ABSTRACT

In a more connected world than ever, transportation between hub cities is vital in ensuring the smooth operation of various economic sectors. Traditional methods have developed over the past several decades, but each exists with its own drawbacks. The proposal of a new transportation technology, known as the hyperloop, aims to combine the benefits of the various methods into one fast and energy efficient system. The implementation of such a design would reap benefits on a plethora of stakeholders in Canada. The hyperloop is presented as a solution to finding a sustainable transportation system that can advance us to an energy efficient and economical future. The effectiveness of this solution is evaluated in the following paper with counter arguments addressed. The conclusive point argues that investing and developing such a transportation system is a benefit to the future of sustainability with a positive net result.

A Move to Better Transportation

1 Overview

Efficient transportation methods are an integral part of our connected world. Since the inaugural announcement of a hyperloop transportation system by Elon Musk in 2012, several companies have been developing technologies to turn the idea into reality. A hyperloop transportation system is comprised of a vacuum tube that spans between two major cities and train like pod for passengers that travels through the tube at airplane speeds. Since 2012, there have been various design changes, with the most recent being a vacuum tube and a magnetic levitation and propulsion system (maglev), limiting drag and frictional forces to allow for efficient high speeds. Traditional high-speed travel methods like airplanes use colossal amounts of energy, making up more than three percent of Canada's total emissions [1]. According to the International Civil Aviation Organization, 160 megatons of fuel were used globally for international aviation purposes in 2015 alone [2]. A paper by The International Council on Clean Transportation found that commercial aviation resulted in 918 million metric tons of carbon dioxide in 2018 [3]. While commercial aviation is effective in transporting large amounts of people over great distances, it sums to a high energy cost. The hyperloop is meant to be a culmination of the positive aspects of the various traditional methods, the relative convenience and inexpensiveness of a car, the speed of an airplane, and the environmental friendliness of an electric railway.

This report is addressed to the government of Canada because of its influential policies and impact on Canadian citizens and relevant corporations. These three primary stakeholder groups account for the transportation industry in Canada. The Canadian government and corporations are responsible for the implementation of a hyperloop transportation system with major city residing Canadians being the predominant consumer. The impact of a hyperloop system far outreaches the three main stakeholders; the local natural environment and the energy production sector are punctualized stakeholders also impacted by the addition of such a transportation system. With this established, the following claim is presented:

The implementation of a hyperloop transportation system between at least two major Canadian cities would advance us to a more energy sustainable future.

2 JUSTIFICATION

With its own new infrastructure, a hyperloop system will have no direct operational emissions. This is the result of highly efficient electric motors and 'low-drag environments' that result in a transportation system up to ten times more energy efficient than an airplane while faster than traditional railways [5]. In addition, the electricity used in the system can be entirely renewable and thus, even indirect emissions are eliminated. The sustainable energy sources can vary, with one viable option having solar panels along the roof of the tube, converting solar energy into electricity, on site [6]. According to early estimates, solar cells running the entirety of the tube could produce fifty-seven megawatts of power per year, much more than the twenty-one megawatts required to operate [4]. The low friction design results in minimal force required for the majority of the journey; most power is required during the acceleration and deceleration stages of the trip. Therefore, plenty of energy is stored in batteries along the tube and grid power is used only when solar power becomes unavailable [4]. A proposition of a system that involves producing, consuming, regenerating, and storing has also been proposed that would ensure maximum use of generated power [7]. With the development of such a transportation system, emissions are expected to drastically decrease as consumers switch from airlines to hyperloop for travel between major cities on the same landform.

With emphasis on the government of Canada, it is up to them to make the decision to go through with a development plan. Allocating capital and resources to conducting research and implementing necessary infrastructure would greatly benefit various stakeholders. A commitment by the government, and corporations, to construct the system would reap the benefits of a sustainable transportation system. Their investment would encourage consumers to shift to the more energy efficient method of transportation and would result in a snowball effect of positive results. From a social perspective, people would ideally see the benefits of this alternative as opposed to traditional long drives or expensive flights. As more consumers switch, a crowd mentality might kick in, albeit a positive one, where users share positive experiences. This shift in the transportation sector could largely benefit the government. With initial estimates that a pod leaves a station every two minutes and as often as every thirty seconds, the hyperloop system is not only efficient, it is also economical [4].

With regards to the surrounding natural environment, the infrastructure is the main concern. Fortunately, it can be made very unintrusive. The vacuum tube along with electric power and magnetic levitation all combine for a silent ride, much like an electric car. This results in no noise pollution to the surrounding ecosystems and urban areas the tube passes through. The construction of support pillars to hold the tube above ground (in a similar fashion to a bridge) prevent as much land remodelling as possible, significantly decreasing costs of construction. This preservation of the natural landscape benefits all stakeholders and can be a selling point for consumers, their decision to travel by hyperloop instead of aircraft has helped the local ecosystems without contributing to the colossal amounts of carbon emissions. Except for the construction phase, animal habitats remain largely unbothered by the operation of a hyperloop transportation system.

From the perspective of the energy production sector, an efficient system is the right first step in developing renewable energy sources. With such a sustainable form of transportation, energy production is encouraged to adopt a similar approach. As a result, the hyperloop reduces emissions indirectly as well. The grid power supplied to the transit system could be exclusively drawn from

renewable sources; this could be mandated by certain policies. The development of the hyperloop could therefore be the catalyst that shifts energy production to renewable methods.

These are all major benefits of the hyperloop system and how various stakeholders are positively impacted. The design of the system allows for an extremely energy efficient mode of transportation, capable of reaching very high speeds with minimal power due to the frictionless movement of the pod. The system is also greatly affected my government and corporate decisions. They can help turn the tide towards a more sustainable future by encouraging the development of the hyperloop. From an operational standpoint, it is an economical method of transportation between major cities that can improve the job sector and attract tourists. Encouraging the implementation of the hyperloop would increase the consumers' willingness to partake in advancing to a more sustainable future. With proper application of the system, the negative effects on the environment can be mitigated or even diminished. Similarly, the desire for sustainable energy would encourage the energy production sector to shift towards renewable sources, proving that a hyperloop transportation system has huge influence on various stakeholders and can point us in the right direction of a sustainable future.

3 LIMITATIONS

They hyperloop transportation system does not come without limitations, however. The most notable being the cost of implementation. It is expected to be on the order of several billion USD for the construction of the necessary infrastructure (tube, stations, etc.) and over fifty million USD for all the necessary pods [4]. Despite this, the hyperloop is an investment that is expected to have greater returns in the future. Being both an economical and highly sustainable form of transportation, the hyperloop system can attract investors because of the benefits shared by so many stakeholders. The cost of sustainability is money, but the cost can decrease with proper protocols and commitments from the various stakeholders.

In addition, the manufacturing of such infrastructure is a difficult task. Constructing a vacuum tube supported by concrete pillars over several hundred kilometers poses a mountain of an engineering task where a lot can go wrong. However, with careful planning of the route and selecting the optimum cities to connect, the construction would be well worth it. The construction process can also pose a threat to natural habitats and interfere with ecosystems. Therefore, efficient construction methods are required, such as building the tube in manufacturing facilities and limiting on site work to welding the various components only. This would speed up construction and allow for as little invasion into the environment.

A final potential drawback of the hyperloop system is the unproven technology. Much is still unknown and remains conceptual. Various companies around the world have been investing in developing the necessary technologies; improving the levitation system to minimize power input while maximizing power output while allowing for a comfortable ride. The hyperloop concept is open source with various countries and student teams applying their expertise to its development. I am proud to say I am on the University of Toronto Hyperloop Team where we continuously try and improve the sustainable transportation of the future.

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