Green Cluster Analysis

Hubs of green industry in Ontario

August 31, 2009

GREENING GREATER TORONTO

An initiative of the Toronto City Summit Alliance

Overview

The purpose of this deck is to highlight Ontario regions where there are higher concentrations of business activity around various green technologies. This clustering analysis is intended to inform formal cluster building and investment strategies to support the development of green industries in the Province of Ontario.

Data

Data for this analysis was taken primarily from CANMET's *Clean Energy Canadian Technology Directory (CECTD)* and supplemented by additional data from the *Toronto Region Research Alliance (TRRA)*

Limitations:

- *Businesses only:* full cluster picture requires qualitative consideration of all supporting institutions and infrastructure which this document has only touched on briefly
- *Sample only:* analysis can be further strengthened by adding more firms to the database
- *Data fields:* Analysis ignores size of firm. Analysis should ultimately consider jobs and revenue per sector in addition to number of firms

Methodology

To identify a cluster, first the share of businesses within a region as a % of all Ontario businesses was identified (total share)

Next, the share of businesses within a given sector as a % of all such businesses in Ontario was identified (sectoral share)

If the sectoral share was more than 5% greater than the total share, the region was identified as a "light cluster" in that sector. If the sectoral share was more than 30% greater than the total share, the region was identified as a "heavy cluster"

Geographic Breakdown

For this work, regions were defined by grouping postal codes into broad geographic areas that could be analyzed for the existence of industry clustering.

A judgment was made in this geographic break down to balance geographic proximity with population and industrial density. The regions are:

Barrie	Kitchener-Waterloo
Far North	London
GTA Central	Niagara
GTA East	Ottawa
GTA North	Peterborough
GTA West	Sudbury/Muskoka
Kingston	Windsor

Geographic breakdown

Major cities and towns included within each region (1000+ businesses)

Region	Cities/towns
Barrie	Barrie, Collingwood, Midland, Orillia
Far North	Kenora, Thunder Bay
GTA Central	Brampton, Concord, East York, Etobikoke, Markham, Mississauga, North York, Richmond Hill, Scarborough, Thornhill, Toronto, Unionville, Woodbridge, York
GTA East	Ajax, Bowmanville, Oshawa, Pickering, Whitby
GTA North	Aurora, Bolton, Newmarket, Orangeville
GTA West	Ancaster, Burlington, Dundas, Georgetown, Hamilton, Milton, Oakville, Stoney Creek

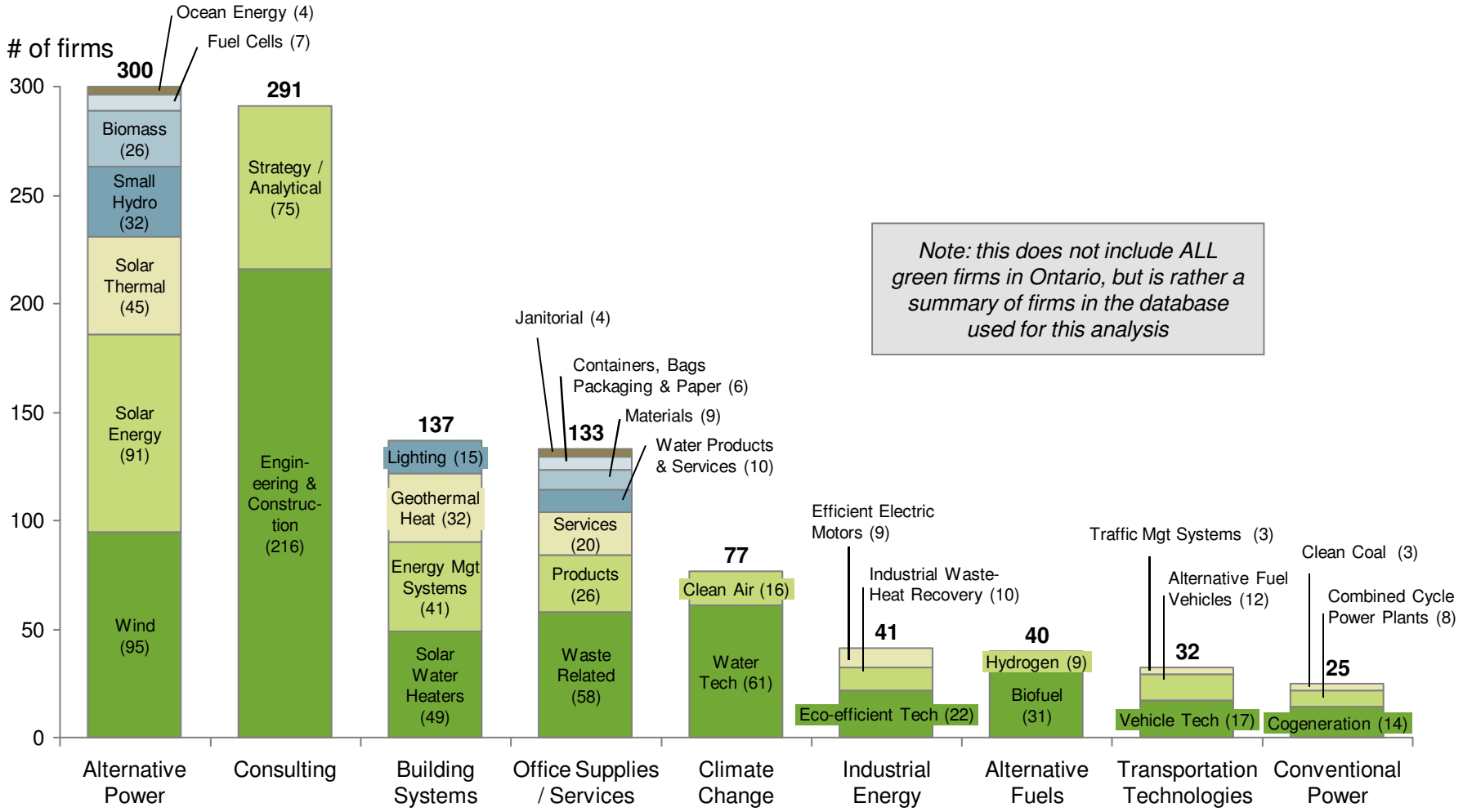
Region	Cities/towns
Kingston	Belleville, Brockville, Cobourg, Kingston, Trenton
Kitchener-Waterloo	Cambridge, Guelph, Kitchener, Owen-Sound, Waterloo
London	Brantford, London, Simcoe, St. Thomas, Stratford, Woodstock
Niagara	Niagara Falls, St. Catherines, Welland
Ottawa	Cornwall, Gloucester, Kanata, Nepean, Orleans, Ottawa, Pembroke
Peterborough	Lindsay, Peterborough
Sudbury/Muskoka	Bracebridge, Huntsville, North Bay, Sault Ste. Marie, Sudbury, Timmins
Windsor	Chatham, Leamington, Sarnia, Windsor

Firms were grouped into 9 sectors for clustering analysis

Sectors	Definitions
Renewable / Alternative Power Generation	Renewable/Alternative Power Generation produces power from resources that do not deplete such as Biomass, Solar Thermal Systems, Fuel Cells, Photovoltaic Systems, Small Hydropower, Wind Energy, and Ocean Energy
Consulting	Consultants provide support to industry to take advantage of green technology by providing expertise in the area of Engineering, Construction, Strategy, or Analytics
Building Systems	Building Systems manage and/or reduce the energy consumed by new or existing buildings. These systems decrease greenhouse gas emissions and may lead to lower costs.
Green Office Supplies and Services	Cleaning/Janitorial, Containers/Bags/Packaging/Paper, Products, and Services, etc.
Climate Change Services	Climate Change Services improve the quality of air or water through monitoring, treatment, filtering, emissions or use reductions, etc.
Industrial Energy Systems	Industrial Energy Systems provide energy solutions to industry using Eco-Efficient Technologies, Industrial Waste-Heat Recovery, and the development of Efficient Electric Motors
Alternative Fuels	Alternative fuels are fuels other than gasoline or diesel that are used to power engines such as Biofuels or Hydrogen. Nominally, alternative fuels tend to have lower net emissions than traditional fuels.
Green Transportation Technologies	Transportation Technologies look to reduce the impact of transportation on the environment through Advanced Vehicle Technology, Advanced Traffic Management Systems and Alternative Fuel Vehicles
Conventional Power Generation	Conventional Power generations includes Combined Cycle Power Plants, Clean Coal, and Industrial Cogeneration solutions

Ontario firms active in a number of key green sectors

Alternative power and consulting together are larger than all other sectors combined

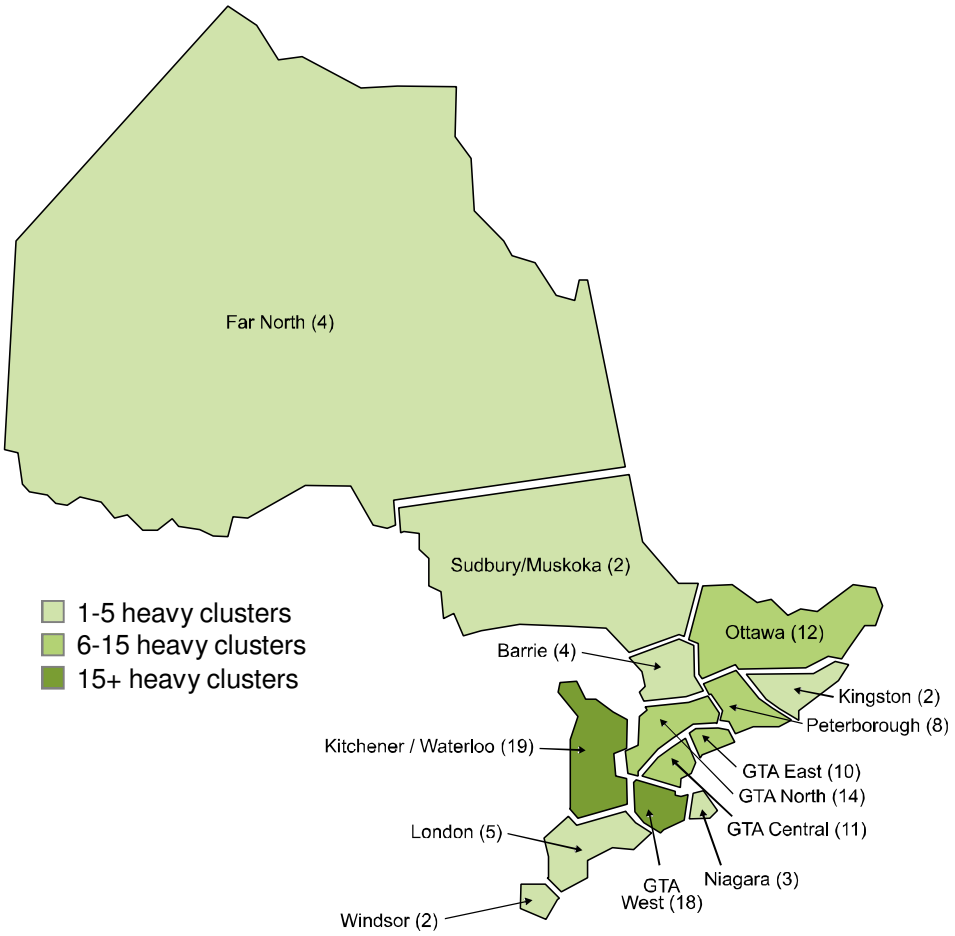


Note: this does not include ALL green firms in Ontario, but is rather a summary of firms in the database used for this analysis

Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Ontario green tech clusters

Summary view

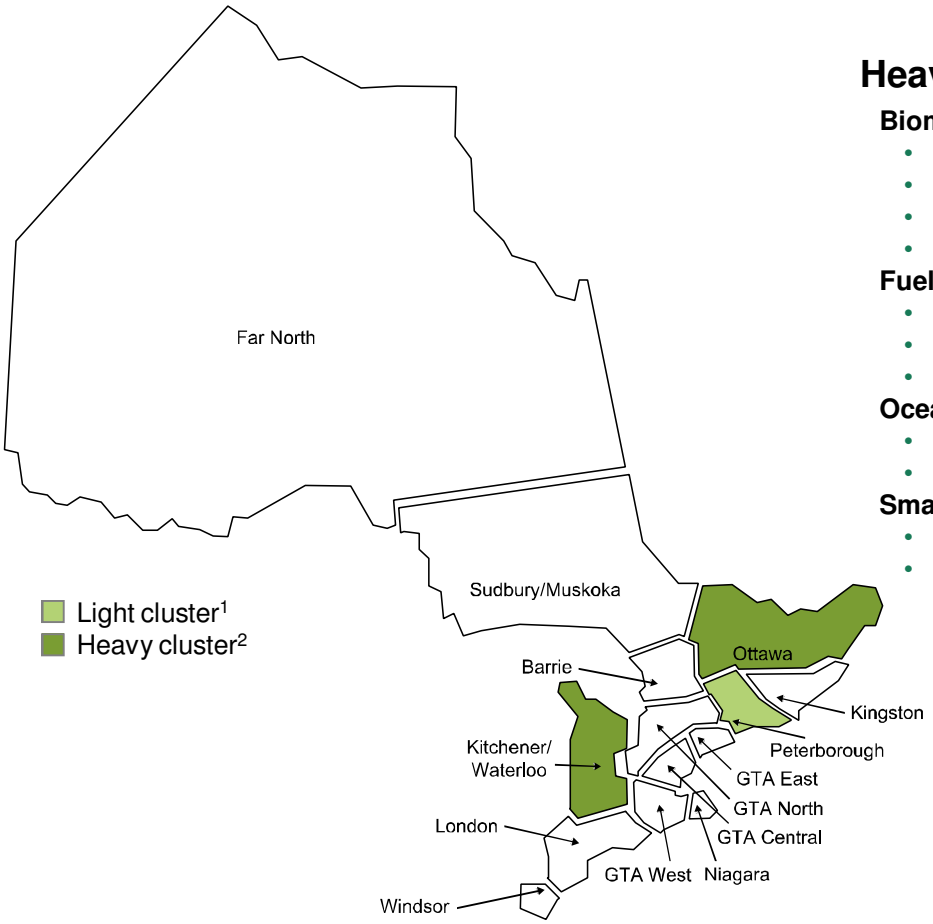


Observations	Implications
All regions with at least 2 heavy clusters	Many opportunities to invest across entire Province with focused attention in certain sectors
Kitchener-Waterloo has largest number of clusters in Province	Strategic placement between universities, population centers and industry hubs gives the region benefits in terms of clustering
Many clusters present in and around GTA	Clusters that are driven and encouraged by population density tend to build up in GTA
Clusters heaviest in regions with multiple universities	Cross pollination of ideas and research strongest when industry and academia in close partnership

Source: Clean Energy Canadian Technology Directory; CanPages.ca Business Directory; TRRA data; BCG Analysis

Ontario green tech clusters by sector

Renewable/alternative power generation (40 firms)



Heavy clusters

Biomass (26):
- Far North
- GTA Central
- Ottawa
- Peterborough

Fuel Cells (7):
- Barrie
- GTA Central
- GTA West

Ocean Energy (4):
- GTA Central
- Niagara

Small Hydro Power (32):
- Niagara
- Ottawa

Solar Energy (91):
- Kitchener-Waterloo
- Ottawa
- Peterborough

Solar Thermal Systems (45):
- Barrie
- Kitchener-Waterloo
- Ottawa
- Peterborough

Wind Energy (95):
- GTA North
- Kitchener-Waterloo

Observations/Insights

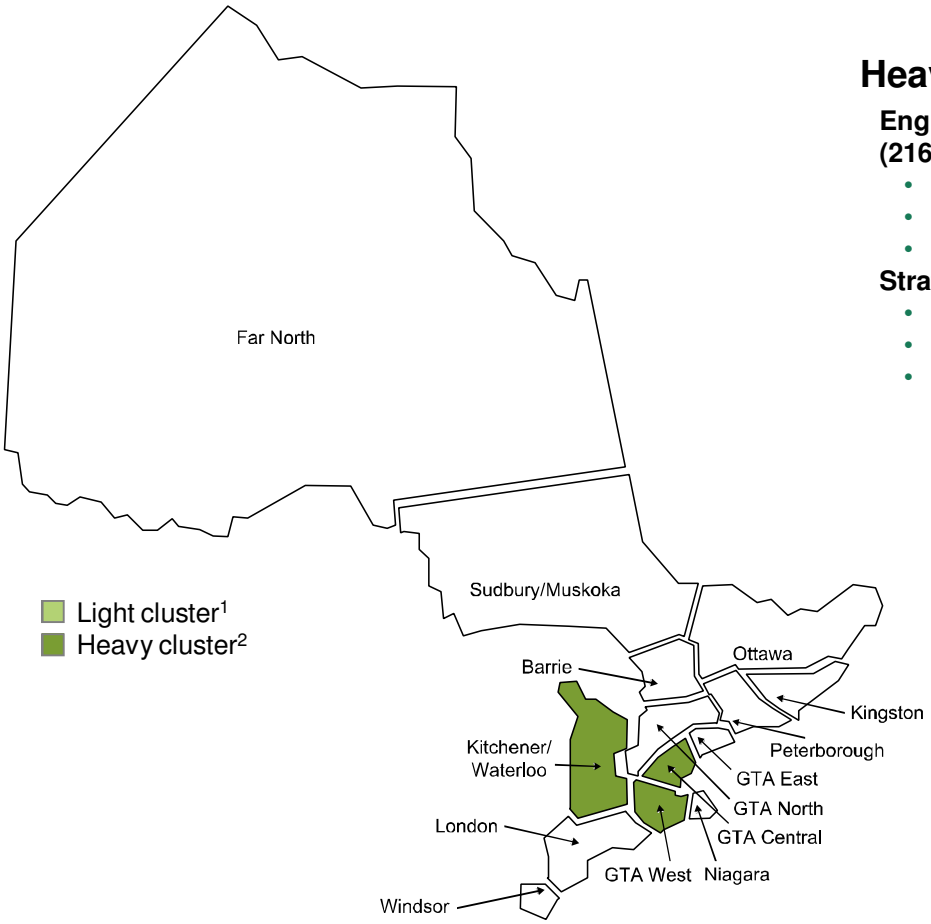
- SWITCH Kingston Alternative Energy cluster is a formal clustering strategy in this sector, yet Kingston does not appear as cluster in data (perhaps due to region definition)
- GTA Central heavy cluster in some subsectors but not overall
- Ontario Green Energy Act is catalyst for sector development
- ecoENERGY grant program from the federal government also support the industry in Ontario and B.C.
- Previous BCG work identified GTA R&D clusters in fuel cells, solar energy and wind energy

1. +5% greater sectoral representation than average for region
2. +30% greater sectoral representation than average for region

Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Ontario green tech clusters by sector

Consulting (291 firms)



Heavy clusters

Engineering/Construction (216):
- GTA Central
- GTA West
- Kitchener-Waterloo

Strategy/Analytical (75):
- GTA North
- GTA West
- Ottawa

Observations/Insights

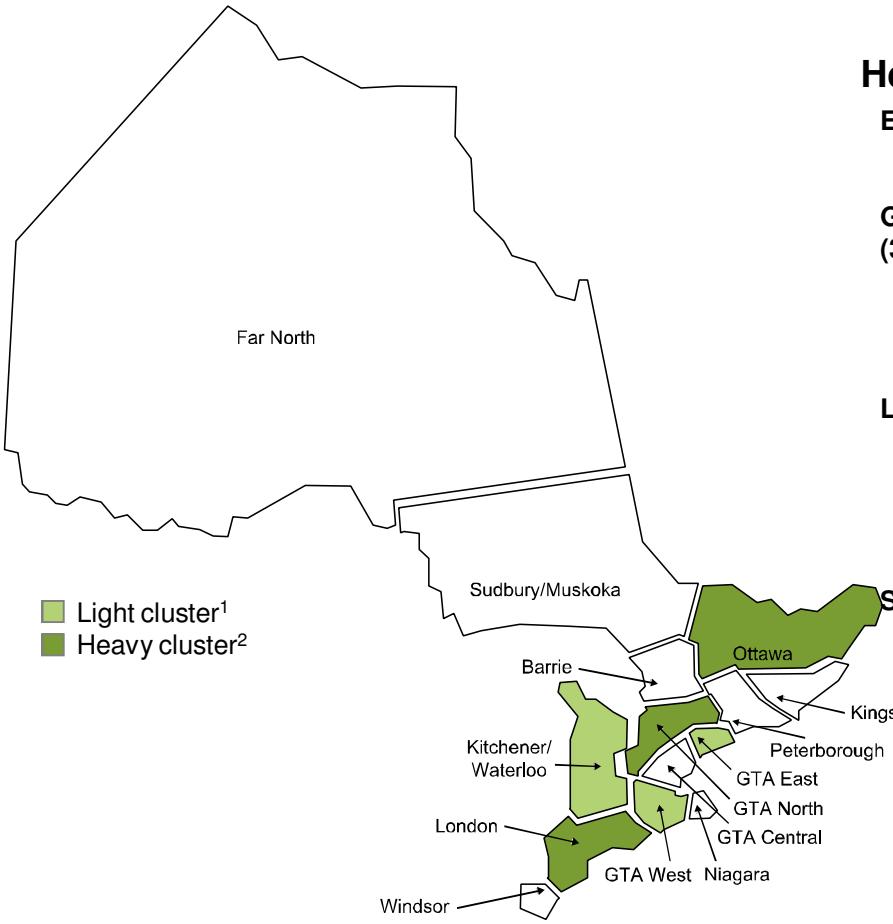
- Strategy/Analytical consultants close to areas of policy development (Toronto, Ottawa)
- Engineering/Construction consultants closer to industrial centers
- Consulting services is a support sector with many small providers (many 1-person operations)
- With further analysis done based on sectoral employment, clustering likely to be less prevalent in this sector

1. +5% greater sectoral representation than average for region
2. +30% greater sectoral representation than average for region

Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Ontario green tech clusters by sector

Building systems (137 firms)



Heavy clusters

Energy Mgt clusters (41):
- GTA Central
- GTA East

Geothermal Heat Pumps (32):
- GTA North
- Kitchener-Waterloo
- Ottawa
- Sudbury/Muskoka

Lighting Systems (15):
- GTA West
- Kingston
- London
- Peterborough
- Windsor

Solar Water Heaters (49):
- Kingston
- Kitchener-Waterloo
- London
- Ottawa

Observations/Insights

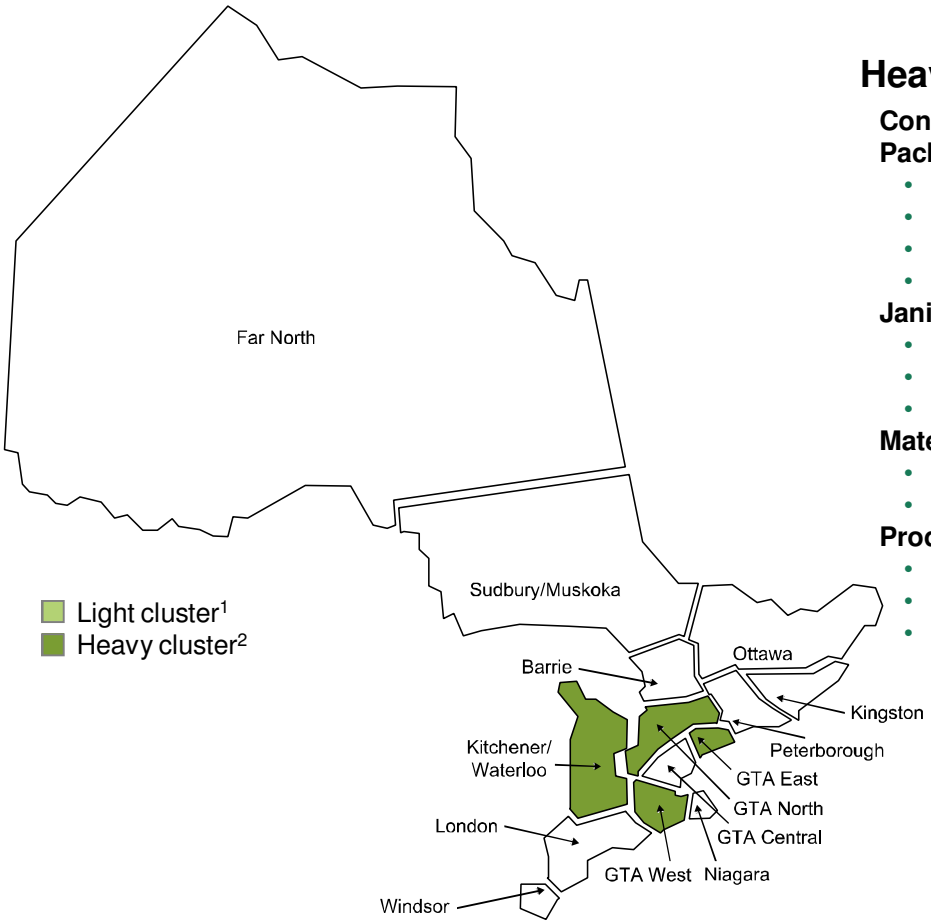
- Natural that Building Systems clusters would be centered in areas of dense population
- A number of programs in existence that support green building, including:
  - Better Building Partnership
  - Mayor's Tower Renewal (Toronto)
  - ReNew Ontario
  - Ontario Growth Plan

1. +5% greater sectoral representation than average for region
2. +30% greater sectoral representation than average for region

Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Ontario green tech clusters by sector

Green office supplies and services (133 firms)



Heavy clusters

Containers, Bags, Packaging & Paper (6):
- GTA East
- GTA North
- GTA West
- Kitchener-Waterloo

Janitorial (4):
- GTA East
- GTA West
- Kitchener-Waterloo

Materials (9):
- GTA West
- Kitchener-Waterloo

Products (26):
- GTA North
- GTA West
- Kitchener-Waterloo

Services (20):
- GTA Central
- GTA East
- GTA West

Waste Products/Services (58):
- Barrie
- GTA East
- GTA North
- GTA West
- Kitchener-Waterloo

Water Products/Services (10):
- Barrie
- GTA West
- Kitchener-Waterloo

Observations/Insights

- Green procurement largely clustered around demand hubs of business and industry
- Green procurement is more of a support sector and therefore not likely responsive to direct clustering forces
- Previous BCG analysis identified GTA R&D cluster in plastics (see Appendix C)

1. +5% greater sectoral representation than average for region
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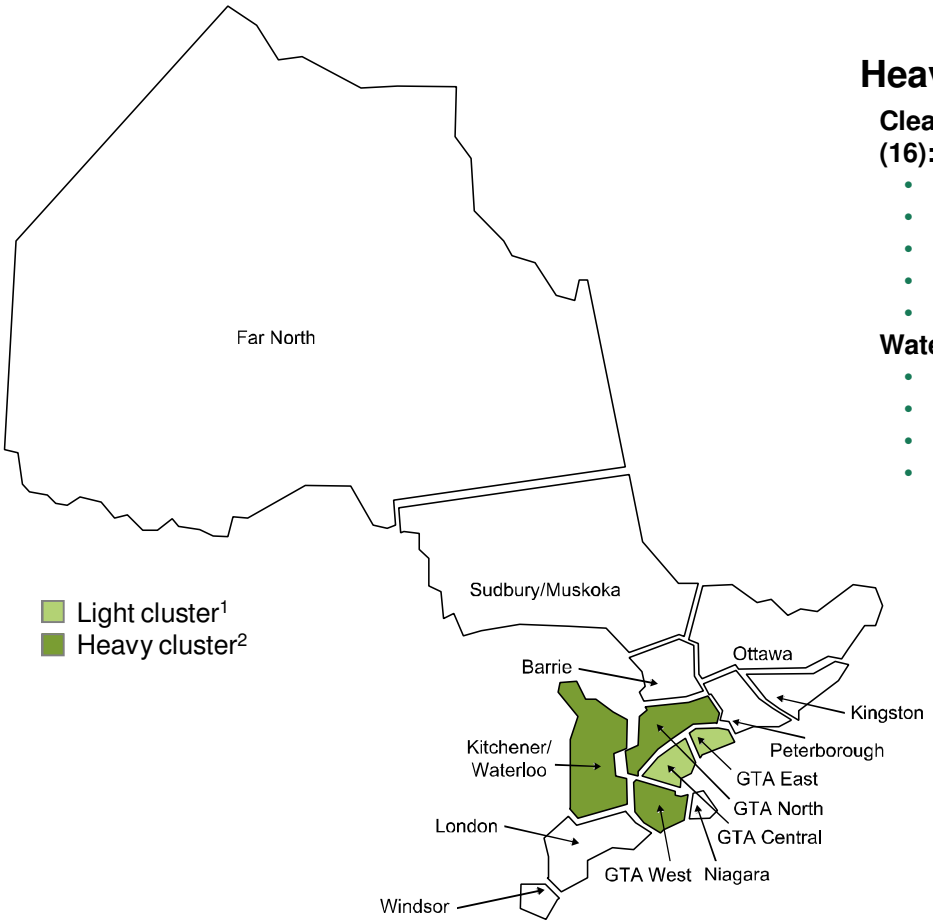
Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Ontario green tech clusters by sector

Climate change services (77 firms)



Heavy clusters

Clean Air Technologies (16):

- GTA East
- GTA North
- GTA West
- Kitchener-Waterloo
- Peterborough

Water Technologies (61):

- GTA Central
- GTA North
- GTA West
- Kitchener-Waterloo

Observations/Insights

- Climate Change Services clustered near population centers, lake water, smog heavy regions
- Previous BCG work identified R&D clusters in water and carbon capture/storage in GTA (see Appendices A and B):
  - University of Waterloo, Ontario Center of Excellence
  - Guelph University, Water Management Group
  - Natural Resources Canada
  - The Canadian CO2 Capture and Storage technology network (CCCSTN)
  - Green Energy Research Institute (GERI) at UWaterloo
  - CO2 capture and storage systems group (UWaterloo)
  - Etc.

1. +5% greater sectoral representation than average for region
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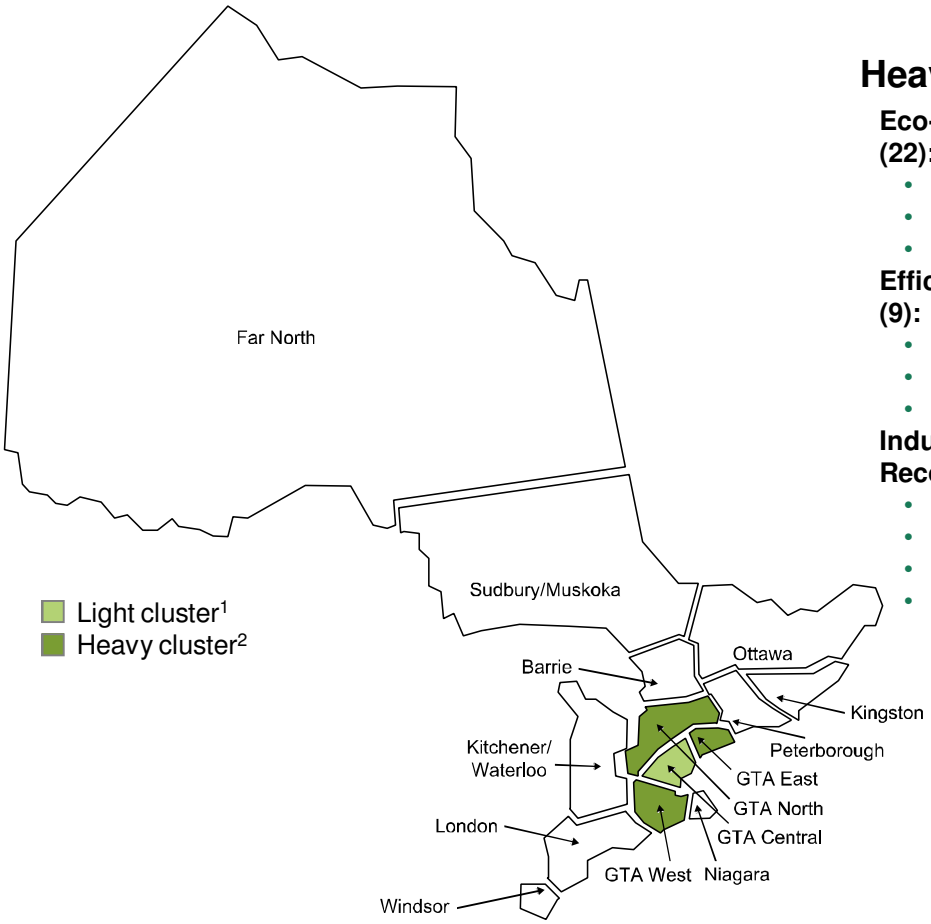
Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Ontario green tech clusters by sector

Industrial energy systems (41 firms)



Heavy clusters

Eco-Efficient Technologies (22):
- GTA East
- GTA North
- Peterborough

Efficient Electric Motors (9):
- GTA West
- London
- Ottawa

Industrial Waste-Heat Recovery (10):
- GTA Central
- GTA East
- GTA North
- Kitchener-Waterloo

Observations/Insights

- Industrial Energy Systems sector as a whole is clustered entirely around the GTA with spill-over into adjacent regions within certain subsectors
- Worth noting that "Efficient Electric Motors" does not include automotive motors perhaps explaining lack of cluster in Windsor

1. +5% greater sectoral representation than average for region
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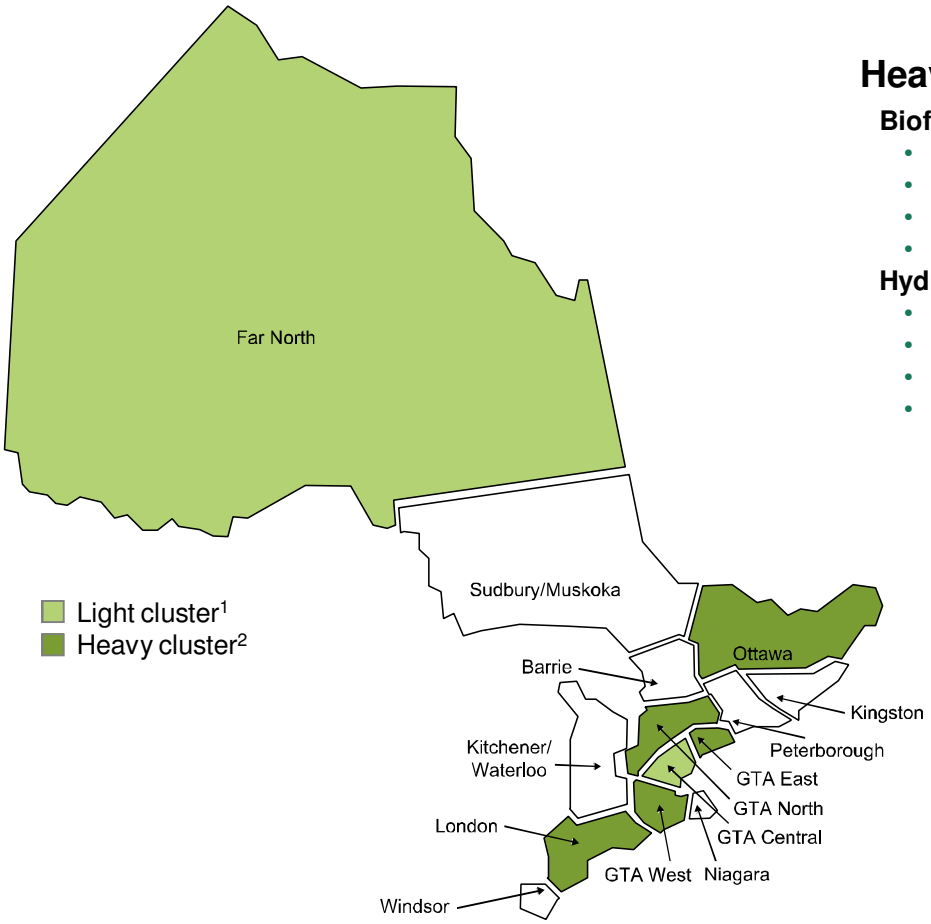
Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Ontario green tech clusters by sector

Alternative fuels (40 firms)



Heavy clusters

Biofuel (31):
- Far North
- GTA West
- London
- Ottawa

Hydrogen (9):
- GTA Central
- GTA East
- GTA North
- GTA West

Observations/Insights

- Alternative Fuel clusters heaviest in Golden Horseshoe region
- *Alternative Renewable Fuels Research and Development Fund*, issued through the Ministry of Agriculture, Food and Rural Affairs, supports efforts to promote and expand agriculture opportunities in Ontario's alternative fuels industry

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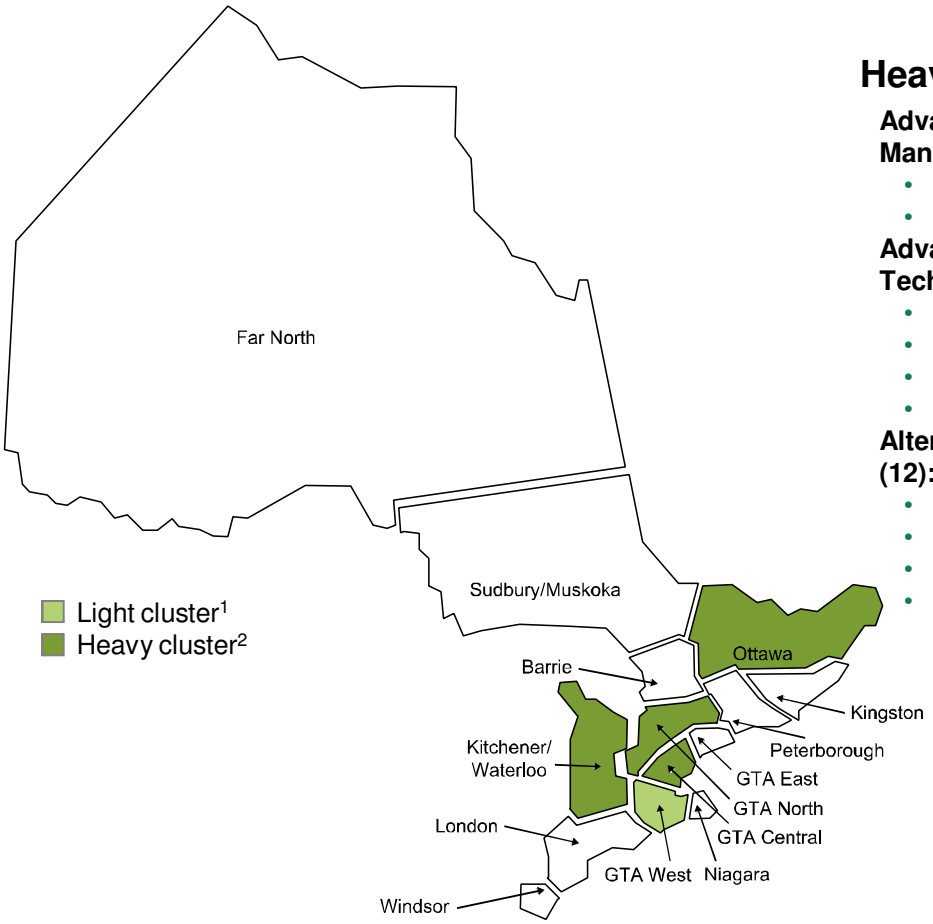
Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Ontario green tech clusters by sector

Green transportation technologies (32 firms)



Heavy clusters

Advanced Traffic Management Systems (3):
- GTA Central
- Ottawa

Advanced Vehicle Technologies (17):
- GTA Central
- GTA East
- GTA North
- Kitchener-Waterloo

Alternative Fuel Vehicles (12):
- GTA North
- GTA West
- Ottawa
- Windsor

Observations/Insights

- While Windsor not an overall cluster for Transportation Technologies sector, identified as cluster for Alternative Fuel Vehicles as would be expected given proximity to Detroit's overall automotive cluster
- $1.15B *Next Generation Jobs Fund* - mandated to support clean automotive and other green technology
- $6.0M Ontario BioCar Initiative
- Previous BCG analysis identified GTA R&D cluster in plastics (see Appendix C)

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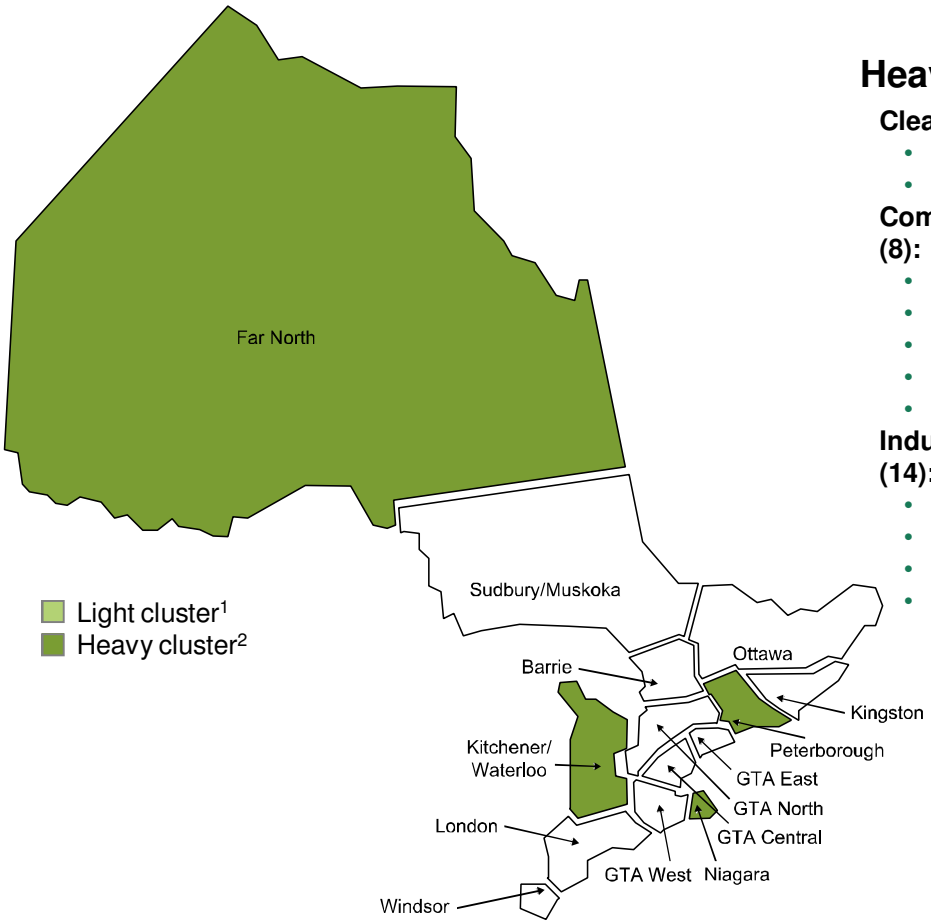
Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Ontario green tech clusters by sector

Conventional power generation (25 firms)



Heavy clusters

Clean Coal (3):
- Far North
- Kitchener-Waterloo

Combined Cycle Power (8):
- GTA West
- Kitchener-Waterloo
- Ottawa
- Peterborough
- Sudbury/Muskoka

Industrial Cogeneration (14):
- Far North
- Kitchener-Waterloo
- Niagara
- Peterborough

Observations/Insights

- Clusters distributed across Province
- Carbon capture, a clean coal technique was identified as a potential GTA cluster by previous BCG analysis based on R&D expertise (see Appendix B):
  - Natural Resources Canada
  - The Canadian CO2 Capture and Storage technology network (CCCSTN)
  - National Energy Board
  - Green Energy Research Institute (GERI) at UWaterloo
  - CO2 capture and storage systems group (UWaterloo)
  - Climate change policy (UofT)
  - Industry research chairs

1. +5% greater sectoral representation than average for region
2. +30% greater sectoral representation than average for region

Source: Clean Energy Canadian Technology Directory; TRRA data; BCG Analysis

Examples of existing programs/green cluster strategies in Ontario

EarthCare	**Sudbury Sustainability Partnership** EarthCare Sudbury is a unique partnership between the City of Greater Sudbury, over 100 community, agencies, organizations and businesses, and hundreds of individuals coming together to chart our own course for a greener, healthier and more sustainable community.
GGT R&D Cluster Analysis	**Toronto Water Cluster** While not a formal clustering strategy, previous analysis identified components of a Water cluster in the GTA and Kitchener-Waterloo regions. An area of expertise has emerged in Water Treatment, Wastewater Management, and Water Reuse (see Appendix A)
Ontario Green Energy Act	**Ontario Government Legislation** Government of Ontario legislation to make Ontario a global leader in clean, renewable energy and conservation with the intent of creating jobs, economic prosperity, energy security and climate protection.
ReNew Ontario	**Ontario Government Legislation** A $30 billion plus investment plan that signals a renaissance for Ontario's public infrastructure. The Ontario Government is matching its investment decisions with land use and community development to stimulate economic growth, build infrastructure where it can best be accommodated, and safeguard Ontario's rich agricultural assets and natural heritage.
SWITCH	**Kingston Alternative Energy Cluster** SWITCH is a network of businesses, research and educational institutions, public sector participants, and community-minded volunteers working together with a common mission: to position the Kingston region as a leading centre for sustainable energy.

Note: The above represents only a sample of the programs/green cluster strategies in Ontario. This list can be expanded and is not intended to be comprehensive.

Next steps

Priority areas for further analysis to deepen clustering insights

1 Add additional data

Supplement current list with more firms to round out the picture

Add additional fields to existing database:

- **Revenue:** using revenue as basis for analysis will help identify which regions are more successful at exploiting sectors
- **Jobs:** number of people employed within a sector gives a better view on cluster strength
- **Primary Activity:** data would allow a cross-section view of which areas of the value chain Ontario is strongest in

2 Create vignettes

Create vignettes that deep dive into key cluster strategy components to highlight additional insights:

- Existing Ontario clustering strategies
- Existing Government programs supporting green technology
- Anchor firms in various sectors upon which clusters may be built
- Key regions (Kitchener-Waterloo, GTA West, GTA North) where clustering is heavy
- Universities and R&D institutions

3 Identify priorities

Identify priority clusters for developments based on:

- Comparative areas of strength in each region
- International clusters with which Ontario would need to compete (use UofT student report as basis)
- Sectoral analysis (which sectors and subsectors are most responsive to investment and other means of stimulation)
- Demand analysis to align investment with areas of high growth and high potential

Appendix

Sub-Sector Glossary

Alternative Power

Ocean Energy: *Capture of energy carried by ocean waves and tides*
Fuel Cells: *Generation of energy from the conversion of hydrogen and oxygen into water*
Biomass: *Generation of energy from biological material derived from living, or recently living organisms*
Small Hydro: *Hydroelectric power on a scale serving a small community or industrial plant*
Solar Thermal: *Technologies for harnessing solar energy for heat*
Solar Energy: *Solar power generation by means of heat engines or photovoltaics*
Wind: *Conversion of wind energy into a useful form of energy, such as electricity, using wind turbines*

Consulting

Strategy/Analytical: *Sustainable business or strategy consultants as well as data analysts*
Engineering & Construction: *Engineering consultants, architects or other technical consultants*

Building Systems

Lighting systems: *Energy efficient/green lighting systems for residential or commercial use*
Geothermal Heat Pumps: *Central heating and/or cooling system that pumps heat to or from the ground. Uses the earth as a heat source, or a heat sink*
Energy Management Systems: *Systems and consultants with a focus on reduction of energy use*
Solar Water Heaters: *Technologies to heat water by the use of solar energy*

Office Supplies and Services

Janitorial: *Green cleaning supplies or service providers*
Containers, Bags, Packaging & Paper: *Recycled or low environmental impact packaging for commercial/retail use*
Materials: *Manufacturing materials (ex: plastics, composites, etc.) with low environmental impact compared to traditional manufacturing materials*
Water Products & Services: *Water related products and services for use in commercial/small business (ex: water filters, coolers, etc.)*
Services: *Services for business with a focus on sustainability or environmental sensitivity*
Products: *Green products for business*
Waste Related: *Waste management, recycling, treatment services for business*

Climate Change

Clean Air Technologies: *Products and services to improve air quality (ex: emissions reduction consultants, equipment, etc.)*
Water Technologies: *Products and services to improve water quality (ex: water quality consultants, water treatment services, etc.)*

Industrial Energy

Efficient Electric Motors: *Efficient motors for manufacturing (does not include vehicular motors)*
Industrial Waste-Heat Recovery: *Technologies to extract energy or heat from work that otherwise would be wasted*
Eco-Efficient Technologies: *Technology, that either directly or indirectly improves the environment*

Alternative Fuels

Hydrogen: *Technologies that efficiently exploit the potential of hydrogen energy*
Biofuel: *Solid, liquid or gaseous fuel obtained from relatively recently lifeless or living biological material*

Transportation Technologies

Traffic Management Systems: *Technologies to better route traffic and reduce vehicle idle time*
Alternative Fuel Vehicles: *Vehicles operating on renewable fuel/energy*
Advanced Vehicle Technologies: *Technologies that better manage fuel and energy use in vehicles*

Conventional Power

Clean Coal: *Technologies that reduce the environmental impact of coal energy generation*
Combined Cycle Power Plans: *In a CCPP, a gas turbine generator generates electricity and waste heat is used to make steam to generate additional electricity via a steam turbine; enhancing the efficiency of electricity generation.*
Industrial Cogeneration: *The use of a heat engine or a power station to simultaneously generate both electricity and useful heat*

Appendix A: Vignette of Toronto water cluster

Leading water customers face common industry pressures

Need for Water Treatment expertise has emerged from common industry pressures

1 Environmental sustainability

Oil and gas, transportation and manufacturing firms under increased pressure to use natural resources effectively

2 Effective asset utilization

Companies looking to extend the life of their infrastructure and investments

- Seeking out advanced engineering, materials and corrosion experts to maximize asset productivity

3 Cost management and reuse

With energy costs on the rise, companies turning to innovative methods to reuse materials, manage water consumption and lower wastewater treatment costs

4 Enhanced product quality

Pressure to deliver superior product quality and integrity at a low cost

Area of Toronto region's R&D Strength

Water Treatment

- Advanced experience in water membrane and filtration technology
- Home of Zenon Environmental

Wastewater management

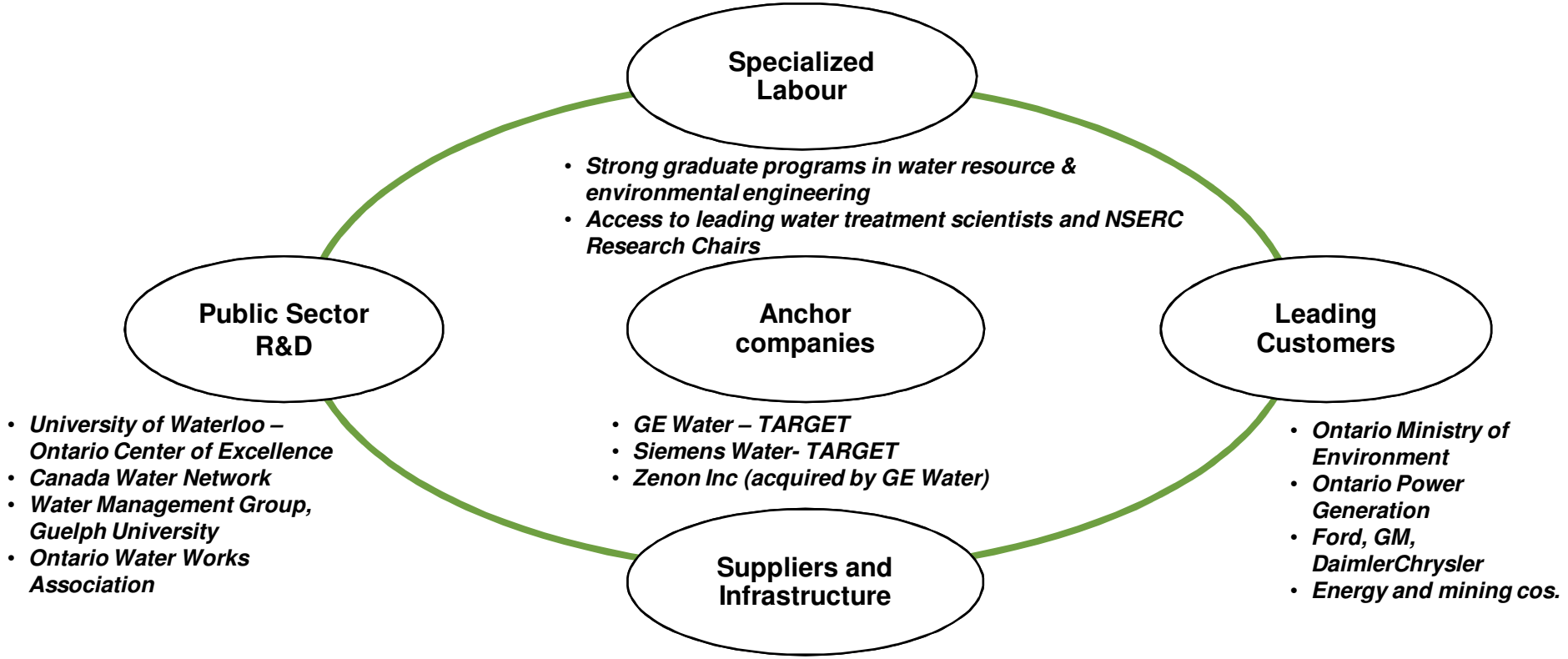
- Expertise in management of water process flows with Great Lakes projects

Water reuse

- Advanced photonics research enables water distillation

Source: Literature search; www.gewater.com, TRRA Interviews.

Appendix A: Water treatment technology is a cluster of expertise to the Toronto region



Appendix A: Sample water treatment opportunity- Siemens water

Siemens investing $7B globally on R&D

- Maintains global presence in R&D with 48,900 R&D employees in over 30 countries including facilities in Peterborough and London, Ontario
- Siemens spending $87M on cooperative research partnerships annually

Siemens Water investing in innovative water treatment technologies and continuing to lead thinking on water related investment frameworks

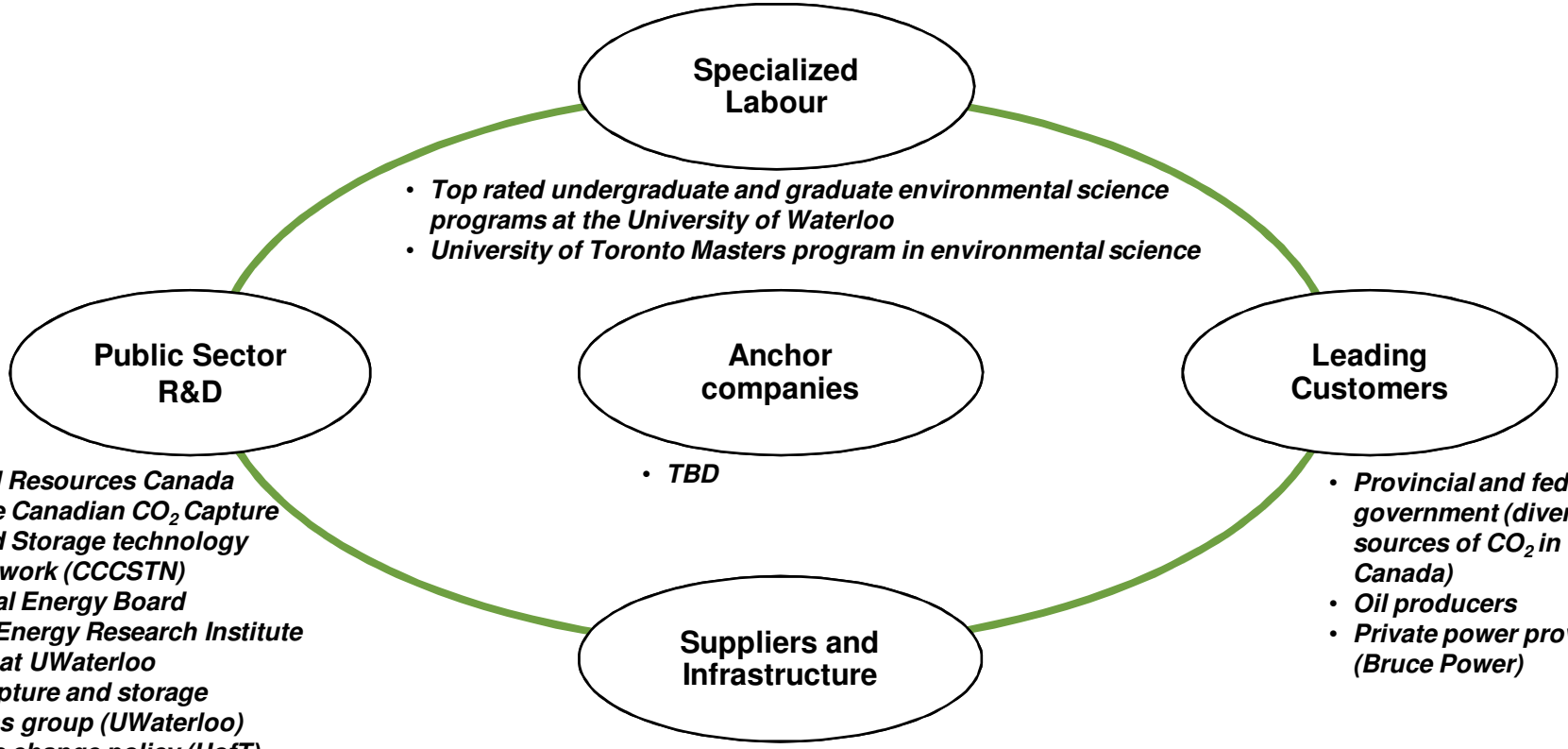
- Expanding in the water treatment market with best in class photonics (e.g. Sunlight Systems-UV purification) technology
- Leading global initiative to identify pain points for water-related infrastructure to encourage greater investment and know-how from the private sector

Toronto region well positioned for Siemens' investment and collaboration on water treatment initiatives

- Siemens strong link to the Toronto region developed through the Great Lakes Cleanup Program
- Toronto is home to world-class expertise in Siemens' areas of interest including: water facility design and water treatment technology
- Region is home to a hub of research academia, water utilities and organizations mandated to promoted water treatment innovation (Canada Water Network)

Source: Siemens' websites; BCG research

Appendix B: Carbon capture and storage is a cluster of expertise to the Toronto region



- *Top rated undergraduate and graduate environmental science programs at the University of Waterloo*
- *University of Toronto Masters program in environmental science*

- *Natural Resources Canada*
  - *The Canadian CO_2 Capture and Storage technology network (CCCSTN)*
- *National Energy Board*
- *Green Energy Research Institute (GERI) at UWaterloo*
- *CO_2 capture and storage systems group (UWaterloo)*
- *Climate change policy (UofT)*
- *Industry research chairs*

- *TBD*

- *Provincial and federal government (diverse point sources of CO_2 in Western Canada)*
- *Oil producers*
- *Private power providers (Bruce Power)*

- *Integrated CO_2 Network (ICO_2N)*
  - *participating companies represent a cross-section of Canadian industry*
- *EnCana (Calgary, AB)*
- *Apache Corporation (BC, AB, SK & NWT)*

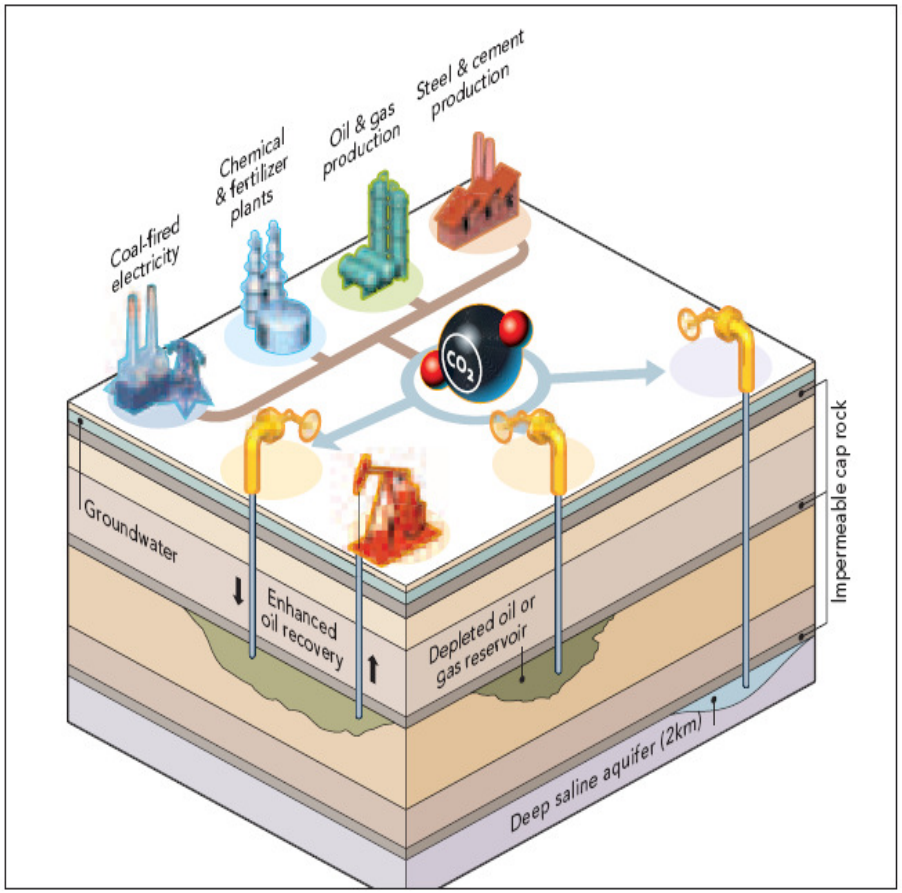
Supportive regulatory and public policy environment

- *Federal government indicated support for mandating renewable fuels standard by 2010*
- *Notice of intent to regulate GHG and CAC emissions from large industry*

Source: BCG research

Appendix B: Carbon capture and storage – background material

1. Capture
   - CO_2 is extracted from flue gases by contact with amine-based solvents (most common method) which are the heated to release CO_2 at low pressures
2. Transportation
   - Separated CO_2 reaches the storage site or oil fields for use in Enhanced Oil Recovery (EOR) by pipeline
3. Storage
   - Storage of the CO_2 in secure geological formations (Canada has a very high number of potential storage sites, particularly in Western Canada Sedimentary Basin)



Various end use applications of CO_2 can provide economic benefit and safe storage

Appendix B: Carbon capture and storage

Canada is a leader in the field

- May 2006 budget provided $2B in funding over 5 years for "Made in Canada" approach to climate change
- ecoENERGY Technology Initiative
  - Government of Canada announced $230M four year initiative to accelerate development and market readiness of clean energy technologies
  - One of the seven on the list of critical clean energy technologies is carbon capture and storage/CO_2 pipeline

Canada is a perfect fit

- Canada has an abundance of geological formations suited for long term storage of CO_2
  - CO_2 capture and storage is applicable to electricity generation, upstream fossil fuels and industrial sectors, all of which account for ~50% of Canada's total emissions (largely point sources)
- Storage capacity is immense relative to Canada's annual emission, a great opportunity for mitigate the environmental effects worldwide
  - several hundred years worth of emissions could be stored safely

Source: BCG research

Appendix C: Vignette of Toronto plastics cluster

Leading plastics manufacturing face common industry pressures

Plastics R&D expertise may emerge as a competitive advantage to offset rising input costs

1 Pressure for eco-friendly products

- Consumer demand for bio-degradable products is growing
  - Recycling and novel materials (e.g. UV-sensitive resins) offers potential solutions to reduce plastics environmental footprint

2 Higher commodity input costs

- Rising energy costs eroding profitability for plastics manufacturers
  - Issue compounded in Canada by high dollar

3 Aging infrastructure

- Capital intensive infrastructure is aging beyond designed service life resulting in productivity issues
  - eg. Nova Chemical $210M expense to upgrade its Corunna, ON facility

4 R&D product and process innovation

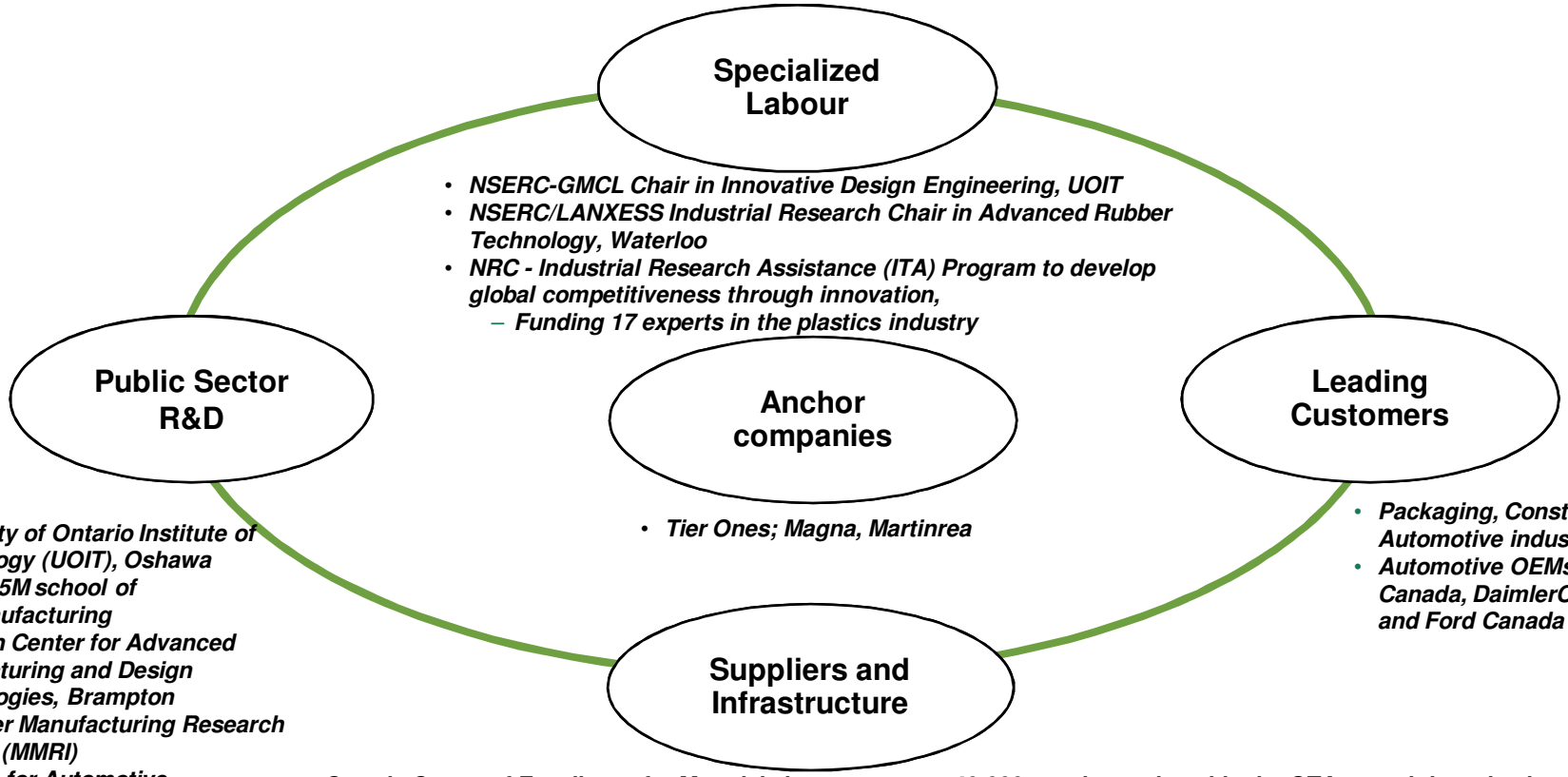
- Innovation efforts directed to improving material properties, growing product scope/applications and addressing manufacturing productivity

Toronto region R&D strengths includes public and private initiatives

- Expertise in polymer technology
  - process for plastics
  - composites or nanocomposites
  - polymer blends by rolling
  - blow moulding
  - injection moulding
  - extrusion moulding
- Plastics material science
  - micro-structural mechanical analysis
  - thermal analysis
  - scanning electron microscopy and light microscopy
- Liqui-Box (DuPont Canada)
  - Turn-key polyethylene film and packaging machinery

Source: BCG research, http://www.2ontario.com/industry/plastics.asp, Canadian Plastics Industry Association (CPIA)

Appendix C: Toronto region home to a plastics R&D cluste



- *NSERC-GMCL Chair in Innovative Design Engineering, UOIT*
- *NSERC/LANXESS Industrial Research Chair in Advanced Rubber Technology, Waterloo*
- *NRC - Industrial Research Assistance (ITA) Program to develop global competitiveness through innovation,*
  - *Funding 17 experts in the plastics industry*

- *University of Ontario Institute of Technology (UOIT), Oshawa*
  - *$38.5M school of manufacturing*
- *Sheridan Center for Advanced Manufacturing and Design Technologies, Brampton*
- *McMaster Manufacturing Research Institute (MMRI)*
- *Initiative for Automotive Manufacturing Innovation*

- *Tier Ones; Magna, Martinrea*

- *Packaging, Construction, Automotive industries*
- *Automotive OEMs; including GM Canada, DaimlerChrysler Canada and Ford Canada*

- *Ontario Center of Excellence for Materials in Manufacturing*

- *40,000 people employed in the GTA at such key plastics manufacturers:*
  - *Royal Group Technologies – home building*
  - *The Woodbridge Group – Automotive Urethane*
  - *ABC Group – Automotive Tier 1*
  - *Husky Injection Molding Systems Ltd. - equipment*
  - *Par-Pak – food packaging*

Supportive regulatory and public policy environment

- *$1.15B Next Generation Jobs Fund*
  - *Mandated to support clean automotive and other green technology*
- *$6.0M Ontario BioCar Initiative*
- *Ontario Apprentice Training Tax credit*

Source: Industry Ontario, BCG research

Appendix C: sample plastics R&D opportunity – 3M

3M spending ~7% of revenues on R&D in 2006 ($1.2B)

- 3M employs ~ 7,000 people worldwide within their R&D network
- Expanding global R&D footprint
  - Expanding R&D facilities and doubled technical personnel to 600 at Shanghai R&D facility (2006)
- Agile R&D organization, de-centralized and deployed against companies seven business units

Toronto is home to world-class expertise in 3M's areas of interest including: polymer technologies, materials science and advanced manufacturing

- Region is home to a hub of research academia, plastics manufacturing expertise and organizations mandated to promote plastics innovation (e.g. CATA,CPIA)

3M has demonstrated its commitment to expanding R&D relationships with Canadian companies

- 3M and CATA announced ongoing business partnership, linking Canadian technology capabilities with 3M's interests in advancing its 'future focus' technologies
- Established a 'real-time' monitoring service providing Canadian companies with continuous opportunities to partner with 3M
- Strengthening collaborative public policy work in outsourcing, the removal of trade barriers and investment

Source: BCG research, CATA (Canadian Advanced Technology Alliance)