Sustainability Challenges of Implementing High Speed Rail in Canada

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Introduction

Ever since the introduction of the Japanese Bullet Train in 1964 [1], high-speed rail ("**HSR**") has been developed in many other major countries around the world. Canada, however, is an exception, as it is the only G7 nation to not have an HSR system. Although steps have been taken to implement HSR routes in some proposed corridors, construction has not started yet.

History of High-Speed Rail in Canada

The discussion of implementing HSR in Canada dates back to the 1970s. Railway companies in North America were finding ways to renew interest in passenger rail transportation after the industry saw declining sales in the decade prior. This was due to the rise of the automobile and construction of numerous new highways. Once such effort was the introduction of the UAC TurboTrain, which was operated by CN Rail (and later VIA Rail) along the Toronto-Montreal corridor from 1968 to 1982. It was one of the first gas turbine-powered trains and one of the first tilting trains in service [2]. Despite moving at speeds over 200 km/h the train came with some major downsides. These include problems with its tilting mechanism, lengthy interruptions, and poor track quality. These problems, along with the rise in oil prices in the 1970s, led to the withdrawal of the TurboTrain in Canada in 1982 [3]. The trainsets, however, were replaced by Bombardier's LRC locomotives [4]. The LRC have a more conventional train design, with separate, diesel-electric locomotives.

Many modern HSR routes have been proposed in Canada over the past few decades. One such proposal is along the Quebec City-Windsor Corridor. This has been the most favourable and studied option for an HSR route in Canada since it encompasses about half of Canada's population, including three of the five largest metropolitan areas in Canada [5], and the nation's capital. The first major development came in 1998 when the LYNX private consortium led by Bombardier, SNC-Lavalin and Alstom, proposed to the federal, Ontario and Quebec governments a 320 km/h high-speed train route from Toronto to Quebec City that will also reach Kingston, Ottawa and Montreal [6]. Alstom and Bombardier were to manufacture the TGV-type trains, SNC-Lavalin was to be involved in the construction of the rail infrastructure, and EllisDon was to be involved in the construction of the bridges, buildings and structures need for the rail. The consortium forecasted that the project was to be completed by 2008, boost Canada's GDP by over $9 billion, and create over 175,000 jobs [6]. However, the government was likely to have to pay about $7.5 billion investment [6]. The House of Commons Standing Committee on Transport ("**SCOT**") – now called the Standing Committee on Transport, Infrastructure and Communities ("**TRAN**") – also saw large risks involved for the government in this project. Unfortunately, the proposal brought a level risk for the government that was beyond its tolerance at the time and the project was scrapped. The next advancement came in the early 2000s when Via Rail put forth a proposal called ViaFast that proposed the use of Bombardier's experimental high-speed train, JetTrain, along the corridor [7]. The JetTrain was able to move at speeds up to 240 km/h [7] and would significantly help alleviate traffic on Highway 401 and reduce fuel consumption. However, political concerns with the cost of the project ultimately led to its cancellation [8]. In 2008, however, then-Ontario premier Dalton McGuinty and then-Quebec premier Jean Charest announced the launch of a study into the development of high-speed rail along the corridor. After delays, the study was released and said that it could generate a positive net economic benefit, however fiscal circumstances at the time led to no developments [9]. A study in 2014 by an English consultancy proposed that a separate line for HSR to be constructed to share the existing corridor from Toronto to Georgetown. High Speed Rail Canada is an advocacy group that has released a lot of studies and other information related to high speed rail along this corridor [10]. In May 2017, it was announced that the province will be moving ahead with "preliminary design work and investing $15 million in a comprehensive environmental assessment" for an HSR along the Toronto-Windsor corridor [11]. The section of the HSR from Toronto to London is expected to be completed by 2025 and the extension to Windsor is expected to be completed in 2031. Seven station stops have been proposed for the project: Toronto-Union, Pearson/Malton, Guelph, Kitchener, Chatham, and Windsor [11].

Figure 1 - Proposed station stops along the HSR system in Ontario [11]

Another proposed route for HSR development in Canada is the Calgary-Edmonton Corridor. Currently serviced by the Queen Elizabeth II Highway ("**QEII**"), the area is home to over two million people and is the most urbanized area in Alberta [12]. The Van Horne Institute produced a 2011 study regarding the cost of implementing HSR in the Calgary-Edmonton Corridor [13]. The study considered three HSR options. One option was to introduce the JetTrain to the existing CP freight route, resulting in upgrades of approximately $1.8 billion. The second option was the construction of a new passenger route, also known as the "Green Field" route, which would use the JetTrain and cost approximately $2.2 billion. The third option is the construction of the Green Field route, but using TGV-type trains instead, which can reach speeds of 300 km/h. This third option would cost $3.7 billion. The report concluded that the added benefit of constructing the

"Green Field" route was not worth it, and therefore recommended the first option [13]. Promise for an HSR was high when then-Alberta premier Alison Redford said in 2011 that HSR was a priority, however the issue never surfaced in the proceeding campaign [14]. In 2015, however, a request for proposal was issued for planning and implementation of a study "to determine the future needs for the QE II Highway" due to high traffic volumes [15].

Environmental Concerns

The environmental advantages of implementing high-speed rail in Canada are obvious. HSR is considered cleaner than traditional commuter trains because it doesn't use diesel. Also, less people will be taking automobiles along highways on the corridor- including the QEII in the Calgary-Edmonton Corridor. However, there are still some environmental concerns that come with implementing HSR.

According to Per Kågeson, a Swedish environmental protection consultant:

> There is no cause to prohibit investment in high speed rail on environmental grounds so long as the carbon gains made in traffic balances the emissions caused during construction. However, marketing high speed rail as a part of the solution to climate change is clearly wrong. ... The principal benefits of high speed rail are time savings, additional capacity and generated traffic, not a reduction of greenhouse gases. [16]

Another important factor to take into consideration when analyzing the environmental impact of an electric HSR is the carbon intensity of electricity. Figure 2 displays the carbon intensity of electricity for different countries. A country with a lower carbon intensity means that it likely uses more renewable energy to power its electricity. It is considered that electricity generation for countries that are below the 600-ton threshold are "carbon competitive" [17]. The gray shaded area indicates the transition zone. Therefore, when electrical transportation is implemented in countries closer to the bottom end of the figure, such as Brazil, there is less of an environmental impact (carbon-wise) than when electrical transportation is implemented in countries closer to the top, such as India. It should be noted that Canada is very close to the bottom of this figure.

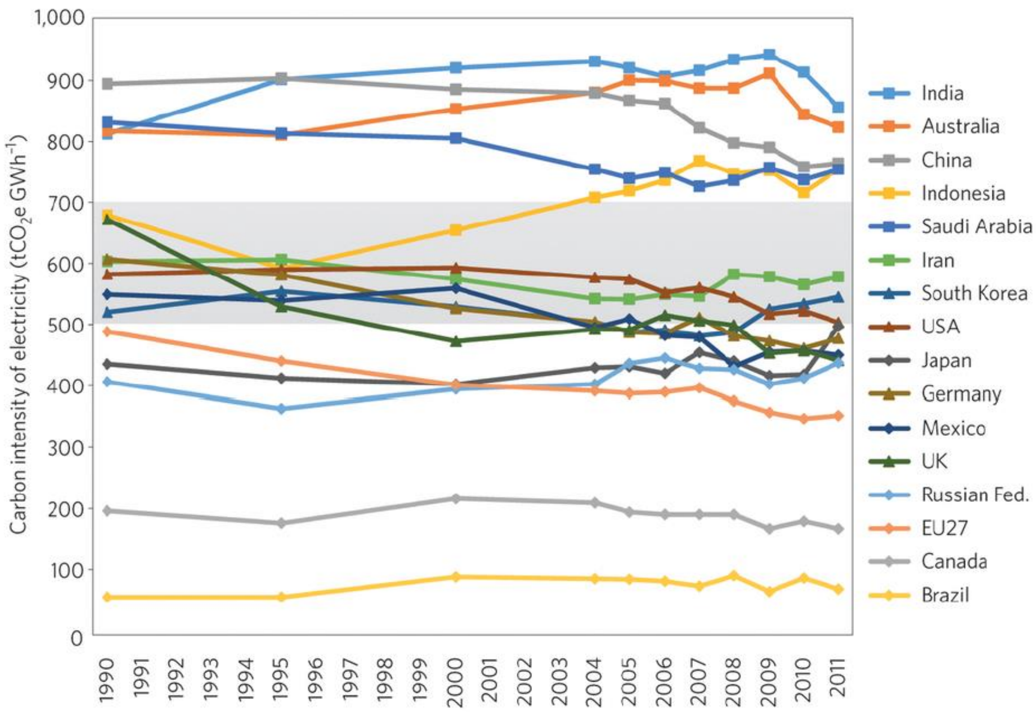

Figure 2 - Carbon Intensity of Electricity by Country [17]

Sustainability Lessons Learned

It is important to take away the sustainability lessons learned from HSR implementation in other countries from around the world in order to avoid HSR problems in Canada. Countless studies have been done on HSR networks around the world and this section will highlight some of the important key lessons and policy recommendations that have come out of this finding.

One important lesson is the fact that there are trade-offs between the speed and connectivity of an HSR network. It is impossible to maximize both HSR travel speeds and the number of origins and destinations. This can be seen when contrasting the HSR systems in France and Germany. In France, the system overall offers reduced travel times, while sacrificing the number of origins and destinations [18]. This means that passengers are often not brought to their exact destination and have to take another subsequent travel mode to get there. What further makes this scenario worse is the fact that the HSR stations in France do not have as good of a connection to other transit modes [18]. This makes this inter-transit travel difficult for passengers. Meanwhile in Germany, although the HSR system has slower average speeds, it has frequent stops that are well connected to other urban transit modes [18]. This philosophy has led to overall shorter door-to-door travel times in Germany than in France.

This German philosophy should be considered in Canada. Although the station stops along the proposed Southern Ontario HSR line are fairly frequent when compared to existing HSR systems (approximately 50 km between stops), proper connections must be made between these stations and the existing local public transit must be made in order to avoid the shortfalls that were evident in France. Although the proposed Union and Pearson/Malton stops would automatically have significant connections due to the fact that they would be located next to some of the busiest transportation hubs in Canada, the other stations must have proper connections to local transit, such as buses.

The HSR station design and the surrounding land use is an important consideration to recognize in the HSR station design and planning process. When a new transportation facility is being constructed, the land within and surrounding the station will become more valuable. Significant development and traffic may take place around the station and the area could become exponentially busier. A downside to this is that pedestrian routes and connections may get compromised over time. Therefore, it is in the designers' best interests to have prioritized pedestrian routes and connections to and from the station.

An unfortunate example of this is the Lyon Part-Dieu station in Lyon, France. The station was "designed in [an auto-centric] era that extended into the early 1980s, the site is sliced up by depressed roadways, parking garages, and the boxy and opaque Part-Dieu shopping center" [18]. Therefore, automobile connections were considered significantly more essential than pedestrian connections during the design. This has led to many pedestrian unfriendly conditions, such as the situation in Figure 3 [18].

Figure 3 - Lyon Part-Dieu Station

Conclusion

There are many factors to consider when implementing HSR in Canada. Economic, environmental, geotechnical, and political challenges must be overcome before making a decision as to whether an HSR network should be constructed. However, with proper research into lessons learned from the problems and solutions other countries have encountered when implementing HSR, overcoming these obstacles can be easier.

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