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SUPPLEMENT

Canada's ICT connections

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Photograph: Eva Bue. Courtesy of Tourisme/Montreal



CANADA MAKES GLOBAL ICT WAVES

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AN ICT STRONGHOLD

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65 Toronto's 40,000 science graduates a year feed into what has become North America's fastest growing jobs market for technology, providing expertise across a wide array of tech areas.

MONTREAL'S BRAIN GAIN

66 Boasting some of the leading global experts in AI, plus a wealth of software companies and games studios, Montreal is developing into a major technology hub that has attracted the likes of Samsung, Google and IBM.

INTELLIGENT LEARNING

67 Edmonton has become a globally recognised hub for machine learning and AI research, thanks in large part to its world-class universities. fDi looks at how the city became so popular with tech companies.

SPREAD FAR AND WIDE

68 Canada's ICT capabilities are not solely concentrated in a few key cities. Several destinations across the country host thriving tech clusters.



The place to be: in 2018 the Economist Intelligence Unit ranked Toronto equal seventh in its list of the world's most liveable cities

Canada makes global ICT waves

CANADA IS A GLOBAL LEADER IN ICT, BOASTING DIVERSE SPECIALISMS AND A LARGE APPETITE FOR INDUSTRY-SPECIFIC INVESTMENT AND EVENT HOSTING, AND THE GOVERNMENT IS FURTHER BACKING SUPERCLUSTERS, WRITES SEBASTIAN SHEHADI

Canada's most renowned tech hub, Toronto, was ranked sixth in the world in Savills' Tech Cities 2017 report, and 12th in KPMG's Global Technology Innovation 2018. However, talent is evenly spread across Canada, with a variety of world-class sub-sectors in Vancouver, Montréal, Ottawa, Edmonton, Waterloo, Calgary, Québec City and Winnipeg.

From the invention of the telephone to IMAX cinemas, Canada has been at the forefront of technological innovation since its foundation 151 years ago. The first settler communities were forced to innovate, co-operate and share knowledge in order to survive, according to Virginie De Visscher, director of business development, economic sectors, at Business Events Canada (a division of Destination Canada, Canada's federal tourism marketing agency).

Digital nation

Fast-forward to 2018, and Canada's 39,000 ICT companies provide almost 600,000 jobs, turning over C\$181bn (\$137bn) in annual revenue and C\$73bn in GDP contribution, according to Statistics Canada. In short, Canadians are tech savvy. Ranked as the OECD's 'most educated' talent pool, generally speaking, 88.5% of Canadians use the internet, with an average of 34 hours spent online weekly among 16 to 24 year olds, according to Media Technology Monitor.

Canadian ICT companies – among them CGI, Blackberry and Celestica – account for an average of 53% of Canada's total ICT revenue. Foreign companies make up the remainder, and include among their ranks the world's largest multinationals, such as Samsung, Apple, Amazon, Facebook and Microsoft.

Canada is the world's 11th top destination for greenfield FDI in ICT, with \$10bn invested between 2014 and 2017, and the

eighth largest source of FDI in the sector, according to greenfield investment monitor **fDi** Markets. Montreal and Toronto ranked first and third, respectively, for FDI Strategy in **fDi**'s Digital Economies of the Future 2018/19 ranking.

To boost these strengths, the Trudeau government launched the 'supercluster initiative' earlier in 2018, pumping C\$950m into priority industry clusters, two of which are in ICT – digital media and artificial intelligence (AI). Collaboration between government, industry and academia in Canada, especially in ICT, is strong.

Diverse specialisms

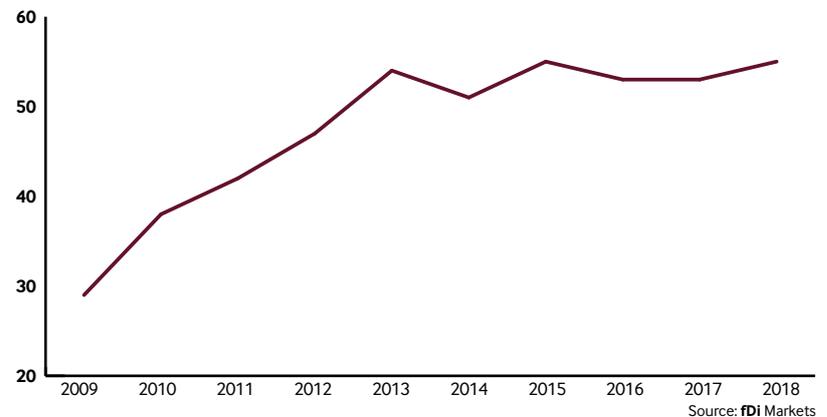
Toronto is the country's largest ICT hub and a North American leader alongside San Francisco and New York. It is home to one of the largest clusters of mobile application companies in North America and has the world's highest concentration of AI start-ups. Montréal is a global hub for AI research and deep learning, as well as digital sound and media, commstech and data centres. It boasts 250 researchers at Université de Montréal and McGill University – the largest number of researchers in the country.

Meanwhile, Vancouver is emerging as a digital technology supercluster characterised by digital media and gaming, virtual reality (VR), cryptocurrency, cloud computing and Software as a Service (SaaS). The Electronic Arts campus in Vancouver employs 1300 people. Capital city Ottawa is another tech hub. With almost one-tenth of its workforce in ICT, Ottawa is the most technology-intensive city in Canada, according to local newspaper the *Ottawa Citizen*. The capital is a leader in autonomous vehicles, communications technology, digital media, fintech, govtech, 5G, photonics and SaaS.

Edmonton is a major innovation hub for AI, bioinformatics and human-machine interaction. As well as offering state-of-the-art research into bionic limbs, Edmonton boasts one of the world's leading 4D medical simulation labs. Waterloo, a powerhouse for ICT innovation, is home to Canada's leading Internet of Things cluster and the world's highest concentration of mathematical and computer science talent. It hosts software giants BlackBerry, D2L, Google and OpenText, and more than 70 automotive innovation leaders.

Much of Calgary's ICT work is geared towards its oil and gas industry, and the city has Canada's highest concentration of start-ups per capita. Its strengths lie in agri-technology, cleantech, geospatial, communications technology, data analytics, digital media and VR. Québec City offers a thriving optics-photonics industry and Canada's largest national defence research centre. It is a world-class centre for geospatial companies, software integrators and designers, and is home to companies such as CGI, Oracle and Microsoft.

NUMBER OF FOREIGN GREENFIELD INVESTMENTS IN CANADA'S ICT AND ELECTRONICS SECTORS



Last but not least, Winnipeg nurtures a community of small and medium-sized ICT enterprises, with strengths in machine learning, data collection, robotics and interactive digital media/video game development. The city also houses data centres for many of the largest Canadian companies and, recently, gaming giant Ubisoft opened an office there.

Benefits beyond tourism

Though Canada's stunning scenery is recognised throughout the world, making it a popular tourist destination, this image has meant that its technological prowess has been somewhat overlooked by investors and events decision makers, says Ms De Visscher. "We are breaking that perception. We have big neighbours, but the developments being made within our world-leading subfields are changing the discussion. We're seeing huge talent from the US into Canada. Our work environment is different, in terms of diversity, triple helix, and going from incubation to market."

In 2018, the Economist Intelligence Unit ranked Calgary, Vancouver and Toronto among the world's top 10 most liveable cities. Moreover, Vancouver and Toronto ranked 15th and 16th, respectively, as top cities in the world to start a tech business, according to Startup Genome.

This is borne out by the growing number of international ICT events being held in Canada, such the World Summit AI North America, the International Joint Conference on Artificial Intelligence, Collision, and the International Cybersecurity & Intelligence Conference.

Tech professionals from around the world will, once again, flock to the annual C2 Montreal that marries Cirque du Soleil with technology, so to speak, according to Ms De Visscher. "[In 2017] they bio-printed a 3D nose right in front of me," she says. "Attracting outside business to meet in Canada means another step towards potential investment. We're not trying to be everything to everyone. We're specific to our strengths and are we matching them with those who are interested." ■



Satellite office: the David Florida Laboratory, the Canadian Space Agency's spacecraft assembly, integration and testing centre, is a key part of Ottawa's ICT cluster

An ICT stronghold

WITH INTERNATIONAL NAMES SUCH AS AMAZON AND HUAWEI SETTING UP IN OTTAWA, THE CANADIAN CAPITAL IS CARVING OUT A NAME FOR ITSELF AS A MAGNET FOR ICT AND A FRONTRUNNER WHEN IT COMES TO 5G RESEARCH, AS JASON MITCHELL REPORTS

Ottawa has established itself as an internationally recognised centre for R&D in ICT, with more than 90% of Canada's telecommunications-related research happening in the city.

Some of the world's leading wireless telecoms network equipment makers – including Ciena, Cisco, Ericsson, Nokia and Huawei – have centres located in Ottawa. A considerable proportion of the research is dedicated to innovation around 5G networks.

Tech surge

“Over the past five years, Ottawa has seen a surge in the technology economy,” says Blair Patacairk, vice-president, global expansion, at Invest Ottawa, the city's inward investment agency. “With the likes of Amazon setting up a fulfilment centre here in Ottawa, coupled with home-grown companies such as Shopify, the city has become the centre of attention with the right mix for a vibrant ecosystem.

“Invest Ottawa's global expansion team has been very targeted on markets of interest that line up with our sector strengths. The strategy is paying off in spades and we are attracting great companies to our region, such as Syntronic from

Sweden and Aurrigo from the UK.”

By April 2018, Swedish design house Syntronic had a total of 200 employees in Ottawa. The company has moved to a new 2200-square-metre building in which it has invested C\$6.2m (\$4.6m) of its own money, plus C\$600,000 from the province of Ontario. This will create 45 new jobs in Ottawa over the next five years.

Also, in April, Aurrigo, the UK's leading self-driving vehicle specialist, opened a new sales and technical office in the centre of Ottawa and is now seeking academic and industry partners to support the testing and development of its innovative autonomous vehicle technology. The firm has already enlisted research leaders at Carleton University in Ottawa to work on trials on its campus.

“Invest Ottawa has been very supportive and has assisted us in finding a suitable location in the heart of the city and introducing us to possible partners,” says Aurrigo CEO David Keene. “It has really made the process a lot easier and we are delighted that we can now start turning the discussions into actual trials – moving autonomous vehicles being used in Canada one step closer.”

Ottawa, Canada's national capital with a population of 970,000, has

77,000 people employed in the ICT industry. Some 980 companies in the sector are located in the city.

Doing the research

Ottawa's ICT cluster has a host of R&D facilities, including the Communications Research Centre, a federally funded centre of excellence specialising in wireless telecoms; Canadian Photonics Fabrication Centre, the only pure-play optical fabrication centre in North America; the Centre of Excellence in Next Generation Networks; David Florida Laboratory, the Canadian Space Agency's spacecraft assembly, integration and testing centre; and Defence Research and Development Canada, the country's leader in defence and security science and technology.

It is also home to other incubators and research centres, including the National Research Council of Canada and Canada's Advanced Research and Innovation Network.

Ottawa is cultivating world-class expertise in technology fields such as cybersecurity, connected cars and autonomous vehicles, artificial intelligence, machine learning, wearables and the Internet of Things.

A large number of annual conferences in the ICT industry take place in the city, including Conference on Security and Defence (in February 2019); IoT613 Conference (in early 2019); Canasa, Security Canada Expo (in May 2019); and CAV Canada, Autonomous Vehicles (September 2019). ■

Toronto on the up

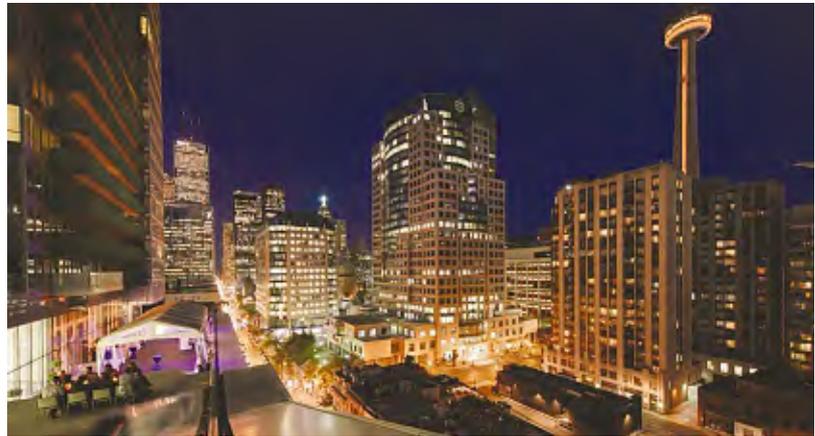
TORONTO'S 40,000 SCIENCE GRADUATES A YEAR FEED INTO WHAT HAS BECOME NORTH AMERICA'S FASTEST GROWING JOBS MARKET FOR TECHNOLOGY, PROVIDING EXPERTISE ACROSS A WIDE ARRAY OF TECH AREAS. JASON MITCHELL REPORTS

Toronto had the fastest growing tech jobs market in North America in 2017, seeing 28,900 new jobs created in the sector. The city – Canada's biggest, with a population of about 2.8 million – saw the total number of employees in the industry jump to 241,000 at the end of 2017, a 52% hike during the preceding five years, according to real estate group CBRE. Tech firms accounted for more than one-third of the demand for office space in central Toronto.

The city's tech sector is growing faster than its equivalents in New York and San Francisco. On some measures, up to 400,000 people are employed in the ICT sector in the city. About 14,000 companies from the industry are located in the city and the sector's total GDP amounts to C\$52bn (\$39bn).

Northern Silicon Valley

"Toronto is attracting tech firms from all around the world," says Sunil Sharma, managing director of Techstars Toronto, an accelerator programme. "Canada generally is seen as a good country in which to start up a tech company. There is an incredible concentration of computer science in the city. Fintech and technology relat-



Switched on: Toronto's tech sector is growing faster than its counterparts in New York and San Francisco

ing to healthcare are also important." The city, known as the 'Silicon Valley of the North', is strong in a number of tech areas, including artificial intelligence and machine learning; fintech; blockchain; enterprise software; virtual and augmented reality; gaming; and hardware related to the consumer and food tech sectors.

"Toronto is very strong in all areas of technology," says Janet Bannister, a partner at Real Ventures, a leading early-stage investor located in the city. "University of Toronto is one of the world's leading AI centres, so that sector is important. Toronto is the banking capital of the country with the five biggest banks [in the country] based here. That has led to the rise of one of North America's principal fintech hubs. Business-to-business tech is also significant. There are many health tech-related companies, as the city has a strong hospital and medical school network."

The top five international ICT firms all have their Canadian headquarters in Toronto: Alphabet (Google), Cisco Systems Canada, HP Canada, IBM Canada and Microsoft Canada. It was the only city in the country to make the shortlist for Amazon's second headquarters.

Incubating talent

Toronto has more than 40,000 graduates in the science, technology, engineering and mathematics subjects every year and has about 65 accelerators and incubators and more than 4100 tech start-ups. It is home to the IBM Innovation Space, as well as the IBM Blockchain Global Data Centre, which uses IBM Z, a new system designed to encrypt large volumes of data.

At 56,000 square metres, Metro Toronto Convention Centre is the country's largest convention centre, while Enercare Centre, at 93,000 square metres, is its largest exhibition space. Events companies – including Business Events Toronto, Toronto Global and the Toronto Leader's Circle – organise a wide range of tech-related events and conferences in the city. In May 2019, Collision, the fastest growing tech conference in North America, will take place in the city, and is expected to pull in up to 25,000 attendees.

Meanwhile, in terms of access, Toronto's Pearson International Airport is the fifth most connected airport in the world (and the second most connected in North America after Chicago O'Hare), according to OAG, the air travel intelligence company. ■

UNIVERSITY OF TORONTO
IS ONE OF THE WORLD'S
LEADING AI CENTRES, SO
THAT SECTOR IS IMPORTANT



MONTREAL HAS BECOME A MAJOR GLOBAL HUB FOR THE GAMING INDUSTRY. THE CITY HAS A LOT OF ENERGY AND IS VERY COSMOPOLITAN



Montreal's brain gain

BOASTING SOME OF THE LEADING GLOBAL EXPERTS IN AI, PLUS A WEALTH OF SOFTWARE COMPANIES AND GAMES STUDIOS, MONTREAL IS DEVELOPING INTO A MAJOR TECHNOLOGY HUB THAT HAS ATTRACTED THE LIKES OF SAMSUNG, GOOGLE AND IBM. JASON MITCHELL REPORTS

Montreal, Canada's second largest city, is becoming a global hub for research into artificial intelligence (AI), partly because some of the world's leading experts on 'deep learning' – a machine learning technique – are located there.

Yoshua Bengio, a professor at University of Montreal Institute for Learning Algorithms, is one of the world's leading experts on deep learning and set up Element AI – a company that seeks to transform AI research into real-world business applications – in the city in 2016.

Greater Montreal now has 250 researchers focused on AI and 9000 students on university programmes related to the field.

Attracting the experts

"The main people who invented deep learning are based in Montreal," says Claude Theoret, president of Nexalogy, a start-up that is creating AI applications for social media networks. "That really helped the AI ecosystem to explode in the city. It is one of the biggest university cities in North America and that has contributed to a highly creative and innovative

business environment.

"It is a post-industrial city and has rent controls, making it one of the cheapest cities in Canada in which to live. It also has some of the lowest university tuition fee rates in the country and one of the highest employment rates. All of these factors make it an attractive place in which to live and have been essential for the tech start-up ecosystem to take off."

In October, Samsung opened an AI centre in Montreal dedicated to R&D of core AI technologies, including machine learning, language, vision and other multi-modal interactions.

"This new research centre will help make AI more accessible right here in Montreal," Marc Garneau, Canada's transport minister, said at the time of the opening. "It will open the door for collaboration and grow opportunities for our universities and our businesses."

Top for tech jobs

Greater Montreal – with 4 million inhabitants – enjoys the highest concentration of tech sector jobs of any Canadian city: 107,500 employees, or 8% of the total workforce. There are 5250 tech companies and the sector has a total GDP of C\$11.6bn (\$8.7bn). The city has 11 universities and institutions of higher education and 60 vocational colleges.

This year, Greater Montreal won the award for fDi Magazine's best FDI Strategy in the Digital Economies of the Future ranking. Montreal is a major player in software and IT services and leading companies – among them CGI, IBM, Google, SAP, Accenture, Fujitsu, Autodesk, Tata Communications, and Dassault Systems – have centres there.



Photograph: Eva Blue. Courtesy of Tourisme Montréal

Shining reputation: Montreal is a major player in software and IT services

The city has more than 30 incubators and accelerators, including FounderFuel, TandemLaunch, XR Concordia and Ubisoft Virtual Reality.

Overall, the city is home to 150 games studios and 12,000 games developers. Eric Kucharsky, director of business development, ICT, Europe foreign investments, at Montreal International, the city's economic development agency, says: "As well as AI, Montreal has become a major global hub for the gaming industry. Ubisoft Entertainment, the gaming company, has 3500 employees in the city and three large buildings. The city has a lot of energy and is very cosmopolitan. Its vibe is similar to that of Berlin."

In 2018, Montreal was the top host city in North America for international association events, according to the Union of International Associations. The main events in the tech sector include C2MTL, Startup Fest, Movin'On, Effects MTL, MIGS, HUB Montréal, Canada Fintech Forum, and NeurIPS. ■

Intelligent learning

EDMONTON HAS BECOME A GLOBALLY RECOGNISED HUB FOR MACHINE LEARNING AND AI RESEARCH, THANKS IN LARGE PART TO ITS WORLD-CLASS UNIVERSITIES. JASON MITCHELL LOOKS AT HOW THE CITY BECAME SO POPULAR WITH TECH COMPANIES

In Edmonton – Canada’s fifth biggest city – a world-leading artificial intelligence (AI) R&D cluster is fast emerging in the heart of the city. Its innovation corridor stretches from Northern Alberta Institute of Technology through the downtown core to the University of Alberta.

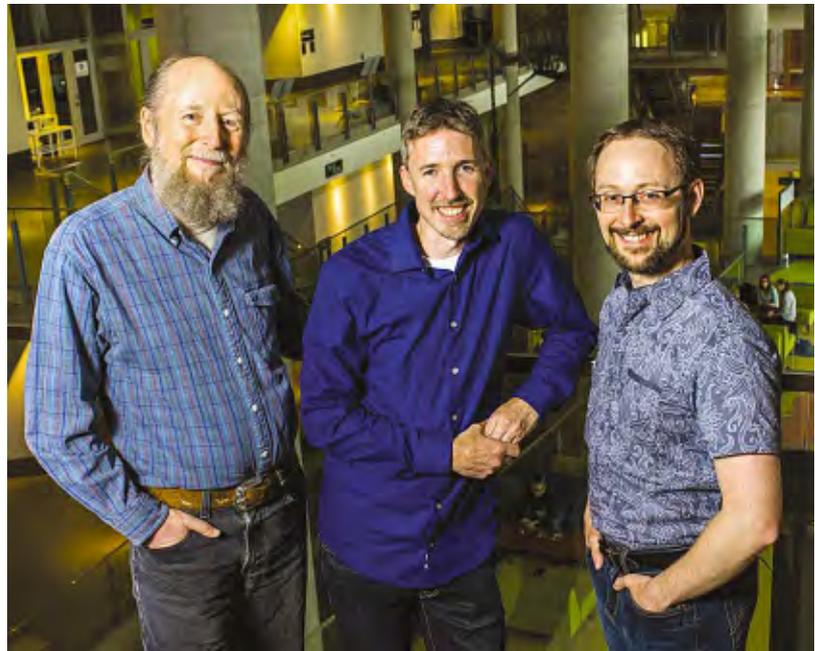
The city – with a population of just over 1.3 million – has more than C\$5.5bn (\$4.17bn) in development happening in the downtown area, more than any other major market in North America. This is centred around a new professional sports and entertainment complex.

AI hub

Edmonton is a hub of AI and machine learning in Canada. Alberta Machine Intelligence, a research institute associated with the University of Alberta, features in the country’s national strategy for this type of research. The university’s computer science department is also internationally recognised.

The university is second in the world for academic papers and research on AI and machine learning, according to CSRanking.org, an international ranking of computer science research institutions.

In 2017, DeepMind, a British company at the forefront of machine learning, chose Edmonton for its first laboratory outside the UK. It wanted to recruit three key research-



DeepMind’s Edmonton choice: from left: Richard Sutton, Michael Bowling and Patrick Pilarski

Photo: John Ulin

ers from the University of Alberta: Richard Sutton, Patrick Pilarski and Michael Bowling. However, they did not want to leave the city or the teams they had built up at the university, so DeepMind came to Edmonton. The firm now has 15 researchers at its downtown lab.

Furthermore, in 2016, Royal Bank of Canada’s R&D lab, Borealis AI, also decided to establish a lab in Edmonton, dedicated to research in ‘adversarial machine learning’. “Great minds attract great minds,” says Mario Nascimento, professor and chair of the University of Alberta’s department of computing science. “As a global leader in AI research, the university’s many excellent professors and researchers produce leading-edge scientific discoveries and play a vital role in attracting and retaining top AI talent and companies to Edmonton.”

Glen Vanstone, vice-president of Enterprise Edmonton at Edmonton Economic Development Corporation (EEDC), the city’s inward development agency, says: “The city is becoming recognised internationally for the excellence of its research on ‘reinforcement learning’. It is becoming a gravity well for talent and companies in the AI field. Important research in biotechnology and health sciences, and

in clean technology and renewables, is also taking place here.”

Innovative spirit

Edmonton has six major public tertiary institutions and a talent pool of more than 100,000 students with a significant number of graduates in engineering, machine learning, medical sciences and law. It is home to 1300 companies in the ICT sector, employing about 19,000 people.

In October, EEDC and Epic Realty Partners, a real estate group, agreed to launch an innovation hub in downtown Edmonton. This is expected to be a key entry point and home for technology-enabled start-ups and scale-up companies, and aims to bring together entrepreneurs, mentors, investors, talent and business experts in an environment designed to support the growth of tech start-ups.

“We are solving some of the world’s most important problems right here in Edmonton,” says Cheryl Watson, vice-president of Innovate Edmonton at EEDC. “The innovation hub would increase visibility to the incredible work happening at Startup Edmonton and TEC Edmonton.”

Two major tech conferences will take place here in 2019: Blockchain and Technology Symposium in March and SingularityU Canada Summit in April. ■

WE ARE SOLVING SOME OF THE WORLD’S MOST IMPORTANT PROBLEMS RIGHT HERE IN EDMONTON



Vision quest: Québec City's National Optics Institute has generated more than 30 spin-off companies

Spread far and wide

CANADA'S ICT CAPABILITIES ARE NOT SOLELY CONCENTRATED IN A FEW KEY CITIES. SEVERAL DESTINATIONS ACROSS THE COUNTRY HOST THRIVING TECH CLUSTERS, AS **SEBASTIAN SHEHADI** REPORTS

While Toronto, Montréal and Vancouver garner the most international attention, Canadian tech talent is widespread among the country's other cities, such as Edmonton, Ottawa, Waterloo, Calgary, Québec City and Winnipeg. The tech sectors in these locations offer tens of thousands of full-time jobs, with each city boasting specialities and subsectors.

Waterloo

Waterloo, in Ontario, has the world's highest concentration of mathematical and computer science talent. It boasts the Institute for Quantum Computing, the Institute for Theoretical Physics, and an Internet of Things manufacturing space (Catalyst137), each the largest of their type on the planet.

The city also specialises in artificial intelligence (AI), autotech, big data, cybersecurity, machine learning and robotics. Leading Canadian ICT companies OpenText and D2L are based there, alongside large foreign firms such as Google.

The Toronto-Waterloo innovation corridor ranks 16th among the top 20 global start-up ecosystems, according to the Global Startup Ecosystem Report 2018. Incubator hub Communtech is one example, boasting 1266 technology members including start-ups, SMEs and large corporations. Communities such as these are

supported by Canada's R&D and corporate investment tax rates, the lowest among the G7 countries.

Calgary

To many, Calgary in Alberta is synonymous with the oil and gas industry, yet its thriving technology and innovation sector contains the country's highest concentration of entrepreneurs and start-ups per capita.

"Calgary's rapidly growing cleantech sector is a natural evolution from its position as a global hub for the energy industry. Our decades of experience driving innovation in and around energy forms a strong backbone for our future as a cleantech hub," says Dr Terry Rock, chief executive of Calgary Technologies.

The IBM Natural Resources Solution centre uses AI to develop solutions for the oil and gas industry.

The province of Alberta also specialises in Canada's C\$20bn (\$15.1bn) geospatial industry, hosting 22% of the country's geospatial companies. The city's other ICT specialisations are in agri-tech, big data, cleantech, communications technology, digital media, geospatial, Industry 4.0 and virtual reality.

Québec City

Québec City's crown jewel is its optics-photonics industry, home to the world-leading National Optics Institute that has generated more

than 30 spin-off companies, and developed technology such as the portable 3D camera for the International Space Station.

The city is home to Canada's largest national defence research centre, Valcartier Research Centre, and another 64 research centres, clusters and institutes in various ICT subsectors, such as AI, digital media, geospatial, interactive entertainment and Software as a Service (SaaS).

Winnipeg

Although Winnipeg in Manitoba is one of Canada's lesser known cities, internationally speaking, it is set to have the fastest growing metropolitan economy among Canada's western cities in 2018, behind only Montréal, according to Canada NewsWire.

The city hosts international giants such as Ubisoft, Microsoft and Amazon Web Services, as well as locally grown success stories. One such is Sightline Innovation, one of Canada's largest machine learning companies that provides AI-based solutions for Industry 4.0 to the insurance, healthcare, manufacturing and agriculture sectors.

Winnipeg's location and low-cost energy has also made it an attractive location for data centres. The city also specialises in communications technology, cybersecurity, digital media, fintech, machine learning and AI, and SaaS. ■