and corporations) play an important role in 7 of the top 9 Canadian companies that raised the most capital. They are less present in the top 11-20:

- Most active corporate VC groups are all foreign. They are only present in a small number of companies but mostly in large rounds; and
- Canadian resource companies such as Enbridge and Cenovus, are present alongside US corporations. Waste Management, Cenovus, Enbridge and Valero played an important role in 3 of the top 20 Canadian companies that raised the most capital: Enerkem (number 1), Morgan solar (number 4), and General Fusion (number 5).

An equity financing environment that is not conducive to the scaling up of independent cleantech companies in Canada.

The environment for equity financing in cleantech is relatively weak in Canada for a variety of reasons: the small number of specialized cleantech funds; the smaller size of these funds than in the US; a lack of Canadian cleantech corporate VC funds; and a low level of involvement of Canadian corporations in cleantech deals.

As a consequence, Canadian cleantech companies have to rely on foreign sources (independent VC funds, corporate VC funds and corporations) for larger rounds and scale up phases. These foreign investors play an important and positive role as they bring capital, expertise and networks to scale up companies.

However, when the ownership of companies becomes largely foreign and Canadian investors are marginalized, this diminishes the probability of scaling up independent companies in Canada.

4.7. VENTURE DEBT: IMPORTANCE OF US GOVERNMENT AGENCIES

Venture debt[14] plays an important role in cleantech, especially in those sectors that require large amounts of financing for the industrial scale up phase.

[14] Chrysalix counts among its LPs Fortum, Robeco, Mitsubishi, Shell and Total and Cycle Capital counts Brookfield, Cascades, Groupe M3, Gaz Métro, Rio Tinto, Lonza, Systemex, Hydro Québec and Aluminerie Alouette.

Overall, venture debt raised by Canadian cleantech VC-backed companies as a percentage of the US appears to be very similar to the US (Table 11): the number of rounds (8.0%) is close to the relative size of the Canadian economy (10%). The average round size is significantly smaller (65%). Consequently, the total amount of venture debt raised is about half of what it is in the US (5.2%).

TABLE 11:

CLEANTECH VENTURE DEBT AND VC INVESTMENTS (2010-H1 2016): CANADA VS. US

	CANADA / US %		
	Number of rounds	$ invested	Average size
Venture Capital	9.8%	5.5%	56.1%
Debt	8.0%	6.2%	64.8%

Source of data: Pitchbook

However, the distribution by sector is very different.

In the US, the debt is concentrated in solar (71%) and biofuel & biochemicals (17%).

In Canada, 88% of all venture debt raised is concentrated in biofuels and biochemicals. As a percentage of the US, the only significant sector in which Canada is strong is biofuel & biochemicals: 24% of the US in number of rounds; 27% in amounts raised; and 112% in average size of debt round. Debt in Canada is absent or quasi absent in solar, nuclear and recycling & waste where it plays a significant role in the US, especially in solar.

In the US, 13 out of the top 20 companies in terms of total amounts raised, secured some debt. The amount they raised ($2.2B) represents 22% of the total equity raised by the top 20 companies and 36% of the equity amount raised by those companies that raised some debt.

In Canada, according to Pitchbook, only two out of the top 20 companies raised some debt, one in biofuel & biochemical and one in wind. Other top 20 in biofuel & biochemicals, advanced materials, solar and conventional fuels did not raise debt[15].

Venture debt obviously plays an important role to scale up independent companies and it is less developed in Canada than in the US.

Most active debt providers

The top 10 cleantech venture debt providers in the US by amount loaned are government agencies (Department of Energy, Federal Financing Bank, Department of Agriculture) and large international banks.

[15] Additionally, the government of Canada through SDTC has contributed $92M debt towards large scale biofuels projects, including $63M to a venture backed facility. These numbers are not reported in Pitchbook.

The most active venture debt lenders by number of rounds are specialized venture debt funds (Trinity Capital, Hercules and Horizon Technology Finance), banks and government agency and a specialised venture debt bank (Silicon Valley Bank).

The largest providers of venture debt to Canadian cleantech companies are US government agencies (DOE and DOA), a Canadian alternative asset manager (IAM), US venture debt funds (Hercules and Western Technology Investment) and a US bank (Comerica). Smaller Canadian lenders include a retail fund (Fondaction), government agencies (Agriculture and Agri-food Canada, AVAC), Canadian financial groups (Kirchner Group and Espresso Capital Partner) and a law office (Fasken Martineau). Canada's largest venture debt fund (Wellington Partners) has done no cleantech deals over the period.

To sum up: there are no Canadian equivalents to the American DOE, DOA and Federal Financing Bank to provide large amounts of cleantech venture debt. The largest providers of cleantech venture debt to Canadian companies come from the US and the size of their financings is much smaller than in the US[16] .

[16] This conclusion has to be nuanced as the activity of Export Development Canada (EDC) does not seem to be fully reflected in Pitchbook's statistics. Since the beginning of 2014, EDC has provided debt financings or guarantees to 12 Canadian VC backed companies. However these financings remain small: 18 financings below $1M, 7 between $1M and $5M and one between $5M and $15M (source: EDC). They are not comparable to large financings available in the US.
SDTC NextGen Biofuels Fund, now closed, has also been an important debt provider for biofuel companies.

4.8. GRANTS

In the US, the US Department of Energy (DOE) is the largest grant provider to cleantech companies: $277M to 68 companies with an average of $4.1M per company.

But there are five other government agencies in the US that provide significant dollar amounts of grants with an average per company between $1M and $13.4M: the US Department of Agriculture ($134M), the California Energy Commission ($47M), the National Science Foundation ($36M), NASA ($30M) and ARPA-E ($13M) (Table 12).

Since 2010, SDTC has signed 94 funding contracts totaling $290M at an average of $3.1M each. Of these companies, 24 had venture backing at the start of the project. Taking into account the relative size of the economies, this represents a larger impact in Canada than the DOE in the US. Other federal and provincial agencies are also active in these fields. Unfortunately, Canadian agencies are not well represented in the Pitchbook database, thus making comparisons difficult.

TABLE 12

TOP GRANT PROVIDERS TO VC-BACKED CLEANTECH COMPANIES IN THE US (2010-H1 2016)

#	INVESTOR NAME	INVESTOR TYPE	DEALS	COMPANIES	$M INVESTED	AVERAGE PER COMPANY ($M)
1	**US Department of energy**	Government	85	68	$277.3	$4.1
2	**National Science Foundation**	Government	41	37	$36.1	$1.0
3	**US Department of Agriculture**	Government	12	10	$134.1	$13.4
4	**The California Engergy Commission**	Government	11	10	$46.7	$4.7
5	**NASA**	Government	8	8	$29.9	$3.7
6	**Arpa-E**	Government	5	5	$13.0	$2.6
7	**US EPA**	Government	4	4	$0.7	$0.2
8	**US Department of Defense**	Government	3	3	$2.3	$0.8
9	**Oregon BEST**	Government	3	3	$0.3	$0.1
10	**Massachusetts Clean Energy Center**	Government	3	2	$0.1	$0.1

Source of data: Pitchbook

5. CONCLUSION

The above analysis has allowed us to identify some strengths and weaknesses of the Canadian cleantech start up chain.

Among the strengths:

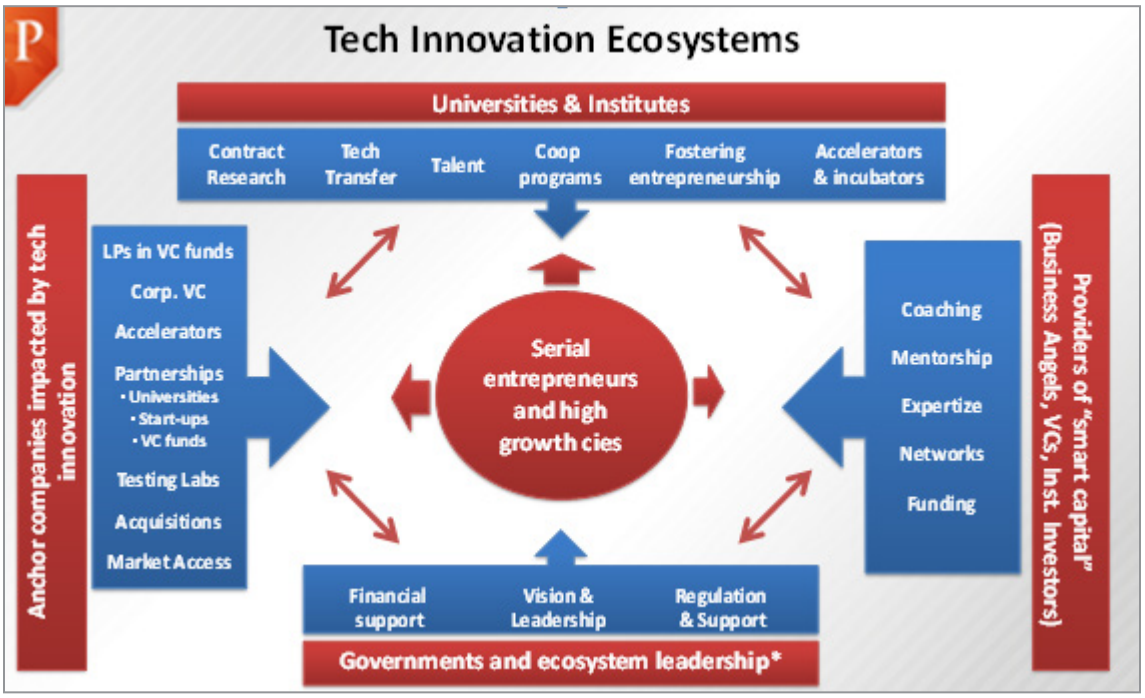
- The high level of academic publications;
- A relatively high level of industrial patents owned by companies based in Canada;
- The emergence of specialized cleantech VC teams (Cycle Capital, XPV Water partners, Arctern) and accelerators (Ecofuel/Ecofuel fund, MaRS Innovation cleantech branch, Foresight);
- A strong specialized federal government agency (SDTC) as well as specialized provincial agencies and a larger pool of agencies that provide grants for clean technology; and
- Sectors that stand out all along the chain: biofuels & biochemicals and, to a far lesser extent, advanced materials.

Among the weaknesses:

- The low rate of conversion of academic publications into academic patents;
- The high proportion of industrial patents that are owned by multinationals' Canadian subsidiaries and not by companies that originate from Canada;
- The absence of global champion based in Canada and the very small number of companies able to raise large rounds in order to scale up;
- The relatively small size of Canadian cleantech VC funds and the absence of a large specialized cleantech fund based in Canada able to take a lead role in scale-up financings;
- The very low level of involvement of Canadian corporate venture and Canadian corporations in the cleantech financing chain;
- The absence of specialized large scale venture debt providers in Canada for early commercialization or technology scaling such as the now closed SDTC managed Next Gen Biofuels Fund[17];
- In terms of sectors, the low level of Canadian participation in sectors that get a lot of traction in the US (solar, energy storage, transportation) and the relatively large number of small rounds without larger follow on financing in a great number of sectors.

[17] EDC and BDC are preparing to expand their activities in this field.

The above analysis has focused on the financing chain. The financing chain is just one part of tech innovation ecosystems as illustrated in the graph below. The success of the Canadian cleantech ecosystem will depend on the level and intensity of collaboration among all the stakeholders of this ecosystem. Future recommendations will have to take into account this necessity.



Source: QCC Tech Innovation Platform (TIP)

APPENDIX 1
CLASSIFICATIONS

CLEANTECH GROUP	VC ANALYSIS (REPORT)	PUBLICATIONS AND PATENTS ANALYSIS (REPORT)
Advanced materials	Advanced materials	Advanced materials
Agriculture and food	Agriculture & food	Agriculture
Air	Air	Air
Biofuels and biochemicals	Biofuels & biochemicals	Biofuels & biochemicals
Energy efficiency	Biomass generation	Energy efficiency
Energy storage	Conventional fuels	Energy storage
Fuel cells and hydrogen	Energy efficiency	Fuel cells & hydrogen
Biomass generation	Energy storage	Industrial IoT
Internet of things	Fuel cells & hydrogen	Nuclear
Nuclear	Geothermal	Recycling & waste
Recycling and waste	Hydro & marine power	Renewables: Solar
Resource sharing	Nuclear	Renewables: Wind
Smart grid	Recycling & waste	Renewables: Geothermal
Solar	Renewable energy generation	Smart grid
Transportation	Services	Transportation
Unmanned aerial vehicles	Smart grid	Water & wastewater
Water and waste management	Solar	
	Transportation	
	Water & wastewater	
	Wind	
	Other cleantech	

APPENDIX 2
SUPPORTING INFORMATION FOR PARAGRAPHS 1 & 2

1. THE GLOBAL CLEANTECH OPPORTUNITY

Cleantech[18] represents a huge global opportunity, with a large and fast growing market, and main drivers – especially environmental and economic – that are well entrenched and, in many cases, intensify.

Goldman Sachs estimates the market size of the low carbon technologies at $603B in 2014 and given the increasing environmental constraints, it will grow at an accelerating pace. Among these low carbon technologies, four front-runners that combine scale and rapid growth presently stand out: solar PV (36.3% 3 year trailing volume CAGR), onshore wind (10.3%), hybrid and electrical vehicles (32.3%) and LED (73.0%)[19].

Bloomberg New Energy Finance forecasts $9.2T of new energy investment worldwide ($370B per year) between 2016 and 2040. These investments will be largely concentrated in solar and wind power generation, battery storage and smart grid with non-OECD countries receiving the bulk of new capacity. This is due to OECD countries focusing more on system services such as demand response, battery storage, interconnectors, and control systems[20]. "Despite all these investments, power sector emissions will still be 5% higher in 2040, as progress in the EU, US and China is offset by steep emissions growth in India and SE Asia.To bridge the gap to a two-degree emissions trajectory, we would need another $5.3T, or $212B per year, over the next 25 years."[21]

Goldman Sachs evaluates the global environmental market (water, waste management and remediation) at US$492B[22]. In China alone, environmental investment will grow by 60% from US$5 to $8B between 2011-2015 and 2016-20.

Reviewing the "Myths and realities of clean technologies", McKinsey identifies three main factors that will continue driving strong growth for cleantech:

Growing demand and resource constraints

"The sources of underlying demand—a growing middle class around the world and resource constraints — aren't going away, and cleantech is pivotal in dealing with both".[23]

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18 The main subsectors of cleantech are (i) the "low carbon technologies" (renewable energies, smart grid and energy storage and low carbon transportation), (ii) water and waste management and (iii) agriculture and bioproducts.

19 Goldman Sachs, "The Low Carbon Economy", November 30, 2015.

20 Bloomberg New Energy Finance, "New Energy Outlook 2016".

21 Ibid. p.4

22 Data for North America, Western Europe, Japan, China, India, Australia and New Zealand. Source: Goldman Sachs, "China's Environment", July 13, 2015.

23 McKinsey&Company, "Myths and realities of clean technologies", April 2014, p.2

Potential for disruption

"We looked at 16 important clean technologies and found that while every single one has made progress over the past decade, some are moving much faster than others. Just over half of them—advanced building technologies, advanced agriculture, food life-cycle optimization, grid analytics, grid-scale storage, intelligent transport, next-generation vehicles, solar PVs (photovoltaics), unconventional natural gas, and water treatment—could become truly disruptive to the incumbent industries. The others have enormous potential and could well succeed, but without disrupting the status quo". [24]

Cleantech is getting more economically competitive

"Yet cleantech has far exceeded expectations in many areas; technological innovation and manufacturing improvements have driven prices down. Costs for onshore wind, solar PV, and lithium-ion batteries have all fallen faster than many industry watchers anticipated, for example, and are continuing to drop. The cost of electricity from onshore wind facilities is half what it was 15 years ago, thanks to technological innovation and business-model changes. In the lighting market, LED gained market share as manufacturing costs and prices fell; over the last 5 years, the cost of super-efficient LED lights has fallen by more than 85 percent. And the cost of electrical storage fell by roughly half, from $1,000 per kilowatt hour (kWh) in 2009 to $500 per kWh in 2012. Similar shifts are taking place in less prominent arenas, such as water reuse, waste separation, and anaerobic digestion. Total installed costs that US residential consumers pay for solar PV have also been falling fast, from nearly $7 per watt of peak system capacity in 2008 to less than $4 in 2013. We think that could fall to as little as $1.60 by 2020. The bottom line: cleantech is getting more economically competitive". [25]

2. THE SMART PROSPERITY CHALLENGE

"The world is changing and the most advanced economic players are forging cleaner, more innovative economies. An emerging consensus of the world's most trusted economic and business authorities is that the global economy is moving toward a new, low-pollution model built on clean innovation. This transformation is inevitable, and Canada must act fast to secure a prosperous future as the world's leading economies reinvent themselves." [26]

Transitioning to a cleaner economy is both a challenge and an opportunity. For Canada, the challenge is particularly big as our economy is largely based on natural resources and fossil fuels and we are presently lagging most OECD countries in terms of carbon emission reductions.

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[24] Ibid., p.3

[25] Ibid., p. 3-4

[26] "New Thinking - Canada's Roadmap to Smart Prosperity", February 2016, p.1
http://www.smartprosperity.ca/sites/default/files/documents/spfullreport2016feb25a-final.pdf

Overall, Canada's environmental performance ranks low by international standards:

- 19th in Environmental Performance Ranking 2014-2015;
- 14th out of 15 on CO2 productivity;
- 15th out of 15 on energy productivity;
- 9th out of 11 on water withdrawal productivity; and
- 11th out of 15 on material consumption productivity.[27]

It is therefore all the more important for Canada to invest in cleantech innovation and production in order to rectify this situation, to benefit from the large and growing domestic and global opportunity and to mitigate the costs of transition in terms of jobs, growth, and economic wealth.

3. CANADA'S CLEANTECH SECTOR

With over 775 technologies companies, Canada's cleantech sector is already an important component of our economy. In 2014, its revenue was an estimated $11.6B and clean technology companies directly employed 55,600 people. Export revenues were approximately $6.6B [28].

Its performance as measured by the Global Cleantech Innovation Index is mixed:

- 7th for the overall score;
- 3rd for the general innovation drivers (general innovation inputs, entrepreneurial culture) but only 18th for the cleantech-specific innovation drivers (government policies, government R&D expenditure in cleantech sectors, access to private finance for cleantech startups, country attractiveness of renewable energy infrastructure and cleantech cluster programs and initiatives); and
- It ranks higher (10th) for evidence of emerging cleantech innovation (patents in cleantech sectors, early-stage private investment, high impact cleantech startups) than our ranking (14th) for emergence of commercial cleantech innovation (revenue of cleantech companies, renewable energy consumption, late stage private investment and exits, successful publicly traded cleantech companies, renewable energy jobs).

And the report concludes: "Canada sits in the top 10 of the overall index and has excellent general innovation inputs, but does not stand out on cleantech-specific drivers. With excellent entrepreneurial attitudes, the country has very strong general innovation inputs but lacks strong government policies in support of cleantech innovation. The country has seen strong VC investment, along with a good number of high-profile cleantech

[27] S Ibid. p. 19 and 21

[28] Source: Analytica Advisors, "2016 Canadian Clean Technology Industry Report", Synopsis, p. 5.

companies and scores well on emerging cleantech innovation. On the downside, the country's commercialized cleantech score is held back by small cleantech revenues."[29]

With a CAGR of 8% from 2005 to 2014, global trade in clean technology exports doubled during this period to reach over $1T. But Canada's market share of manufactured environmental goods declined by 41%, from 2.2% to 1.3%. Among the top 24 exporters, our global ranking fell from 14th to 19th. [30]

[29] Source: Cleantech Group, "The Global Cleantech Innovation Index 2014"

[30] Source: Analytica Advisors, "2016 Canadian Clean Technology Industry Report", Synopsis, p. 5.

APPENDIX 3

TOP 20 CANADIAN CLEANTECH COMPANIES THAT RAISED THE MOST EQUITY (2010–H1 2016) – LIST OF EQUITY INVESTORS*

COMPANY	INVESTORS
Enerkem Inc.	Alberta Energy, **ATEL Ventures,** BDR Capital, **Braemar Energy Ventures**, Cycle Capital Management, Fondaction, Fonds de solidarité FTQ, Innovatech Quebec et Chaudiere-Appalaches, Investissement Quebec, **Quince Associates, Rho Ventures, The Westly Group, Valero Energy, Waste Management**
Bioamber**	**AquaRIMCO**, Avrio Capital, **Lanxess, Mitsui Global Investment, NAXAMBER S.A, Naxos Capital Partners, Parametric Clifton, Samsung Venture Investment, Siclanova S.A.S., Sofinnova Partners, Unigrains**
Potentia Solar Inc.	Conundrum Capital Corporation, MacKinnon, Bennett & Company Inc. (MKB), Victoria Square Ventures Inc.
Morgan Solar	ArcTern Ventures, Enbridge, **EnerTech Holding Company, Iberdrola, Kuwait Investment Authority, Nypro, PERSEO, The Frost Group, Turnstone Capital**
General Fusion	BDC Industrial Clean and Energy Technology Venture Fund, **Bezos Expeditions**, Braemar Energy Ventures, Business Development Bank of Canada, Cenovus Energy, Chrysalix Energy Venture Capital, **Entrepreneurs Fund**, ETF Partners, GrowthWorks Capital, **Khazanah Nasional, New Ground Ventures**, Robeco Group, **SET Ventures**, Wutif Capital
Ecobee	**Amazon.com**, Carrier Corporation, Export Development Canada, JLA Ventures, **Just Energy** Group, Ontario Capital Growth Corporation, Relay Ventures, Tech Capital Partners, **Thomvest Ventures**
ENBALA Power Networks	Chrysalix Energy Venture Capital, **Edison Energy**, EnerTech Capital Partners, Export Development Canada, **GE Ventures**, Individual Investor, **Obvious Ventures**, **Sorfina Capital**, Walsingham Growth Partners, XPV Water Partners
Dundee Sustainable Technologies	Investissement Quebec, Dundee Corporation

COMPANY	INVESTORS
Distech Controls***	Caisse de dépôt et placement du Québec, **EnerTech Capital Partners**, Fonds de solidarité FTQ, Investissements W2, **Lior Investissements, Samsung Venture Investment**
GaN Systems	BDC Capital, BDC Industrial, Clean and Energy Technology Venture Fund, Chrysalix Energy Venture Capital, Cycle Capital Management, **RockPort Capital, Tsing Capital**
Endurance Wind Power	Yaletown Partners, BC Advantage Funds, Tsleil-Waututh, Indegenous Canadian group
Atlantic Hydrogen	New Brunswick Innovation Foundation, Emera, University of New Brunswick, PrecisionH2 Power, **Kyoto Capital Partners**, Hydrogen Engine Center, Energy Reaction, Encana
Icynene	**Element Partners, Friedman Fleisher & Lowe**
LED Roadway	NSBI Venture Capital, Cycle Capital Management, Mistral Venture Partners
GreenMantra Recycling Tech.	Cycle Capital Management, ArcTern Ventures, MaRS Investment Accelerator Fund
FilterBoxx W&E	XPV Water Partners, **Enertech Capital Partners**, Walsingham Partners
Solantro Semiconductor	**Clean Energy Venture Group, Presidio Ventures**, Export Development Canada, BDC, Black Coral Capital, Ontario Centers of Excellence, Inerjys Ventures, BDC Industrial Clean and Energy Technology Fund
Ecosynthetix	VentureLink Fund, Tera Capital, **Northern Rivers Funds, Invest Michigan, H.B. Fuller Ventures, Cargill Ventures**, Canacord Genuity, **Beringea**, 401 Capital Partners
Minesense Tech.	**Prelude Ventures**, Chrysalix Energy Venture Capital, Export Development Canada, Cycle Capital Management
Inventys Thermal Technologies	**The Roda Group, Mitsui Global Investment, Element 8**, Chrysalix Energy Ventures Capital, **Chevron Technology Ventures**

Source: Pitchbook

*** Blue = foreign investor** **The company went public ***The company was acquired

FORGING **A CLEANER AND MORE INNOVATIVE ECONOMY** IN CANADA

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