

15 THINGS TO KNOW ABOUT CANADIAN INFRASTRUCTURE



Prepared for the CanInfra Challenge
by the BCG Centre for Canada's Future

15 THINGS TO KNOW ABOUT CANADIAN INFRASTRUCTURE

WHAT'S "INFRA" ANYWAY? WHY DOES IT MATTER?



1. **Infrastructure has many definitions;** it's typically a large physical asset shared by many users and can be built and owned by government, the private sector or in partnership
2. Infrastructure is being enhanced by **smart technologies** but disruptions will also pose significant challenges

IS INFRASTRUCTURE AN ISSUE IN CANADA?



3. When it comes to infrastructure investment, Canada has been **distinctly average**
4. Canada's infrastructure **quality is mediocre;** with a significant portion of assets in poor (or very poor) condition
5. Canada has consistently lagged peers in **transportation, utilities and energy investments**
6. Estimates of Canada's "infrastructure deficit" vary widely, **ranging from \$110B-\$270B on average**

DO WE LACK FUNDING OR IDEAS FOR NEW INFRASTRUCTURE?



7. Canada has a strong pipeline of potential projects but **are they as transformational** as our past nation-building projects?
8. **Government funding capacity is average** relative to peers...
9. ... and there is a **disconnect in orders of government that build assets** and those with the capital to invest
10. Canada has a **strong pool of private capital to tap**, but our ecosystem fails to fully match demand & supply

HOW HAVE OTHERS ADDRESSED SIMILAR CHALLENGES?



11. Enhance the **selection and prioritization** of potential projects
12. Streamline **approvals processes** while maintaining effectiveness
13. Innovate **engineering and construction** to significantly improve the productivity of infrastructure builds
14. Better leverage **novel financing structures** to increase private investment rates
15. Unlock trapped value through increased **brownfield PPPs and asset privatization**

1A. Infrastructure has many definitions; it's typically a large physical asset shared by many users

The term infrastructure most commonly refers to a large-scale physical asset that meets a basic human need, such as transport, energy, water and waste, social services and—increasingly in today's world—digital. The assets developed, such as power grids or plants, generally last decades or longer. Infrastructure projects typically require large, up-front investment from public or private sources. Those investments can be paid back in different ways, such as through taxpayer funding and end-user fees.



FINANCING PLAYERS

Offer financing through various tools

Public entities

Federal, provincial and city governments

Banks

Banks providing loan financing

“Infra” investment funds

Investment vehicles focused on infrastructure

Retail investment funds

E.g. Mutual funds, ETFs

Other institutional investors

Sovereign wealth funds



Repay financing over long term



INFRASTRUCTURE PROJECTS

Transport

Roads, public transport

Energy

Pipelines, energy transmission

Water & Waste

Sewage, water purification

Social

Hospitals, schools

Digital

Broadband



FUNDING PLAYERS

Offer infrastructure for usage

Taxpayers

Paying through collected taxes

Either local, regional or national taxes

End-users

Paying through user fees

Either collected directly (e.g. tickets) or through cost-allocation (e.g. airlines)

Pay for usage

(single use or long term contract)



Challenges today

Opportunities tomorrow

Tangible examples of how infrastructure can tackle those challenges

ECONOMY

Shifts in traditional sources of **economic growth**

Key industries constrained by export and **supply chain bottlenecks**

Productivity choked by **congestion**

Big opportunities from new technology, growing global markets

- Digital infrastructure enables next wave of businesses, jobs, innovation
- Port, highway, pipeline capacity enables more exports
- Better roads and transit improves supply chains, wastes less time for workers

ENVIRONMENT

Growing threat of **climate change**

Pollution and smog, especially in major cities

Clean energy with massive potential

- Green power grids provide sustainable, clean energy
- Better mass-transit, taking cars off the road and cutting smog

SOCIAL INCLUSION

Isolated and disconnected **rural communities**

Income inequality, many not fully included in benefits of Canadian society

Strong Canadian talent to be unlocked

- Trade corridors to remote regions increase economic inclusion
- National broadband/mobile for northern and rural businesses and citizens
- Clean water for all Canadians, fewer neighbourhoods with poor public transit

1B. Infrastructure matters because it can help tackle our biggest challenges

Canada faces big challenges and opportunities that include sustaining our economic growth, addressing climate change, and fostering the financial and social inclusion of aboriginal people, rural communities and lower-income Canadians. Whether through ports that allow new exports, green power grids that reduce carbon emissions, broadband and mobile connectivity that links rural and Northern communities to the internet economy, or other assets, infrastructure plays an important role in advancing our prosperity.





GLOBAL EXAMPLES OF SMART TECHNOLOGIES BEING IMPLEMENTED:



SMART PARKING (BARCELONA)

- Street sensors and app to match available parking spots with drivers
- Greatly reduces parking time
- Increased city parking revenue by \$50M/year



SMART TRAFFIC LIGHTS (LOS ANGELES)

- LA synchronized every one of its 4,500 traffic signals across 469 square miles
- Magnetic sensors in the road to measure the traffic flow
- Software, designed by the city, analyzes the data and automatically makes second-by-second adjustments



ST ANTHONY FALLS BRIDGE (MINNEAPOLIS)

- 300 sensors measure corrosion, weather conditions, bridge movements and traffic conditions
- Predictive, early maintenance 5x cheaper than late repair preventing unexpected closures
- Improved safety though sensors activating anti-freeze spray and preventing bridge from icing up

2A. Infrastructure is being enhanced by **smart technologies**...

Digitally enabled or “smart” infrastructure offers dramatic benefits

Via big data analytics, Internet of Things, sensors, drones, better connectivity or other digital innovations.

NEW REVENUES

- Value add tools to improve productivity of infrastructure and increase income
- Secure, anonymized sale of data to 3rd parties

LOWER COST

- Cheaper (and more granular) usage tracking
- Tools to adjust supply with demand
- Peak-shaving cuts traffic, amount of infra needed
- Digital tools cut cost of construction and maintenance

REDUCED RISK

- Predictive maintenance of assets to maintain integrity proactively
- Adapting assets to changing conditions to optimize user safety
- Better tracking of mobile assets

FOR EXAMPLE, AUTONOMOUS VEHICLES (AV) WILL UPEND TRANSPORTATION AND CHANGE MANY ADJACENT INDUSTRIES

Strong demand for AV in Canada

4 of 15 most congested cities in North America are in Canada

\$6B in lost productivity per year from traffic in GTA alone

>25% of auto purchases forecast to be AV by 2035

AV will change the transit market...

Robotaxis could decrease the number of cars on city streets by 90%

AV estimated to benefit Canada by \$65B per year...

...but risk of some planned transit projects turning into multi-billion dollar stranded assets in 10-20 years

...resulting in changes beyond transit

~40K Canadian taxi jobs could become obsolete

\$740M per year parking industry also potentially at risk

But Waterloo tech cluster/ Ontario OEMs potentially positioned for high market share of AV

Smart technology poses big questions to our infrastructure planning

How to balance investment in current versus next-gen technologies?

How do we manage large-stranded infrastructure in the future?

How to anticipate and address potential social disruptions?

2B. ... but **disruption** will also pose significant challenges

Infrastructure is in the midst of a technological revolution, fueled by big data analytics, Internet-of-things capabilities, sensors, drones and network connectivity. These advances can increase the revenue potential of different infrastructure initiatives and reduce their cost and risk. For example, Barcelona embedded sensors in parking meters and created an integrated app that made it easier for drivers to find open parking spaces. Within a year the “Smart Parking” app was issuing 4000 parking permits a day and the city increased annual parking revenue by more than \$50M.

Technological change can have disruptive implications for current and future infrastructure. Since infrastructure is built for decades, any technology-induced changes in behavior can result in stranded assets, where a large investment is made but subsequent use turns out to be much less than expected. Autonomous vehicles, for instance, could dramatically reduce traffic congestion. On a per kilometer basis, our analysis found that autonomous robotaxis could be cheaper than mass transit in many cases. However, increased use would have a ripple effect in other areas—reshaping demand for traditional transit options, impacting employment in the parking, taxi and truck driving industries, and altering traffic and revenue streams. Planners and financiers will need to take these issues into account when developing new projects.

3. When it comes to infra investment, Canada has been **distinctly average**

When we compare per capita infrastructure investment among similar OECD countries that have a population over five million, Canada's performance is distinctly... average. Since 1960, Canadian infrastructure investment rates have been below the median nearly as often as they have been above.

The years between 1975-2005 make up a long period of relative underinvestment - culminating with especially low investment during the 1990's while Canada was focused on deficit reductions. The economic stimulus program that followed the financial crisis in 2008 has resulted in higher investment rates over the last decade.

By contrast, Norway's investment track record has been consistently strong, particularly in energy where sustained funding has enabled the industry to compete on a global level. Likewise, while Australia's infrastructure spending trailed Canada and many other OECD countries from 1960-1989, that changed in the 1990s when the country's focus on microeconomic reforms, deregulation and competition led to a significant and sustained increase in infrastructure investment. A subsequent focus on project prioritization mechanisms and asset recycling has rocketed them to the top of the peer set in recent years.

Peer set rank in absolute growth of infrastructure investment per capita (\$2010 USD)

Rank	'60-'64	'65-'69	'70-'74	'75-'79	'80-'84	'85-'89	'90-'94	'95-'99	'00-'04	'05-'09	'10-'17
1	DEN	DEN	DEN	JAP	MEX	JAP	JAP	JAP	JAP	AUS	AUS
2	US	SWE	JAP	BEL	JAP	NOR	NOR	NOR	NOR	SPA	NOR
3	SWE	SUI	SUI	DEN	BEL	FIN	SPA	SPA	SPA	NOR	JAP
4	AT	NED	SWE	SUI	NOR	SUI	SUI	SUI	SUI	JAP	SUI
5	NED	JAP	AT	AT	FIN	US	DEN	CZR	AUS	SUI	SPA
6	GER	UK	GER	NOR	SUI	SPA	CZR	DEN	AT	AT	DEN
7	UK	FRA	NED	FIN	AT	FRA	FIN	AUS	DEN	SWE	AT
8	SUI	US	FIN	SWE	SWE	ITA	AT	AT	SWE	DEN	CZR
9	FRA	AT	BEL	GER	ITA	SKR	NED	SWE	NED	CZR	NED
10	JAP	GER	UK	FRA	FRA	BEL	AUS	NED	CZR	NED	SWE
11	ITA	FIN	NOR	MEX	SPA	MEX	SWE	FIN	FIN	FIN	🇨🇦
12	FIN	NOR	FRA	ITA	GER	CZR	FRA	SKR	FRA	FRA	CHI
13	NOR	🇨🇦	ITA	NED	POR	GRE	UK	UK	GRE	🇨🇦	BEL
14	🇨🇦	ITA	🇨🇦	SPA	SKR	AT	GER	FRA	SKR	SLO	FIN
15	BEL	BEL	POR	TUR	CZR	POR	🇨🇦	BEL	ITA	ITA	FRA
16	POR	POR	SPA	UK	GRE	SLO	BEL	POR	POR	POR	SKR
17	SPA	AUS	GRE	🇨🇦	SLO	TUR	ITA	GER	UK	GRE	POL
18	GRE	SPA	AUS	AUS	TUR	🇨🇦	SKR	🇨🇦	BEL	SKR	UK
19	CZR	GRE	CZR	POR	🇨🇦	HUN	SLO	ITA	🇨🇦	CHI	SLO
20	AUS	CZR	SLO	CZR	NED	SWE	US	CHI	CHI	BEL	ITA
21	TUR	SLO	ISL	POL	US	POL	POR	US	GER	US	GER
22	SLO	POL	POL	GRE	HUN	AUS	GRE	SLO	US	UK	US
23	POL	TUR	US	SKR	POL	GER	CHI	ISL	ISL	POL	POR
24	MEX	ISL	HUN	SLO	ISL	CHI	ISL	POL	SLO	GER	ISL
25	HUN	HUN	TUR	US	AUS	ISL	POL	GRE	POL	ISL	HUN
26	CHI	MEX	SKR	HUN	CHI	UK	HUN	HUN	HUN	HUN	MEX
27	SKR	CHI	CHI	ISL	DEN	NED	MEX	MEX	MEX	MEX	GRE
28	ISL	SKR	MEX	CHI	UK	DEN	TUR	TUR	TUR	TUR	TUR

MEDIAN

Note: Rankings pre-1990 based on absolute dollar growth in government gross fixed capital formation (WEF); rankings post-1990 based on cumulative investment in infrastructure assets over period based on IHS Construction Data (ie., public + private investment) Sources: WEF, IHS Construction Database, BCG Analysis

4. Canada's infrastructure **quality is mediocre**; with a significant portion of assets in poor (or very poor) condition

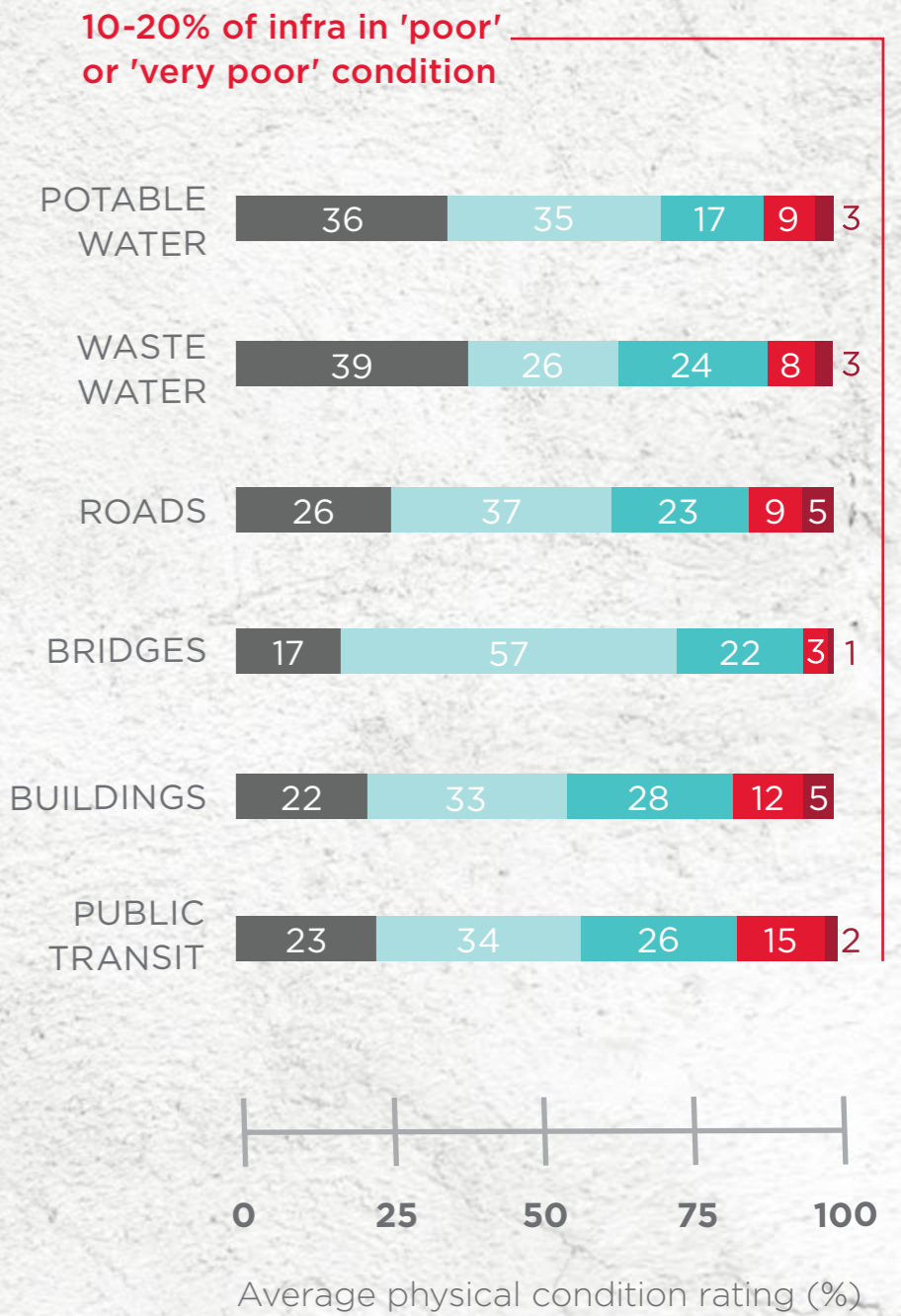
A 2016 World Economic Forum survey ranked Canada's infrastructure quality at 14th among 28 OECD countries. Many higher-rated countries, such as Switzerland, Finland, Australia, France, Netherlands, Denmark and Japan, outperform Canada when it comes to per capita infrastructure spending.

The 2016 Canadian Infrastructure Report Card concludes that between 10 to 20% of Canada's infrastructure assets are in poor or very poor condition. "Very poor" suggests that assets are unfit for sustained use and are near or beyond their expected service life. "Poor" suggests that assets are approaching the end of their useful life. Another 20-30% of assets were rated to be in "fair" condition, indicating they have signs of deterioration. All told, between 30% and 50% of Canadian infrastructure assets will soon require attention or replacement.

Canada has average infrastructure quality ...



... and a significant share of assets in poor condition



■ Very Good ■ Good ■ Fair ■ Poor ■ Very poor

Note: Infrastructure quality data is based on a qualitative survey conducted by the World Economic Forum
 Source: World Economic Forum, Canadian Infrastructure Report Card, BCG Analysis

Investment in infra/capita, \$2010 USD (1990–2016)

🇨🇦 Canada
 ■ 4th quartile
 ■ 3rd quartile
 ■ 2nd quartile
 ■ 1st quartile



ENERGY & UTILITIES

Energy transmission, distribution, and storage for oil and gas, natural gas and power; power generation, incl. renewables



TRANSPORT

Roads, public transit, airports, ports, etc.



WASTE & WATER

Water treatment/supply, waste handling, recycling centers, etc.



COMMUNICATIONS

Telecom, broadcasting, maintenance structures, etc.



% of total investment

🇨🇦 Difference Peer avg

30% -7% 37%

44% -7% 51%

18% +9% 9%

8% +5% 3%

5. Canada has consistently lagged peers in **transportation, utilities and energy investments**

Since 1990, Canada has invested heavily in public health and telecommunications, but we have spent significantly less than other OECD countries greater than population of 5M in transport, energy, and utilities investments—areas that are critical to fueling and supporting our economic growth.

This trend is not new. In transportation, Canada has remained in the 3rd quartile from 1990 to 2016, with the exception of 2009 where spending was just over the median. In energy, after periods in the bottom quartile from 1996-1999, investment picked up post 2000 to land us in the 2nd quartile, but just barely.

Further, while other countries have stepped up investment in newer technologies to modernize their infrastructure assets—for example, Spain's high speed rail network and Chicago's O'Hare Airport expansion—much of Canada's key infrastructure still relies on older technology.



Source: IHS Construction Database, peer set includes G7+OECD countries with population greater than 5 million, BCG Analysis

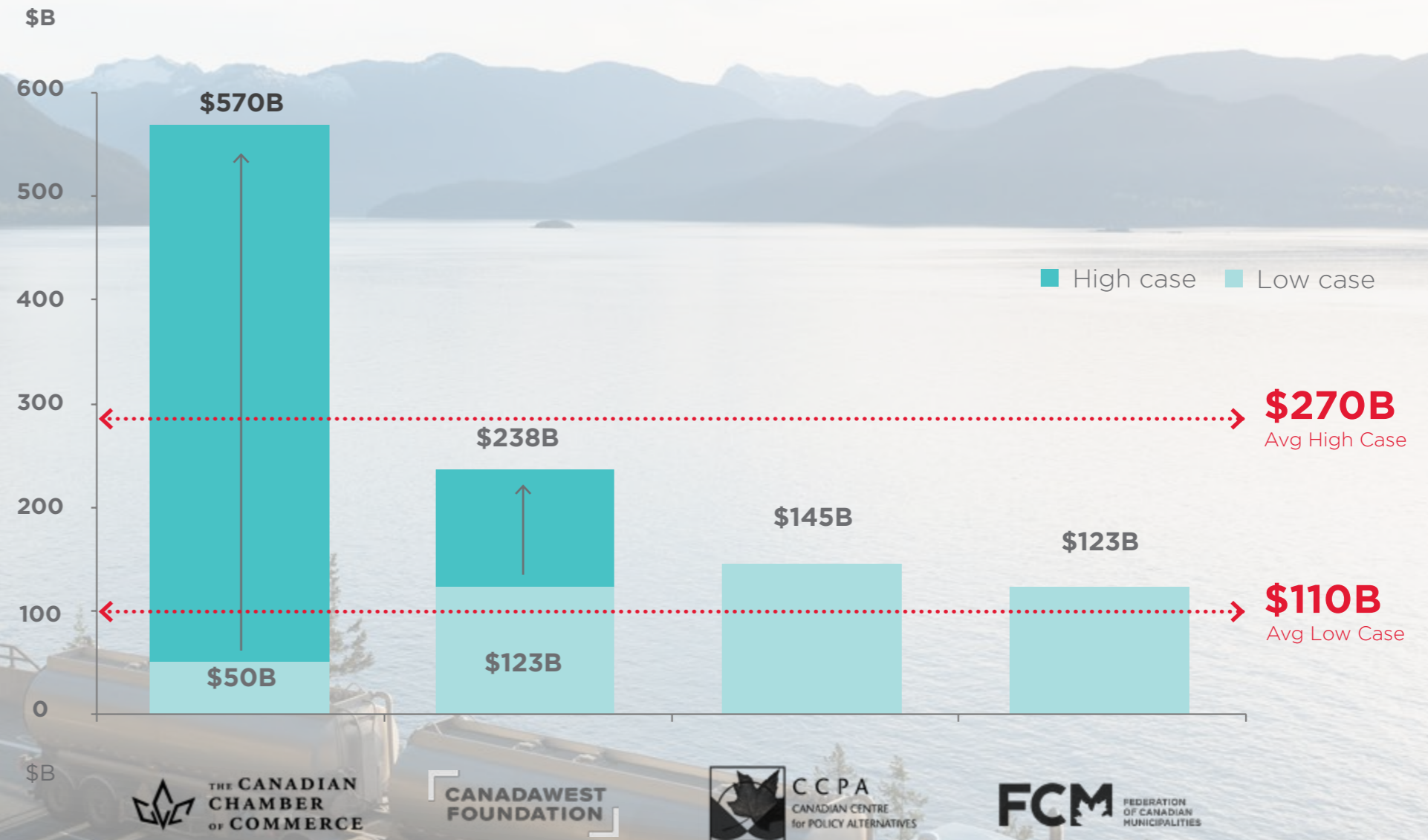
6. Estimates of Canada's infrastructure deficit vary widely, **ranging from \$110B-\$270B on average**

The scale of Canada's infrastructure deficit is difficult to estimate precisely. There currently exists no national source on the stock and condition of infrastructure assets in Canada. Fortunately, Statistics Canada is currently undertaking a survey to shed more light on the issue. When complete, it will report on the stock, condition, performance and asset management strategies associated with Canada's core public infrastructure.

In addition, a number of prominent think tanks and thought leadership institutions have attempted to size Canada's infrastructure deficit. Estimates range from \$50B to \$570B with most averaging between \$110B and \$270B. The consensus opinion is that Canada should be investing significantly more capital in infrastructure.

Over the past 10 years, the federal government has responded by increasing investments in infrastructure and launching targeted initiatives, such as the creation of the Canada Infrastructure Bank. However, the federal government will not be able to tackle this issue alone. Provinces, municipalities and the private sector will also need to play prominent roles in reforming Canada's infrastructure.

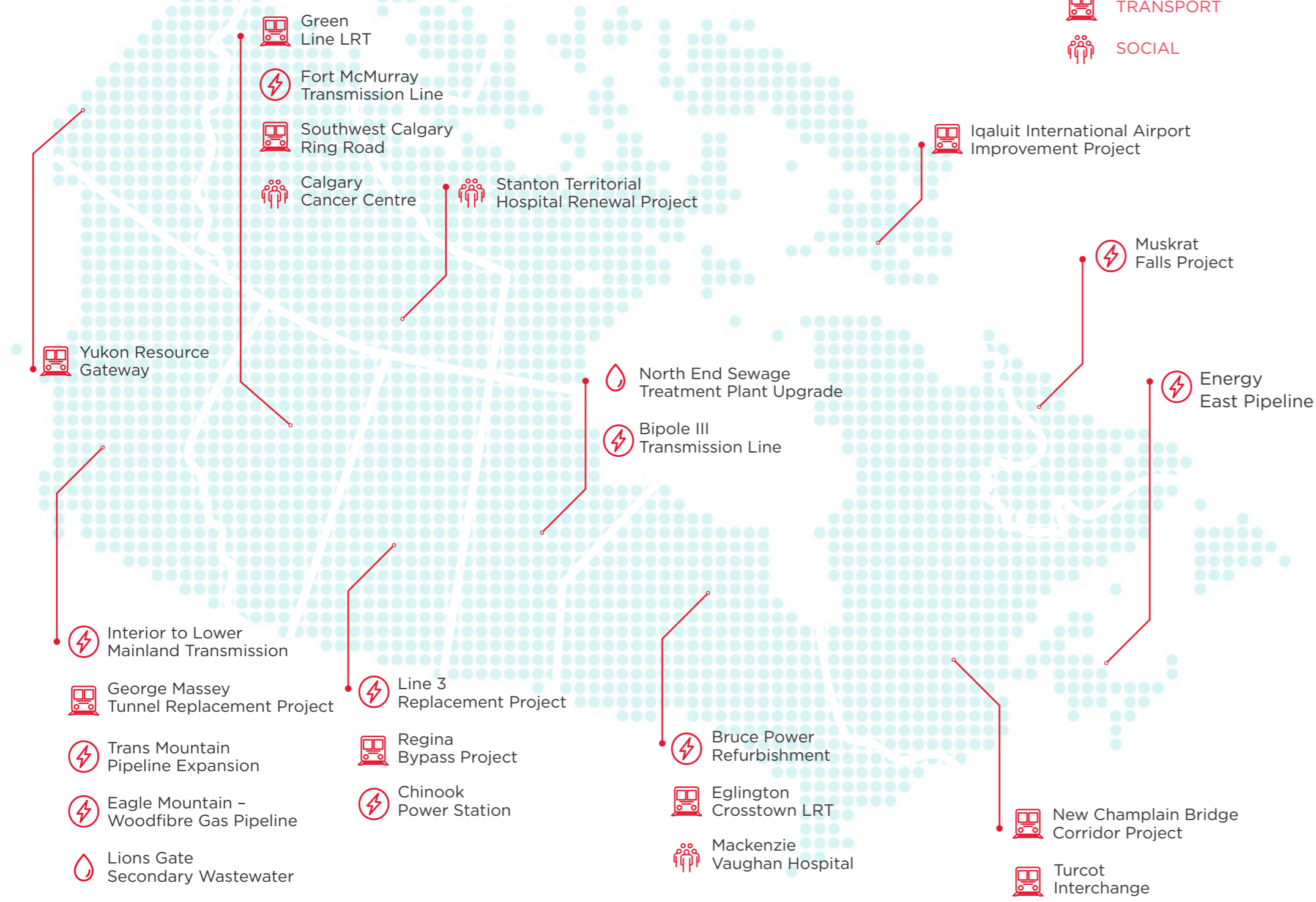
Estimates of Canada's Infrastructure Deficit



Sources: The Canadian Chamber of Commerce, Canada West Foundation, Canadian Centre for Policy Alternatives, Federation of Canadian Municipalities, BCG Analysis
 Note: Approaches to sizing the infrastructure deficit or gap vary by institution.

Illustrative pipeline of infrastructure projects planned or underway across Canada

-  WASTE & WATER
-  ENERGY & UTILITIES
-  TRANSPORT
-  SOCIAL



7. Canada has a strong pipeline of potential projects but **are they as transformational** as our past nation-building projects?

There are many large projects being planned or underway across Canada. These projects span the range of infrastructure classes this country needs to continue to flourish. These include our transportation infrastructure such as the replacement of the George Massey Tunnel in BC or The Eglinton Crosstown LRT in Toronto. Energy Projects such as Muskrat Falls in Labrador or Bipole III in Manitoba. Upgrades to our water and wastewater management such as the Lions Gate Treatment plant in BC or the North End Sewage Project in Manitoba. We are also improving our social infrastructure with projects such the Vaughan Mackenzie Hospital in Ontario and the Calgary Cancer Centre.

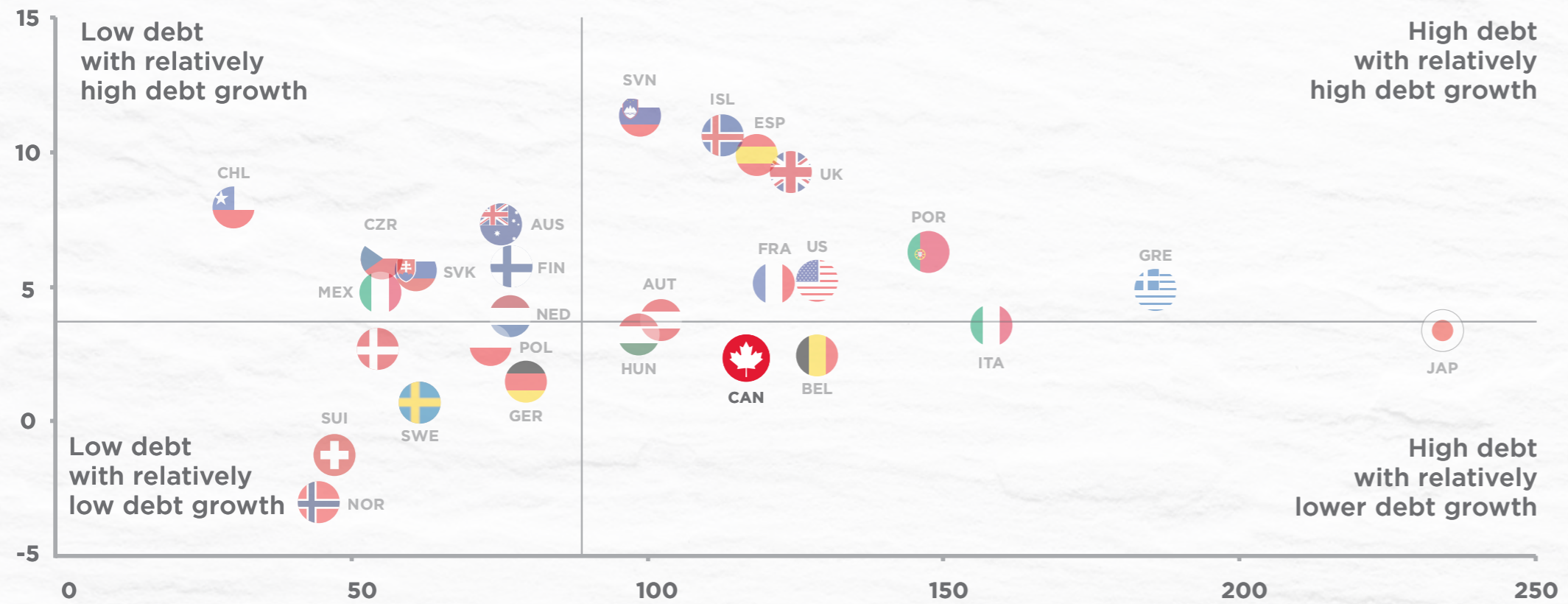
These projects are all vital to the continued prosperity of our nation and in aggregate the money we collectively spend on these projects is impressive. However, these projects are disparate and lack a clear overarching national infrastructure strategy. We need only look at some of the nation building infrastructure from our past such as the St Lawrence Seaway or Canadian Pacific Rail as examples of an infrastructure strategy that is country-wide in scope and impacted every Canadian. **When we look at the current pipeline of infrastructure builds, are we really setting Canada up to be a global leader for the decades to come? Are these projects going to dramatically affect the well-being of all Canadians? If not, why don't we have a strategic and national vision for our infrastructure projects that will result in step-change benefits to our economy and society?**

Note: This is a sample list of large projects across regions and is not meant to be comprehensive in nature. Multi-province pipelines shown in only one province.



8. Government funding capacity is average relative to peers...

Average annual increase in total government debt, across all orders of government, as a % of GDP (2006-16)



Total government debt, across all orders of government, as a % of GDP (2016)

Our ability to raise our level of infrastructure investment is constrained by our increasing debt load.

Among the OECD our debt burden is the 10th highest—representing nearly 115% of GDP, putting us alongside Spain, the United Kingdom and France. Compared to other OECD nations, however, our debt burden is growing at a slower rate, at just 2.4% per annum over the last 10 years instead of the OECD average of 4.5%.

In addition, much of our recent debt growth has occurred at the provincial rather than at the federal level. Some provinces, like Ontario and Manitoba, have seen their net debt to GDP ratios grow by over 40% over the past decade. By contrast, federal net debt to GDP has been relatively constant. That creates a fiscal imbalance when it comes to infrastructure. Province and municipalities are responsible for a major share of infrastructure costs, but their growing debt burden will make it hard for them to continue doing so.

This trend is one reason why greater coordination between orders of government is required, and why many observers suggest a bigger role for private capital, from domestic players such as Canadian pension funds as well as international investors.

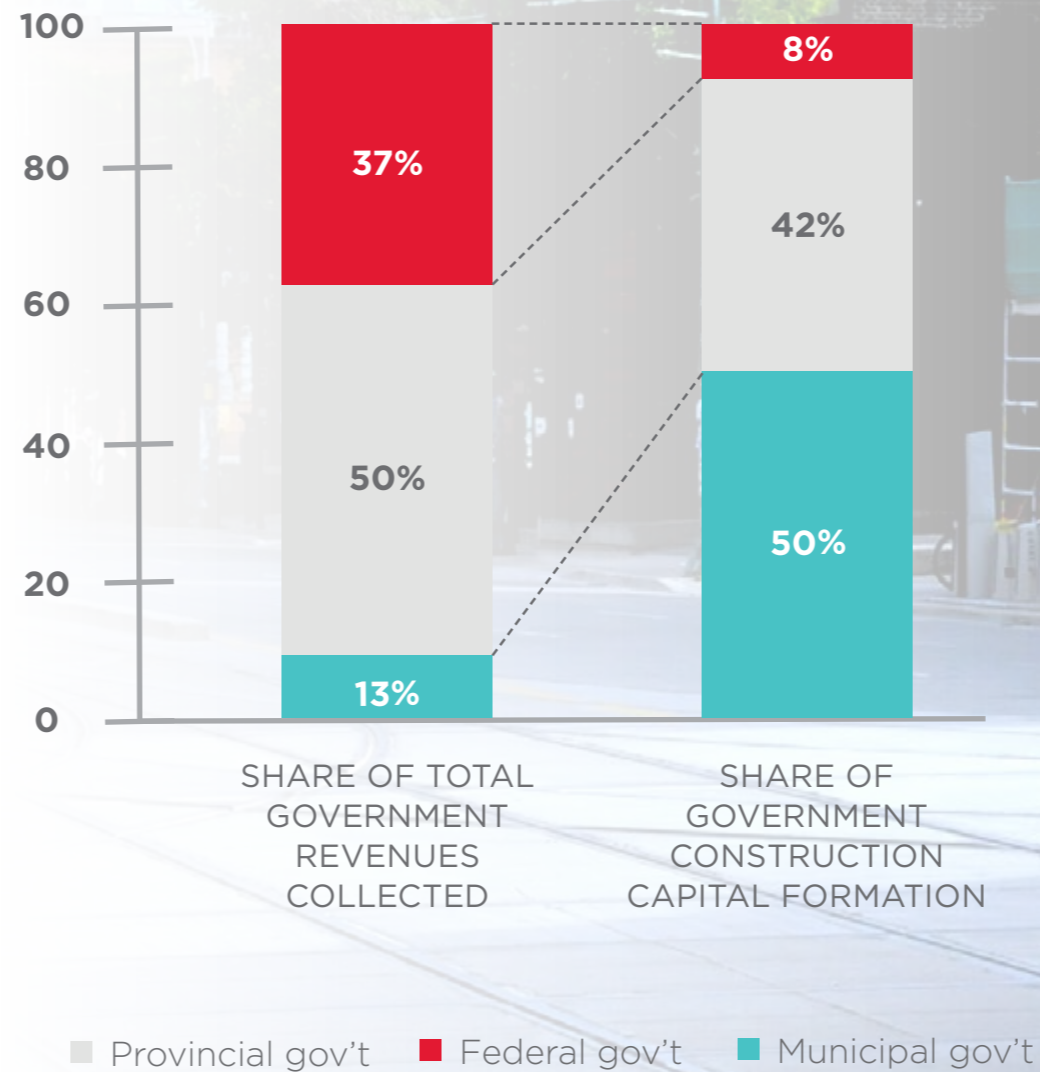
9. ... and there is a **disconnect in orders of government that build assets** and those with the capital to invest

This imbalance creates some inefficiencies:

- Challenges in designing, executing and operating infrastructure involving multiple levels of government
- The need for significant fund transfers between different orders of government
- Scarcity of talent and systems required to deliver projects at a more distributed level
- Limited opportunity to document and broadly share best practices across the nation
- Increased likelihood of optimization for local, rather than national, interests

Provinces and cities collect just over 60% of taxes, but build over 90% of government 'infrastructure'

% (Avg, 2008-2015)



Source: Statistics Canada, BCG Analysis

10. Canada has a **strong pool of private capital** to tap, but our ecosystem fails to fully match demand & supply

On top of government funding, Canada has a large pool of private capital from potential investors, including companies, pension funds and private investors.

Our largest players in telecom, transport, mining, oil and gas generate significant operating cash flows, which could potentially fund even bigger infrastructure programs than they undertake today. In addition, Canada's pension funds include 6 of the top 20 largest pension fund infrastructure investors in the world. Their combined infrastructure investments exceeded \$45 billion in 2016, and infrastructure investments by Canadian investors are growing at 20% or more annually.

However, many Canadian pension funds invest less than 15% of their infrastructure portfolio in Canada, a lower figure than in their other illiquid asset classes.

There are a variety of reasons for this. Some point to a lack of investible projects—those with user fees that could provide a return on investment. Others suggest that too many projects at the local level are too small to be attractive for big investment funds. And still others say that regulatory constraints and approval processes are too long and unpredictable. In some cases, large geographies or limited market sizes make it difficult to sustain a major infrastructure investment.

We need to reduce these inhibitors and enable more domestic investment in infrastructure.

“

\$34 billion in capital spending has moved from Canada to the U.S. since March 2016.

CANADIAN PREMIER

“

It's not a question that the regulations are too tough, it's that the regulations are too uncertain.

PUBLIC THINK TANK

“

If there were enough high-quality infrastructure projects to invest in Canada, we would have a program that was predominantly Canadian.

MAJOR PENSION FUND

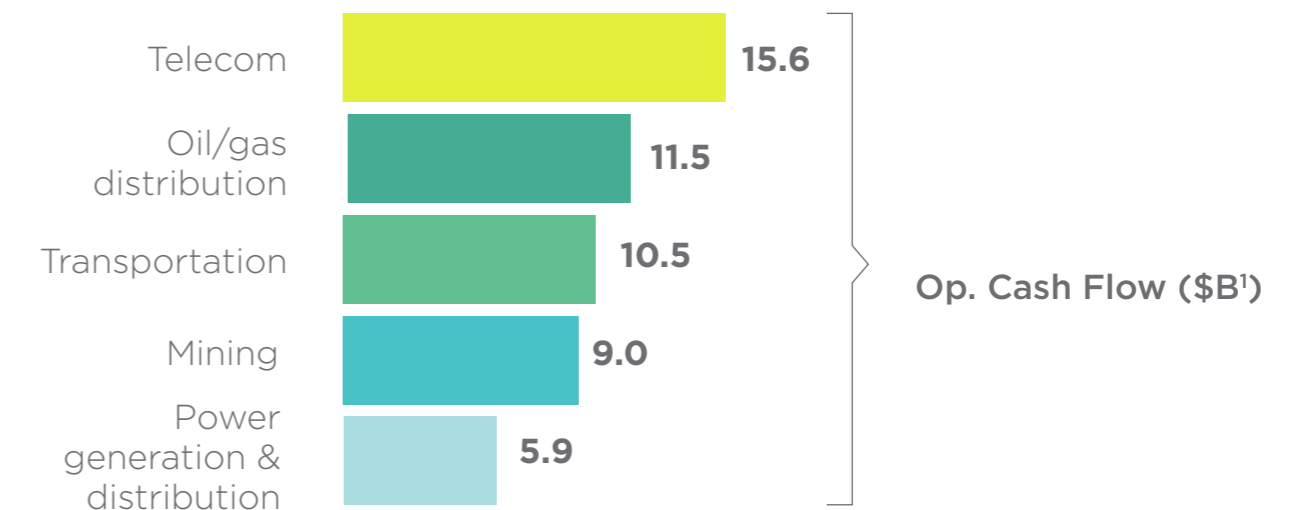
“

There's a massive amount of money out there and investors are more than willing to invest in Canada... [but] it's tough to find opportunities; the real issues is just the size.

INSTITUTIONAL INVESTOR

Private proponents generate significant operating cash flow

Operating Cash Flow of 5 Select Major Canadian Infra players by sector (\$B)



Pension capital underindexed in Canada, with <15% of infra within Canada

Investor	% of portfolio in Canada		Infra portfolio (\$B)	Within Canada (\$B)	Fair-share in Canada ² (\$B)
	% of Net AuM in Canada	% of Infra Net AuM in Canada			
La Caisse	41	9	15	1.4	6.2
PSP ³	15	5	11	0.6	1.7
BCIMC	47	4	11	0.4	5.2
AIMCO	66	5	5.3	0.3	3.5
CPPIB	17	Not available	29	N/A	4.9
OMERS	40	Not available	18	N/A	7.2
OTPP	54	Not available	18	N/A	9.7

Source: Company Annual Reports, BCG Analysis, Capital IQ

¹ Operating cash flows for 5 select major Canadian players (for international players, most recent Canadian divisional information available);

² Represents investment in Canadian infra at level of total portfolio exposure to Canada.

³ Approximate percentages for total portfolio % calculated based on weighted average of asset classes with publicly available geographic split.

CANADA HAS AN OPPORTUNITY TO LEARN FROM PEERS IN CREATING A STRONGER INVESTING ENVIRONMENT



Enhance the
**SELECTION AND
PRIORITIZATION**
of potential projects



Streamline
**APPROVALS
PROCESSES,**
while maintaining
effectiveness



**INNOVATE IN
ENGINEERING AND
CONSTRUCTION**
to significantly
improve the
productivity of
infrastructure builds



Better leverage
**NOVEL
FINANCING
STRUCTURES**
to increase private
investment rates



Unlock trapped value
through increased
**BROWNFIELD
PPPs AND ASSET
PRIVATIZATION**

11. Enhance the **selection and prioritization** of potential projects



A granular 5 year+ plan



UNITED KINGDOM

The UK treasury has detailed a comprehensive pipeline of planned infrastructure investment across the public and private sectors through 2021 (and beyond in some cases). It contains over 600 projects with a combined value of £425B. The pipeline is not meant as a commitment to undertake each and every project, but rather a strategic overview of planned investment.



A rigorous, data driven approach to prioritization recommendations



AUSTRALIA

Infrastructure Australia is an arm's length body tasked with infrastructure oversight. They draft a detailed assessment of each nominated project and initiative. These assessments include an estimated benefit-cost ratio analysis, which makes it easier to rank the relative importance of different projects.



An independent, arms-length point-of-view on a national list of key projects



AUSTRALIA

Infrastructure Australia, overseen by an independent board and CEO, is charged with developing 'The Infrastructure Priority List'—which ranks nationally significant investments based on a set of predefined criteria. The list is updated frequently by Infrastructure Australia, which independently assesses project submissions (or details initiatives and potential infrastructure solutions for which no business case yet exists).



A focus on public transparency



AUSTRALIA

Australia's National Infrastructure Construction Schedule lists all construction projects started or planned over the next 10 years.

12. Streamline **approvals process** while maintaining effectiveness



A clearly defined project approval process



The UK's 2008 Planning Act lays out six well-defined process steps. They include pre-application, acceptance, pre-examination, examination, decision and post-decision stages.



Accelerated timelines for priority projects



For nationally significant infrastructure projects, the six-step approval process must be completed within 15 months, an improvement over the previous two year limit.



A one stop shop for approvals



Australia's Major Projects Approval Agency serves as a single point of entry into Australian government regulation, helping proponents of major projects understand and navigate their regulatory approval obligations.



Effective stakeholder management and inclusive engagement



The UK requires public consultation before a project application can be submitted, frontloading public stakeholder management while reducing drag on the overall process.

13. **Innovate engineering and construction** to significantly improve the productivity of infrastructure builds



Digitizing the engineering & construction business



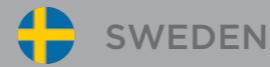
UNITED KINGDOM

Building Information Modeling (BIM): The UK encourages the use of BIM in all large-scale infrastructure projects. By improving knowledge-sharing and transparency, BIM has reduced the lifetime cost and completion time of highway projects by 10-20%.

On-site robotics assembly: The steel structure of London's Olympic stadium roof was pre-fabricated and assembled on-site by automated machines that operated with satellite guidance and BIM. This reduced downtime and cost.



Innovative construction techniques



SWEDEN

Pre-assembled modules: Where the build allows, the use of prefabricated elements can speed development and lower cost. Stockholm city mandated the use of advanced manufacturing to minimize disruption to the existing infrastructure through wide use of prefabricated modules that were assembled off-site—reducing construction time. E.g. Karolinska hospital (Stockholm).



CHINA

3D Printing: Winsun, a Chinese building materials supplier, has completed trials of 3D printing for housing construction, completing its initial batch of 10 proof-of-concept houses using a special “ink” made of cement, sand, fibre and other ingredients.



Improving productivity of trades workforce



AUSTRALIA

Next Generation Skills Training: Boosting digital tool adoption at the worksite to increase productivity through more active onsite training and more tool time.



UNITED STATES

Integrated Construction: Moving from design-bid-build to an integrated approach wherein contractors/subcontractors become an active part of the design process results in more efficient and safer project completion.

14. Better leverage **novel financing structures** to increase private investment rates



Introduce risk mitigating and innovative structuring...



COLOMBIA

Risk transfers: Colombia's development bank, FDN, provides top-up payments in the case of lower-than-projected toll revenue. It also provides termination payments for early termination of concession contracts, both of which reduce investor risk.



EUROPEAN UNION

Project bond credit enhancement: The Europe 2020 Project Bond Initiative provides a subordinated tranche of debt (through a loan or a contingent credit line from the European Investment Bank) to enhance the credit quality of senior bonds; the improved credit quality of the bonds will help to attract additional private financing.



PHILLIPINES

PPP bundles: The Metropolitan Waterworks and Sewerage System in Manila pooled the revenues and risks of smaller projects to privatize its two water-service areas in 1997, making the investment more attractive to a wider audience.



CHINA

Property value incentives: The Hong Kong government provides private company MTR Corporation with land "development rights" at stations along the route, allowing MTR to make money from property-value increases that follow the construction of rail lines. This allows the whole system to self-sustain without taxpayer subsidies.



... and avoid regulatory uncertainty



UNITED KINGDOM

Removal of the **Levy Exemption Certificates (LECs)** for renewable energy in the UK Summer Budget 2015 reduced revenues of operating projects and reduced investor confidence.



NORWAY

In 2013, the Norwegian government **cut tariffs** for the gas transport pipeline, Gassled, surprising investors with a potential 40% reduction in return expectations.

Examples where investor confidence was shaken

15. Unlock trapped value through increased **brownfield PPPs and asset privatization**



An independently developed list of 'privatizeable' assets



AUSTRALIA

Acting in their advisory role, Infrastructure Australia developed a list of government assets that had high potential for privatization. The analysis included an estimate regarding the amount of capital that could be unlocked for future infrastructure projects (A\$220B). This gave decisions makers (and the general public) a more concrete fact base.



'Asset recycling' incentives for state and local governments



AUSTRALIA

In 2013, the Australian government started a A\$5B billion incentive program to spur privatization and asset recycling at the state-level in Australia. The federal government provided a financial contribution to state governments that were willing to privatize infrastructure assets.

This came in the form of a bonus worth 15% of the assessed sale value and could be used in funding future infrastructure projects. The program spurred privatization/investment at the state level.



Brownfield PPPs for marquee assets



AUSTRALIA UNITED STATES

Canadian pension-led consortiums including CPPIB, OMERS, OTPP have recently participated in major international brownfield PPP deals. These include the Chicago Skyway (US\$2.8B, 88 years) and Port of Melbourne (US\$7.3B, 50 years).

The openness of these jurisdictions in exploring marquee Brownfield PPPs drove significant Canadian infrastructure capital into their markets. It's important to note that these PPPs were not full privatizations, but rather concessions with a fixed term.

WITH INFRASTRUCTURE TOUCHING SO MANY PARTS OF OUR NATION,
WE WILL NEED TO BRING TOGETHER MULTIPLE STAKEHOLDERS TO BUILD
THE CANADA OF TOMORROW



**PUBLIC USERS
AND CIVIC SOCIETY**

Residents, taxpayers,
and impacted
businesses



GOVERNMENT

All orders of
government –
Federal, Provincial,
Municipal, Indigenous

Regulatory and
governing agencies



INDUSTRY PLAYERS

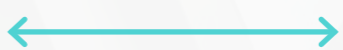
Proponents

Construction firms



FINANCIERS

Domestic and
international investors



**OTHER INDUSTRY
STAKEHOLDERS**

Workers and
organized labour

Industry groups

Infrastructure projects, which impact so many parts of our society, are complex and require significant alignment across stakeholders before they can be designed and built. Every project not only needs to factor in differing

incentives but also optimize for both the short and long-term. If we want to build truly transformational infrastructure for the future, we will need all stakeholders together at the table.

About this report

Effective infrastructure investment will be at the heart of Canadian prosperity over the next century (and beyond). This is why BCG's Centre for Canada's Future decided to work with the Globe and Mail and other private sector partners to launch the CanInfra Challenge and drive a national dialogue around the topic of infrastructure in Canada.

This thought piece is meant to help start this dialogue. We hope it can be a useful tool for contestants in the CanInfra Challenge as well as other Canadians looking to understand more about the infrastructure space.

Over the course of the next 6-12 months we will be working with the Globe and Mail to publish more thought pieces and curate perspectives from other leading thinkers in the space. We hope you will follow along at www.caninfra.ca



Kilian Berz

Senior Partner & Managing Director, BCG, and Chair, BCG Centre for Canada's Future, Toronto



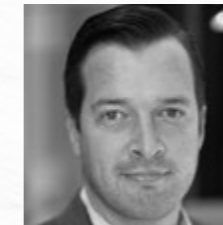
Ishang Jawa

Project Leader
BCG, Toronto



Darwin Smith

Partner & Managing Director
BCG, Calgary



Ian Taylor

Consultant
BCG, Toronto



Vinay Shandal

Partner & Managing Director
BCG, Toronto



Helen He

Consultant
BCG, Toronto



Warrick Lanagan

Partner & Managing Director
BCG, Calgary



Anguel Dimov

Consultant
BCG, Toronto



Keith Halliday

Director, BCG Centre
for Canada's Future



Kate Jamieson

Marketing and Social Impact Manager
BCG, Toronto



Nina Abdelmessih

COO of BCG Canada



CanInfra Challenge

BCG

THE BOSTON CONSULTING GROUP