Criteria for Data Centre Location

Yves Bétournay P.Eng.
June 2017

BBA.CA

Disclaimer

This document is provided for informational purposes only. Anyone who uses this document is responsible for determining whether or not it applies to his or her activities. At no time will BBA or the author be held liable for any error or omission that the document may contain or that may result from its use.

The information contained in this document is subject to change without notice.

Table of contents

Business Challenges

The manufacturers of high-tech computer servers are under substantial pressure to meet new demands in the market. New data centres are subject to heavy economic pressure because they must be secure, reliable and efficient while permitting rapid growth in terms of capacity. As such, the challenge is not restricted to optimizing the capital expenditures to build these data centres: it also involves optimizing their operating costs.

The cost and availability of power, political stability, confidentiality and privacy laws, environmental and social risk, quality of the workforce, and quality of network connections are but a few of the crucial factors to be considered when choosing the location of a data centre.

Moreover, weather conditions have a significant impact on the choice of a data centre's physical location given that certain areas are more exposed to natural disasters (hurricanes, tornadoes, earthquakes, flooding, etc.). The location of a critical data centre must therefore be carefully considered, as it is not just a building filled with hard drives, but a massive infrastructure housing the servers needed for the day-to-day operation of governments and corporations.

Site Selection Criteria

A data centre has a useful life of 10 to 15 years on average, during which time a number of upgrades are required due to increased power consumption. Since the rise of the Internet, the multiplication of data centres has been exponential, leading to challenges inherent to the control of air conditioning and, in particular, power consumption.

Cushman & Wakefield present 10 criteria for measuring the risk index of data centres in their study entitled "Data Centre Risk Index 2016" [1]:

- Energy costs
- Energy security
- Environmental sustainability
- Internet bandwidth

- Natural disasters
- Ease of doing business
- Corporate tax
- Political stability
- Gross domestic product (GDP)
- Water availability

Based on this study, we will show that Canada—and the province of Québec in particular—possesses numerous desirable traits for data hosting and colocation centres. It is among the most developed international poles in terms of data centre potential and security. This document provides an overview of the competitive advantages of Québec over its southern neighbours.

In fact, according to The Globe and Mail [2], Canada has a wealth of cheap electricity, low cooling costs thanks to the country's climate, competitive corporate tax rates, and political stability.

Our country ranks sixth worldwide in terms of capacity to house the enormous computers needed to manage corporate networks and websites. This ranking is courtesy of a publication by the world-renowned brokerage Cushman & Wakefield, which published the 2016 Data Centre Risk Index:

2016 RANK	REGION	INDEX SCORE (100= BEST)	COUNTRY	ENERGY - ELECTRICITY (COST PER KWH)	INTERNATIONAL BANDWIDTH (MEGABYTE PER S)	EASE OF DOING BUSINESS	CORPORATION TAX
1	EMEA	100.00	ICELAND	6	10	14	9
2	EMEA	96.21	NORWAY	11	7	7	23
3	EMEA	90.26	SWITZERLAND	8	5	16	6
4	EMEA	90.19	FINLAND	13	8	8	9
5	EMEA	89.92	SWEDEN	22	4	6	14
6	AMERICAS	85.07	CANADA	4	16	10	22
7	APAC	84.50	SINGAPORE	23	11	1	4
8	APAC	83.23	KOREA, REP.	2	1	2	16
9	EMEA	79.81	UNITED KINGDOM	30	14	4	13
10	AMERICAS	78.73	UNITED STATES	3	15	5	36

The purpose of this document is to analyze the case of the province of Québec using criteria similar to those used in the Cushman & Wakefield study and by factoring in the environmental aspect of the electrical power source.

The infrastructure dedicated to the electrical power that a data centre needs is probably the most critical factor in data storage and processing. About two-thirds of power consumption by a typical data centre is used to supply its servers and other IT loads. The final one-third is used to cool and power auxiliary systems. The cost of electricity represents roughly 30% of a data centre's operating expenses.

Power consumption by data centres has increased considerably over the past decade, reaching approximately 1.3% of worldwide electricity use [4]. To meet this demand, data centres have evolved considerably by adopting more efficient technology and practices. It is estimated that the market will grow by about 5% annually in coming years. This represents $150 billion for 2016 [5].

Green power

Thanks to the predominance of the hydroelectric industry, a renewable and reliable source of power, data centres in Québec enjoy energy costs that are among the lowest in the world.

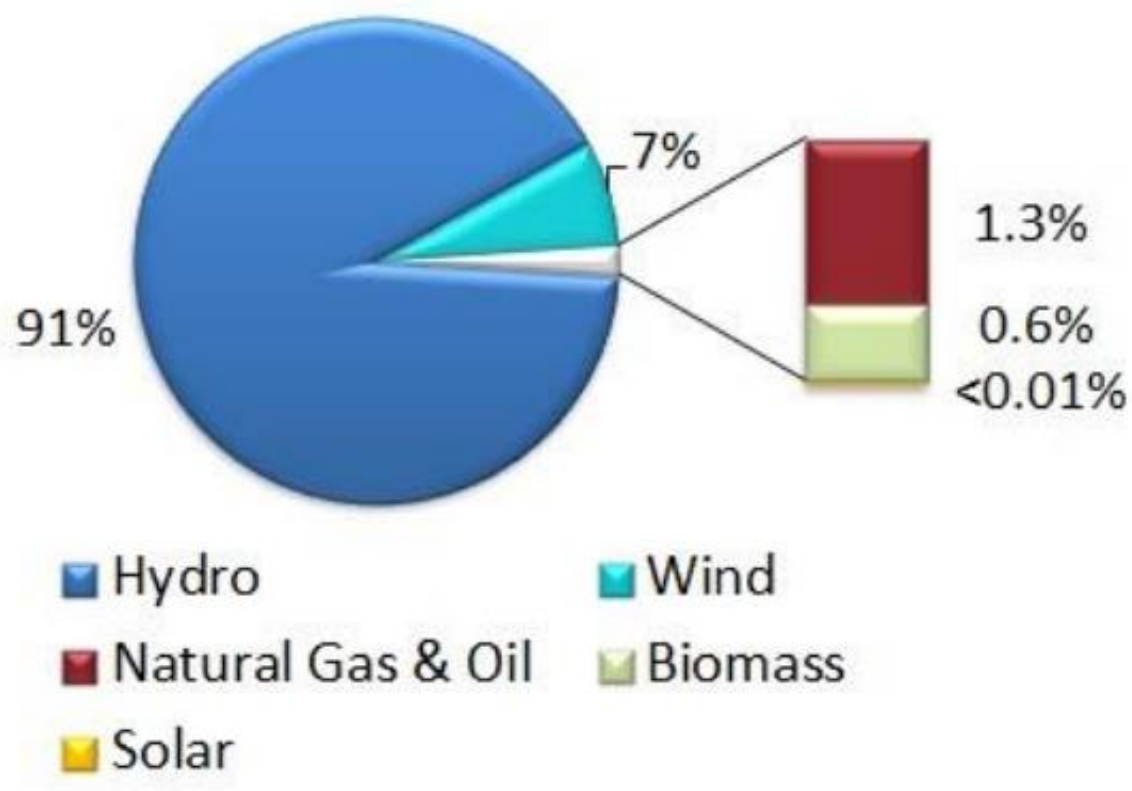
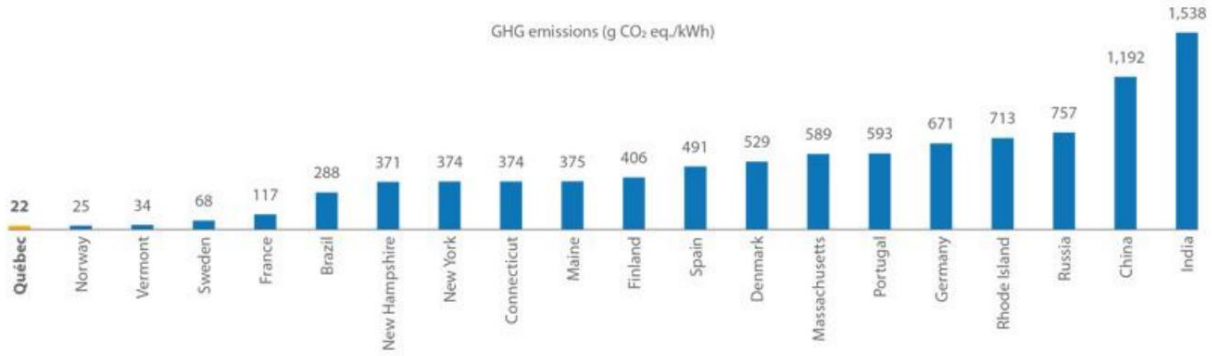


Figure 2: Breakdown of electricity generation by type [6]

Renewable energy accounts for 99% of the electrical power generated in Québec, ranking the province first internationally for its portfolio of renewable energy.



According to the most recent data published by the U.S. government [8], the greenhouse gas emissions (GHG) factor associated with electricity generation in Virginia is 432 t/GWh. For nitrogen oxide (NOx) and sulphur dioxide (SO2) emissions, the factors are respectively 0.48 and 0.81 t/GWh. A data centre in Virginia that burns 100 GWh per year would emit 43,200 t of GHG, 48 t of NOx and 81 t of SO2.

According to the most recent data published by Hydro-Québec [9], the GHG emissions factor associated with electricity distributed in Québec is 0.98 t/GWh. For NOx and SO2 emissions, the factors are respectively 0.0096 and 0.0039 t/GWh. A data centre in Québec that burns 100 GWh per year would emit 98 t of GHG, 0.96 t of NOx and 0.39 t of SO2.

In other words, the same data centre would generate 98% less GHG emissions by setting up in Québec instead of Virginia.

Low costs

As regards the cost of electricity, Hydro-Québec charges C$0.041/kWh for a 5 MW data centre, including the 20% rebate the public utility grants data centres. This rate is lower than the rate of every American state, even with industrial rates.

Below is a comparison of electrical power prices in North America's largest cities:

FIGURE 1

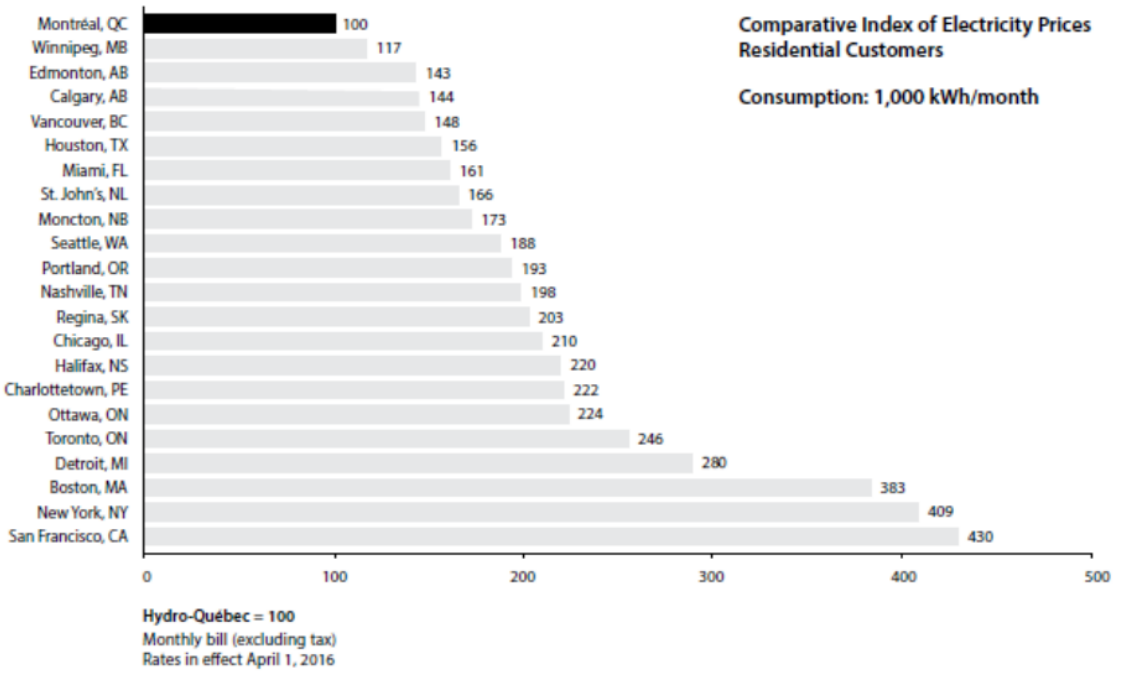


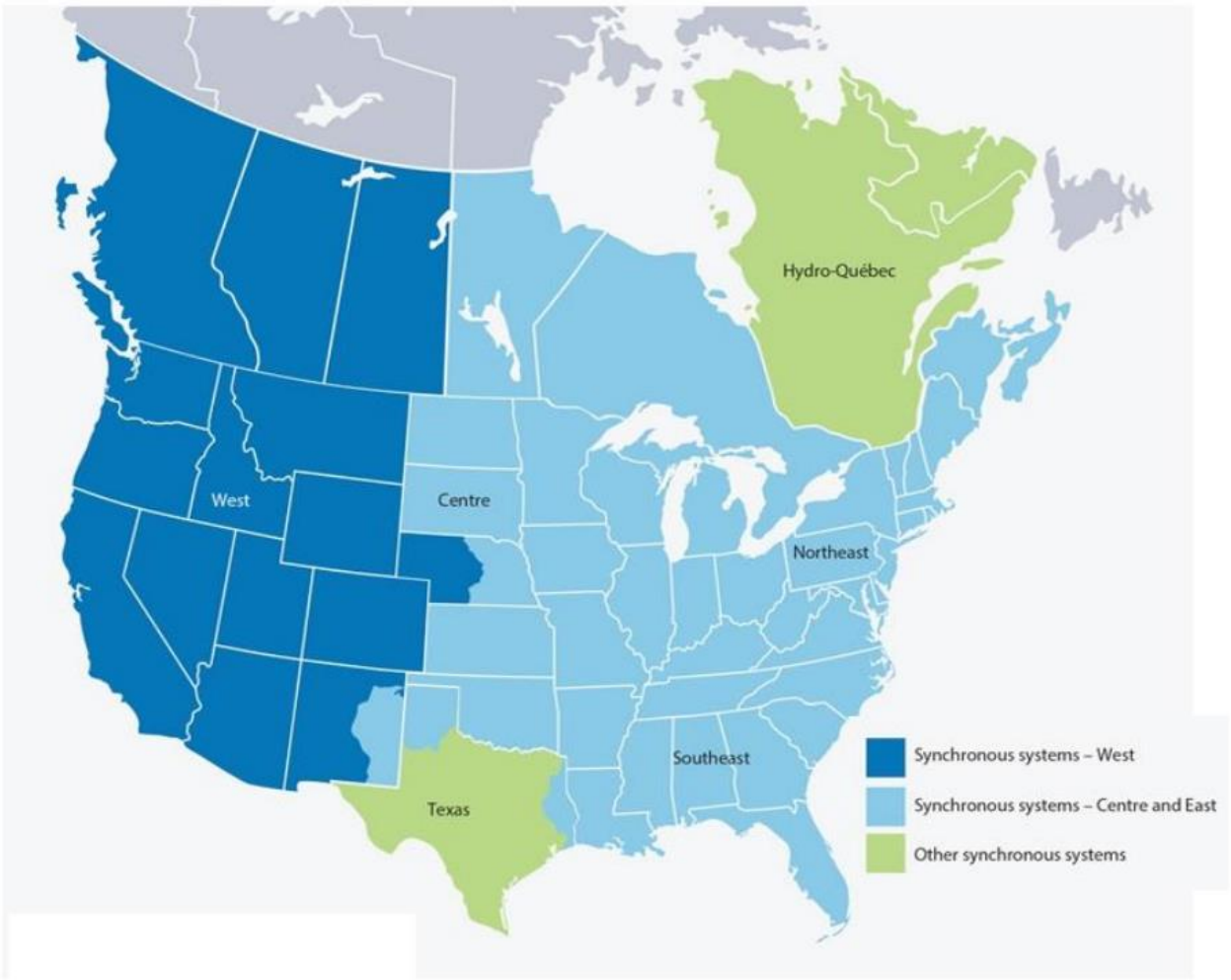
Figure 4: Comparison of electrical power prices in North America's largest cities [10]

To show how these rates affect a data centre's operating costs, the table below presents the difference in annual power costs for a 5 MW IT data centre in various major cities [11]:

City	Cost in ¢/kWh (C$)	Annual cost (C$) 5 MW IT, PUE 2.0
San Francisco, CA	12.61	$11,046,000
Portland, OR	7.90	$6,920,000
Montréal, QC	4.10	$4,292,000

Reliability Above All

Since the reliability of an electrical grid is crucial, Québec has a clear advantage because its system is connected to those of adjacent provinces and states through an asynchronous link. This makes the province practically immune to the general electrical failures that affect the rest of North America, as can been seen in the following figure[12]:



For example, during the major blackout in 2003 that impacted many American states and Canadian provinces, the province of Québec was unaffected.

In 2004, U.S. and Canadian authorities published a joint report entitled "2003 Blackout in the United States and Canada: Causes and Recommendations" [13]. According to the

report, thanks to Québec's geography and electrical characteristics, the province's grid is tied into the rest of the Eastern Interconnection through high-voltage DC (HVDC) connections rather than through AC transmission lines. The province was able to withstand overvoltages because its direct current connections protected it from frequency oscillations.

The cascade was controlled after the northeastern United States and Ontario were completely isolated from the rest of the Eastern Interconnection. In addition, no other power flux was possible in the northeast, with the exception of the data centres in Québec, New York and the New England states. In fact, one can see from the following figure that Québec maintained its power during the blackout.

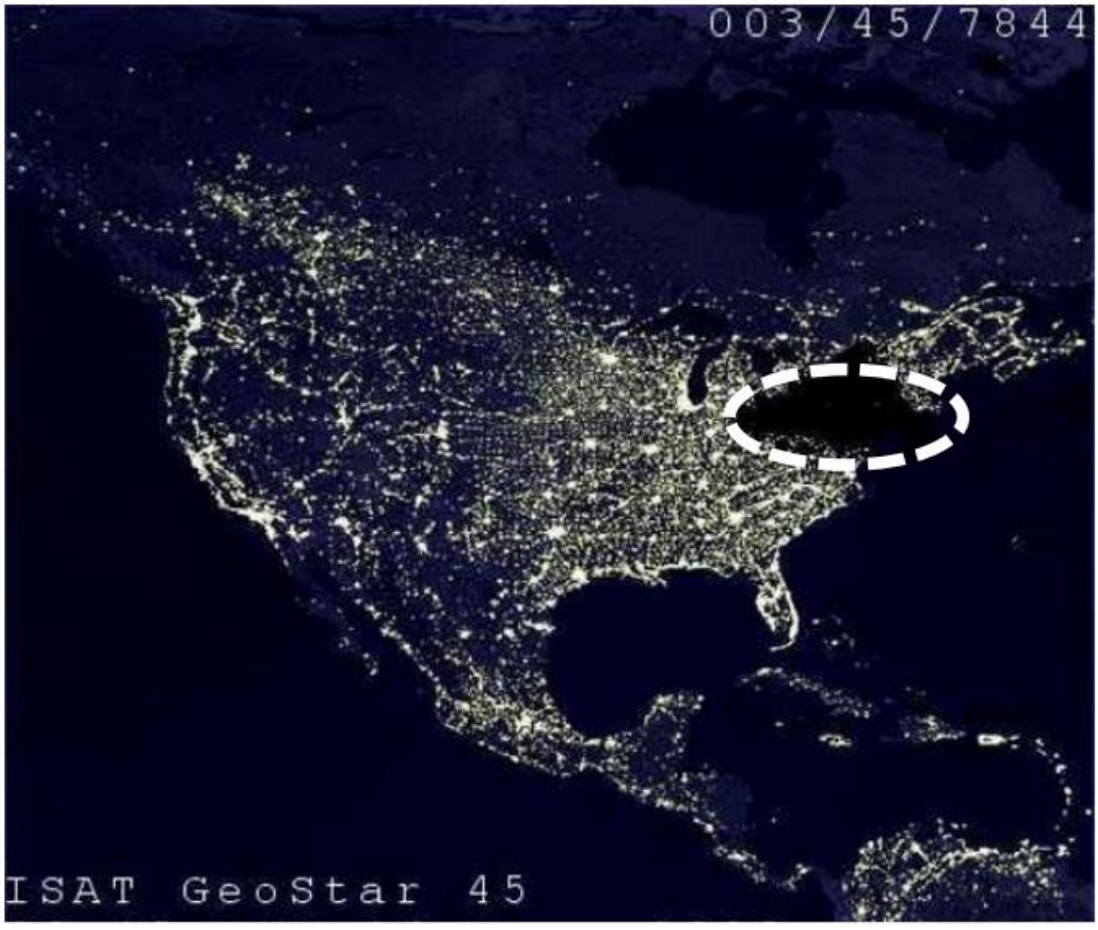


Figure 5: Satellite view of the area affected by the 2003 blackout, leaving Québec unaffected to the north [14]

Unlike the United States, where several thousand entities manage power generation and distribution, Québec has a virtually exclusive stakeholder in the field of power generation and distribution: Hydro-Québec. This alone shows the advantage Québec has in standardized management of electricity generation and distribution, with a direct impact on reliability and the application of recognized practices.

Not only is the province's electrical system reputed to be among the most reliable by virtue of its robustness, its redundancy and the proximity of power plants to urban centres, but it also provides the ideal solution for data centres. Peak power demand in Québec happens in winter, whereas the peak demand for data centres occurs in summer for cooling.

A Favourable Climate

A certain number of factors influence total power consumption and data centre costs, notably weather conditions and the design of cooling solutions. With close to 40% of the power consumed by a data centre directed to the cooling of server rooms, air conditioning infrastructure is an element with a great deal of power savings potential. Access to cost-effective cooling gives Canadian data centres a clear cost advantage over more southerly countries.

A cold climate

Data centres located in areas with a cold climate, such as Québec, can significantly reduce their power consumption using cold air from outside to reduce their power-usage effectiveness (PUE) by almost 25%, thanks in particular to "free cooling". These free cooling systems operate in conjunction with an economizer, a specialized heat exchanger that uses cold outside air to cool water or air that, in turn, circulates in server rooms.

This reduces the load on compressors and pumps, which are the hungriest power consumers of any cooling system.

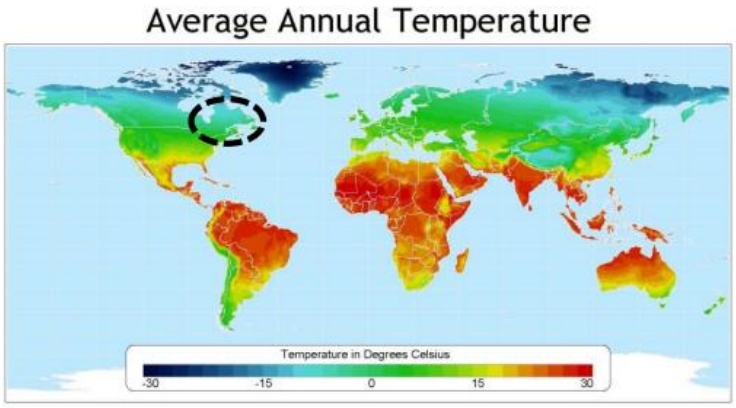
PUE is the energy performance indicator used most frequently for data centres. It is calculated as follows:

$$PUE = \frac{Total\ power\ consumption\ by\ data\ centre(W)}{IT\ equipment\ consumption\ (W)}$$

Québec's cold weather, i.e., periods when the temperature is below 20°C, lasts for more than 180 days per year, which substantially reduces the cost of cooling data centres. The average annual temperature of 4°C to 7°C in southern Québec reduces air conditioning on a yearly basis. For example, for a load of 5 MW IT, the annual savings tied to a lower outside temperature is estimated at over $500,000 (based on a reduction of 0.25 PUE).

The following table compares the average annual temperatures in Québec with that of several major U.S. cities.

		Montréal, QC	Québec City, QC	New York, NY	Washington DC	San José, CA	Dallas, TX
Average annual temperature	6.8	4	12.9	13.8	15.4	18.7	

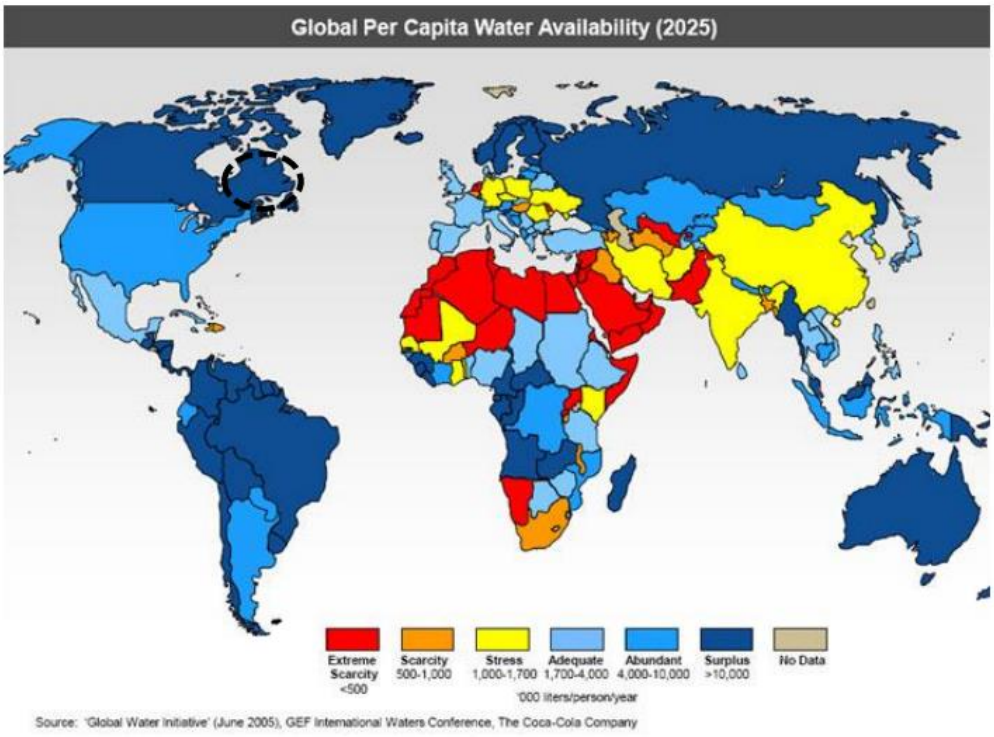


Favourable climate conditions thus have a significant impact on the operating costs of data centres. The table below shows various PUE targets, their implication in terms of technology selection and potential energy savings:

PUE	Efficiency Level	Types of Technology and Realities	Annual Savings for a 5 MW IT Load (C$0.05/kWh)
>2.0	Low	Air conditioning ineffective, no savings strategy, poor management of hot/cool alleys	$0
2.0	Moderate	Conventional air conditioning, no savings strategy	$1,100,000
1.5	Good	Effective air conditioning, good management of hot/cold alleys (confinement), overall efficiency strategy in place, free cooling with economizer.	$2,200,000
1.25	Excellent	Cutting-edge air conditioning with economizer and variable speed drive, confinement, high-efficiency electrical equipment, LEED building, northern climate favoured	$2,750,000
>1.25	Ideal	Cutting-edge air conditioning with economizer in use 75% or more of the time and variable speed drive, evaporative cooling during hot period, optimized confinement, high-efficiency electrical equipment, LEED building, northern climate required	$3,075,000

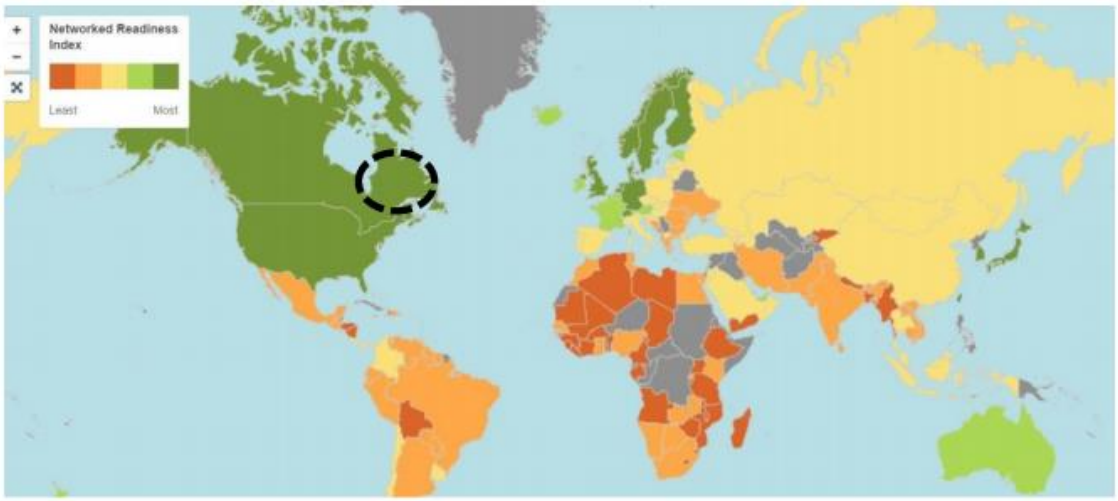
Water availability

Water availability is also an important factor when selecting a site for a new data centre. Because water is often required to operate data centre air conditioning and humidifying systems, a reliable supply is pivotal. The following map shows the availability of water per capita around the world. Note that Québec is considered to have a surplus of water resources [16]:

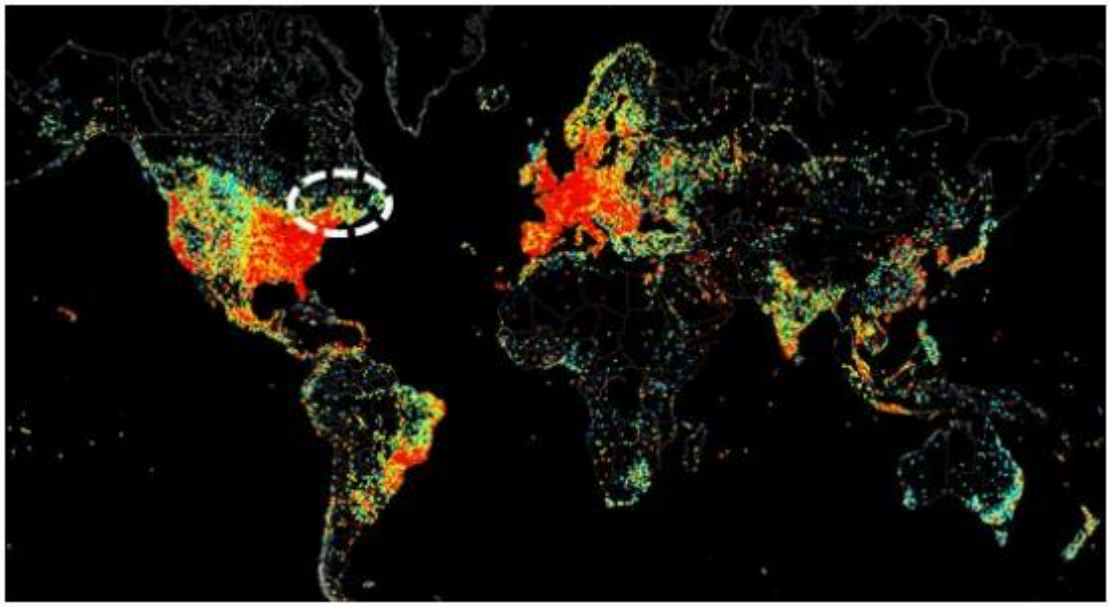


High-Performance Network Connectivity

Canada's Internet network, established by major bandwidth suppliers, reduces the numbers of "hops" to end users while maintaining low response times (or "pings"). Data centres located in a city like Montréal also provide good connectivity to American and European servers and end users. Canadian dedicated servers and cloud hosting suppliers provide a highly favourable advantage to North American and European end users [17].



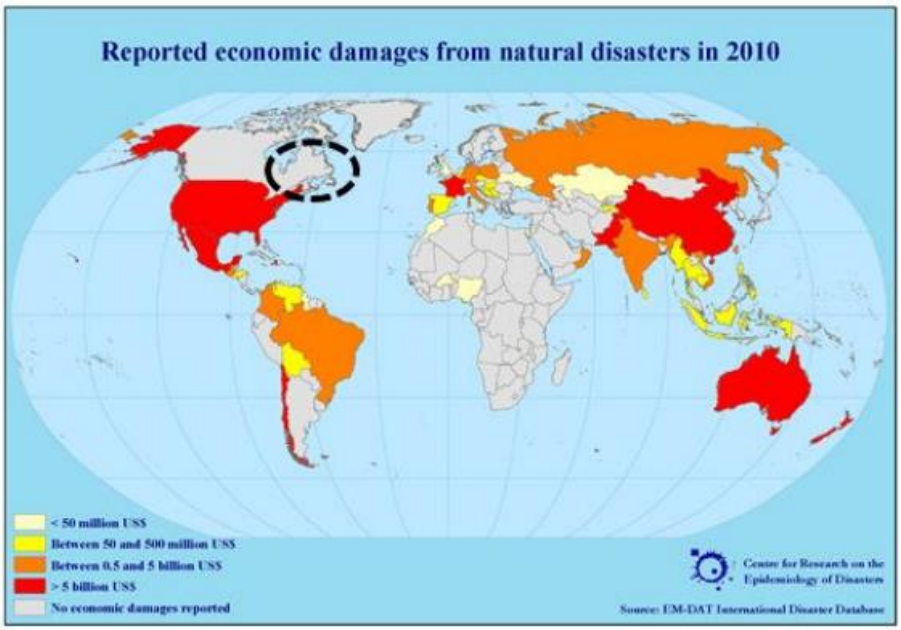
A number of world-class telecommunications companies are established in Québec, including Tata Communications, Verizon and Level 3 Communications. Montréal also has it own Internet exchange, the QIX or Québec Internet Exchange, the mandate of which is to increase the communication speed of local Internet access suppliers. Numerous fibre optic network suppliers operate here: Metro Optic, Bell, Videotron, Telus, Rogers, Fibrenoire, Cogeco, Pixelweb, and Zayo are just a few [18]. The following figure shows the level of network activity (colour-coded) at different points around the globe:



Sheltered from Natural Disasters

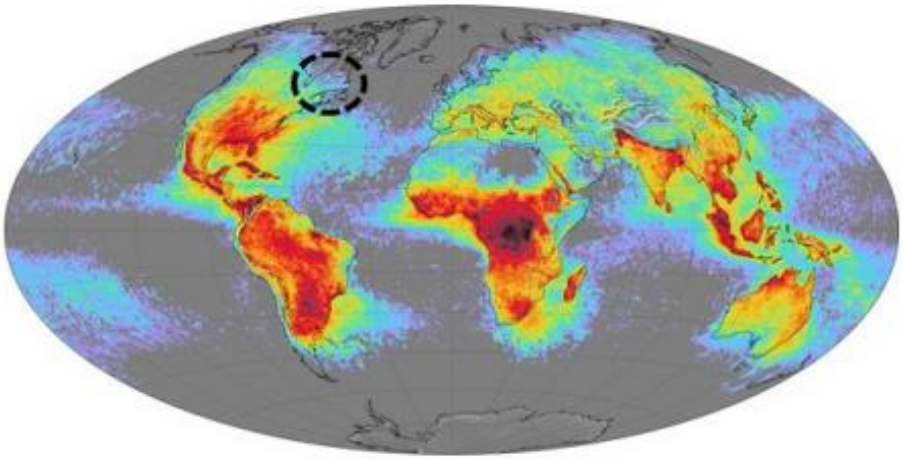
Natural disasters, such as Hurricane Sandy which hit the American seaboard in 2012, remind us that even the best equipped, most modern physical installations are not safe from the threat of storms and other violent weather events.

Although no organization can prevent natural disasters from happening, choosing a location with a relatively stable climate can considerably cut the risk. In this regard, Québec is an excellent choice, as the province's territory is sheltered from most natural catastrophes [19].



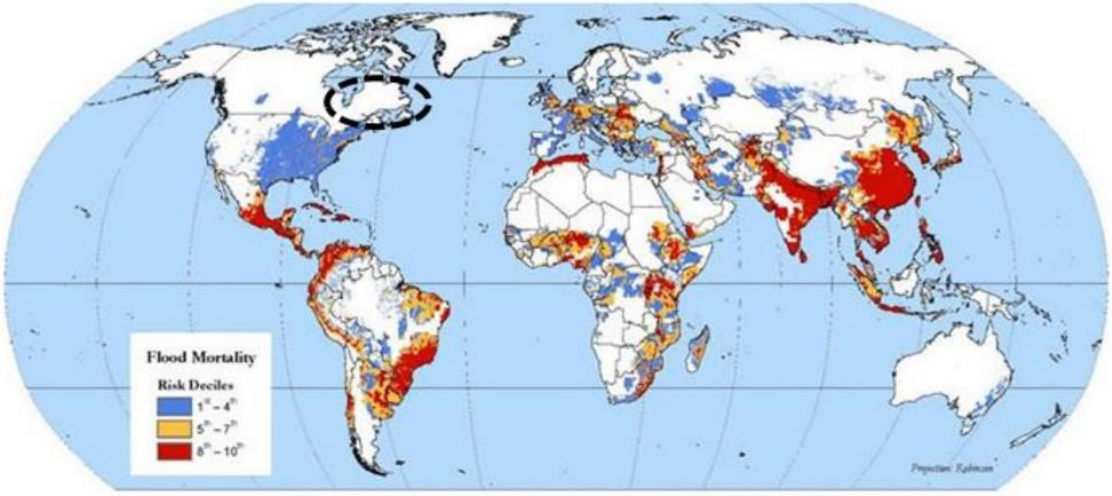
Low risk of lightning

In Québec, there are 10 to 19 days of lightning per year, representing 0.5 to 1 lightning bolt per km2 annually—among the world's lowest levels for a populated area [20]:



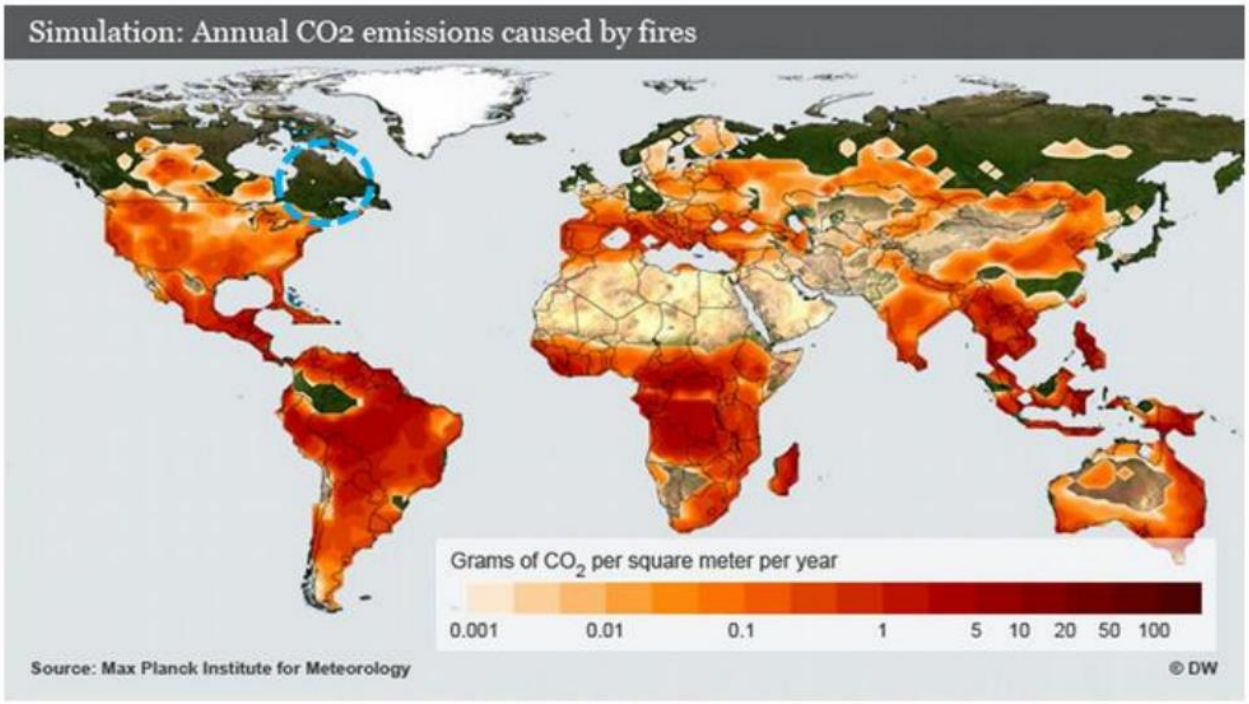
Low risk of flooding

As illustrated by the image below, despite an abundance of natural water resources, Québec has a very low risk of flooding [21]:



Low exposure to forest fires

The province of Québec has very little exposure to forest fires, as shown in this map from the Max Planck Institute [22]:



Advantageous Political and Economic Climate

Information confidentiality

Canada and Québec are recognized as world leaders in the protection of private information. This makes them ideal locations for hosting applications and data centres.

Private-sector use of personal and sensitive data is highly regulated, which protects the personal information of individuals and businesses alike. In contrast, in the United States, the USA Patriot Act adopted after the terrorist attacks of September 11, 2001, gives controlling forces in that country the right to full access to any information exchanged on networks.

Since security is among the most important factors for businesses and government, they choose to host their data and exercise their processing power outside their territory.

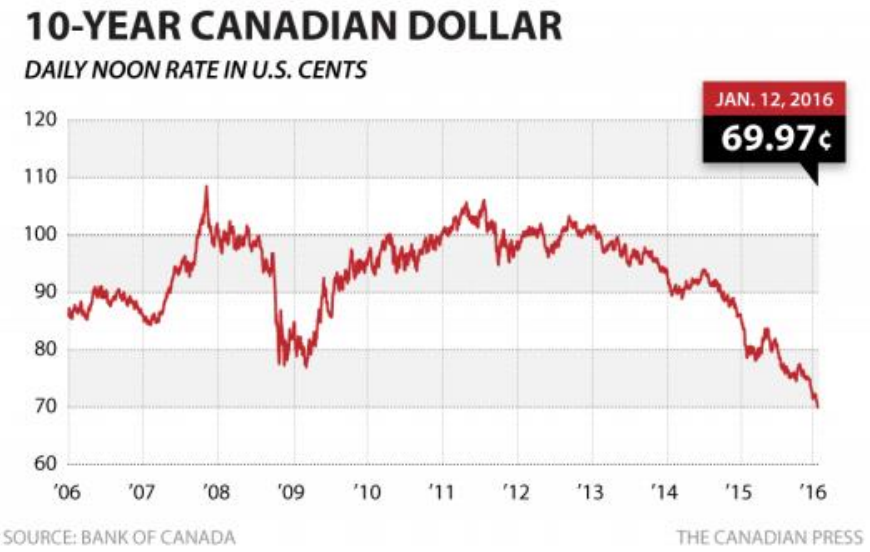
That is why international clients represent about 60% of data centre clientele in Canada. David Drury, general manager of global technology services at IBM Canada, believes that data custody is another good reason why Canada is an attractive location for data centres [23].

An advantageous economy

Many factors make the Canadian IT sector among the best in the world. Case in point, certain cities like Montréal offer a bilingual workforce (French and English). Canadians are also known to be among the most qualified and educated populations.

In Québec, over 3,600 students per year graduate from universities with a degree in computer science, electrical engineering or other related fields.

Another sizable asset in the world data centre market is the Canadian dollar, which is often worth much less than the American dollar, averaging US$0.8146 over the past 25 years [24].



Financially speaking, Canada holds a select position on the world scene with a perfect credit rating [25]:

	S&P	Moody's	Fitch	TERating
Canada	AAA Stable	AAA Stable	AAA Stable	99
United States	AA+ Stable	AAA Stable	AAA Stable	97

Low levels of corruption and stable political climate

Canada ranks among the 10 best countries in terms of democracy and has a low level of corruption [26].

The country has enjoyed political stability for decades, a fact that fosters worldwide confidence in web content, banking and fiscal responsibility, as well as human rights. Canada's reputation is one of compassion, respect and accountability as a member of the United Nations, the North American Free Trade Agreement, UNESCO and the World Health Organization.

With this strict focus on privacy, organizations whose data are hosted in Canadian data centres are not regulated by foreign governments.

Country	Corruption Rank 2015	Democracy Rank 2016
Denmark	1	1
Finland	2	1
Sweden	3	3
New Zealand	4	7
Norway	5	3
Netherlands	5	5
Switzerland	7	6
Singapore	8	72
Canada	9	9
Germany	10	10
United Kingdom	10	12
Australia	12	12
Belgium	13	8
United States	14	16

Attractive taxation and financial incentives

In recognition of the essential role that developing countries play in attracting other technological investments, the province of Québec has developed incentives to attract data storage and processing companies. The financial benefits associated with investment in Québec data centres include:

- A tax holiday representing up to 15% of the capital invested for investments greater than $100 million [27]
- A tax credit equal to 30% of eligible salaries paid by the company [28]
- A loan or loan guarantee for a maximum period of 10 years and other financing facilities [29]

Conclusion

Québec has been a privileged location for data centres for many years now. The province offers facility operators and service providers low-cost green energy, a reliable electrical grid, a cool climate with water availability, high-performance network connectivity, low risk of natural disasters, a stable political and economic climate, a qualified workforce, and attractive financial incentives. In addition, Québec enjoys low public utility costs as well as a strategic location that encourages numerous businesses to choose its territory for growth.

Over 60% of the Québec population lives less than 200 km from the U.S. border. Moreover, most data centres are built near major cities like Montréal or Québec City. This proximity provides excellent connectivity to the United States, while affording data centres protection under Canadian privacy legislation.

Québec provides reliable and renewable electric power that is clean and leaves a low carbon footprint. A data centre would reduce its GHG emissions by 98% if it sets up shop in Québec instead of in most American states or in Ontario [30].

By combining reliable, low-cost power with an advantageous climate and enviable political stability, the province of Québec has caught the eye of key international players in the data centre industry

References

1. Cushman & Wakefield (2016). "Data Centre Risk Index 2016." URL consulted: http://www.cushmanwakefield.com/en/research-and-insight/2016/data-centre-risk-index-2016
2. Ladurantaye, Steve (2011). "Canada Called Prime Real Estate for Massime Data Computers." URL consulted: http://www.theglobeandmail.com/report-on-business/canada-called-prime-real-estate-formassive-data-computers/article584163/
3. Cushman & Wakefield (2016). "Data Centre Risk Index 2016." URL consulted: http://www.cushmanwakefield.com/en/research-and-insight/2016/data-centre-risk-index-2016
4. Koomey J.G. Growth in Data Center Electricity Use 2005 to 2010. Oakland: Analytics Press, 2011.
5. Kovar J.F. "The 2014 Data Center 100," CRN, 2014.
6. Government of Canada, (2016). "Québec's Electric Reliability Framework." URL consulted: https://www.nrcan.gc.ca/energy/electricity-infrastructure/18847
7. Hydro-Québec, (2017). "Québec, a great place for your data center." URL consulted: http://www.hydroQuébec.com/data-center/advantages.html
8. U.S Energy Information Administration, (2017). "Virginia Electricity Profile 2015." URL consulted: http://www.eia.gov/electricity/state/virginia/
9. Hydro-Québec, (2015). "Hydro-Québec's Electricity Facts." PDF available online: http://www.hydroQuébec.com/sustainable-development/pdf/energy-supplies-and-air-emissions2015.pdf
10. Hydro-Québec, (2016). "Comparaison des prix de l'électricité dans les grandes villes nordaméricaines." URL consulted: http://www.hydroQuébec.com/publications/en/corporatedocuments/comparaison-electricity-prices.html
11. Idem.
12. Hydro-Québec, (2017). "Québec: The ideal place to set up your data center." URL consulted: http://www.hydroQuébec.com/data-center/
13. Office of Electricity Delivery & Energy Reliability, (2004). "Blackout 2003: Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and

Recommendations." URL consulted: https://energy.gov/oe/downloads/blackout-2003-final-report-august-14-2003-blackoutunited-states-and-canada-causes-and

14. Snopes, (2012). "North America Blackout." URL consulted: http://www.snopes.com/photos/space/blackout.asp
15. Water Sisweb, (2017). "Global Per Capita Water Availability Map." URL consulted: http://www.siswebs.org/water/Hydrology,Miscellaneous,PlanningandManagement/global-per-capitawater-availability-map-2025/
16. Nelson Institute, (2017). "Average Annual Temperature." URL consulted: https://nelson.wisc.edu/sage/data-andmodels/atlas/maps.php?datasetid=35&includerelatedlinks=1&dataset=35
17. Hutt, Rosamond, (2016). "Google co-founder Sergey Brin (R) walks in front of a giant balloon to show 'Project Loon' to Indonesian delegates." URL consulted: https://www.weforum.org/agenda/2016/02/isballoon-power-the-way-to-get-the-world-online/
18. Vivid Maps, (2017). "Map shows all the devices in the world connected to the Internet." URL consulted: http://www.vividmaps.com/2016/08/map-shows-all-devices-in-world.html
19. The International Disaster Database, (2009). "Natural Disasters – Maps 2010." URL consulted: http://www.emdat.be/maps-2010
20. Geology, (2017). "World Lightning Map." URL consulted: http://geology.com/articles/lightningmap.shtml
21. Macrobusiness, (2013). "World Bank sees $1 trillion bill for rising seas." URL consulted: http://www.macrobusiness.com.au/2013/08/world-bank-sees-1-trillion-bill-for-rising-seas/
22. Grotelüschen, Frank, (2013). "Climate change fuels wildfires around the world." URL consulted: http://www.dw.com/en/climate-change-fuels-wildfires-around-the-world/a-16518572
23. Stolier, Jonathan, (2012). "Why cold Canada is becoming a hot spot for data centres." URL consulted: http://www.theglobeandmail.com/report-on-business/economy/canada-competes/why-cold-canada-isbecoming-a-hot-spot-for-data-centres/article6598555/
24. Canadian Forex, (2015). "My FX Dashboard." URL consulted: www.canadianforex.ca
25. Trading Economics, (2017). "Canada | Credit Rating." URL consulted: http://www.tradingeconomics.com/canada/rating

26. World Audit, (2015). "Corruption." URL consulted: http://www.worldaudit.org/corruption.htm
27. Hydro-Québec, (2015). "Improvements to the Tax Holiday for Large Investment Projects." URL consulted: http://www.revenuQuébec.ca/en/salle-de-presse/nouvelles-fiscales/2015/2015-11-05.aspx
28. Investissement Québec, (2015). "Development of E-Business" URL consulted: http://www.investQuébec.com/Québec/en/financial-products/smbs-and-large-corporations/taxcredits/development-of-e-business.html
29. Investissement Québec, (2017). "Essor." URL consulted: http://www.investQuébec.com/Québec/fr/produits-financiers/toutes-nos-solutions/essor.html
30. Ottawa Power Generation, (2015). "2015 Sustainability Report." URL consulted: http://www.opg.com/reports/Pages/Intro.aspx
31.

Additional references

The Conference Board of Canada, (2011). "Canada's Electricity Infrastructure: Building a Case for Investment." URL consulted: http://www.electricity.ca/media/Know%20Your%20Power%20Stuff/11257_ElectricityInfrastructure%5B1%5D.pdf

Ladurantaye, S. (2011). "Canada Called Prime Real Estate for Massime Data Computers." URL consulted: http://www.theglobeandmail.com/report-on-business/canada-called-prime-real-estate-for-massive-datacomputers/article584163/

Office of the Privacy Commissioner of Canada, (2016). "Privacy topics." URL consulted: https://www.priv.gc.ca/en/privacy-topics/

Stolier, Jonathan, (2012). "Why cold Canada is becoming a hot spot for data centres." URL consulted: http://www.theglobeandmail.com/report-on-business/economy/canada-competes/why-cold-canada-isbecoming-a-hot-spot-for-data-centres/article6598555/

Cushman & Wakefield (2016). "Data Centre Risk Index 2016." URL consulted: http://www.cushmanwakefield.com/en/research-and-insight/2016/data-centre-risk-index-2016/

Investissement Québec, (2016). "Québec: Ideal for data centres." URL consulted: http://www.investQuébec.com/international/en/industries/information-and-communication-technologies/datacentres.html

Wikipedia, (2017). "Power usage effectiveness." URL consulted: https://en.wikipedia.org/wiki/Power_usage_effectiveness

Wikipedia, (2017). "Green Computing." URL consulted: https://en.wikipedia.org/wiki/Green_computing

Weatherbase, (2017). "The world." URL consulted: http://www.weatherbase.com/weather/countryall.php3

Met Office, (2011). "Land surface climate station records." URL consulted: http://www.metoffice.gov.uk/research/climate/climate-monitoring/land-and-atmosphere/surface-stationrecords

Energy Procedia – Volume 75, August 2015, Pages 1255–1260 "Data Center Energy and Cost Saving Evaluation." PDF available online: http://www.sciencedirect.com/science/article/pii/S1876610215009467

Montréal International, (2016). "Les entreprises et organismes du Québec invites à tirer parti de la croissance phénoménale du big data." URL consulted: http://www.Montréalinternational.com/a-propos/salle-depresse/les-entreprises-et-organismes-du-Québec-invites-a-tirer-parti-de-la-croissance-phenomenale-du-bigdata/

Harvey, I. (2010) "The poor economy isn't stopping Canada from becoming the world's data centre." URL consulted: http://www.backbonemag.com/Magazine/2010-04/canada-worlds-data-center.aspx

Smart Data Collective, (2014). "Growth in Canadian Data Center Sector: Operators Illuminate the Benefits of a Canadian Data Center Site." URL consulted: http://www.smartdatacollective.com/datacenters/207586/growth-canadian-data-center-sector-operatorsilluminate-benefits-canadian-data-ce

Canadian Cloud Law Blog, (2011). "Cloud Computing and Privacy FAQ." URL consulted: http://www.cloudlawyer.ca/2011/04/cloud-computing-and-privacy-faq.html

About the Author

Yves Bétournay, P. Eng.
Electrical Engineer, ATD certified
yves.betournay@bba.ca

Yves Bétournay is an Electrical Engineer with over 16 years of experience in data centres and in high-, medium- and low-voltage power systems in the energy, mining, and aluminum sectors. He is recognized for his expertise in critical electrical systems. His versatility, overall vision and vast field experience acquired during years of performance testing and commissioning are a significant asset in carrying out design studies for data centres.

BBA.CA