METROLINX

Hydrail for GO Transit

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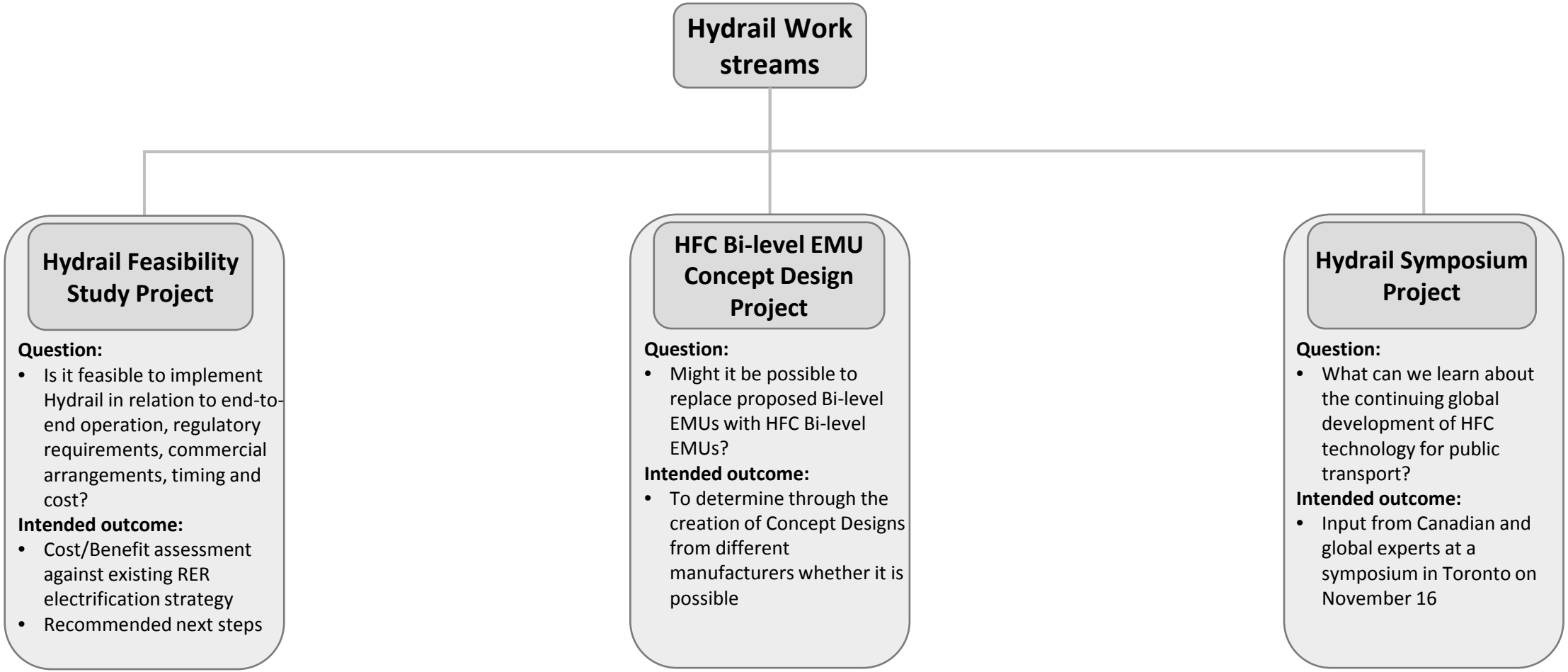
EXECUTIVE SUMMARY

- Metrolinx is studying the technical and economic feasibility of implementing a Hydrail System;
- The study has created an overall system design that includes hydrogen fuel cell powered trains, refuelling facilities, storage facilities and hydrogen production;
- The electricity required for hydrogen production would be drawn from the grid at night-time when there is a surplus of power available in Ontario;
- Metrolinx is also engaging rail vehicle manufacturers to study how a fuel cell system could be integrated into an Electric Multiple Unit type of train. This will help inform the feasibility assessment;
- A one day Hydrail Symposium was held on November 16 which explored topics including:
  - Government leadership and policy for developing hydrogen programs
  - Economic development and energy market considerations
  - Case studies of projects using hydrogen fuel cell powered rail vehicles
  - The importance of communication to the public, particularly in relation to safety and the environment.

AGENDA

- Scope of Hydrail
- Feasibility Study
- Vehicle Concept Design
- Symposium results

SCOPE OF HYDRAIL REVIEW



HYDRAIL FEASIBILITY STUDY

The feasibility study aims to determine whether it is technologically feasible and economically beneficial to use hydrogen fuel cell powered trains on the GO Transit Rail network, as an alternative approach for electric propulsion.

There are four topics that the feasibility study is investigating:

1. the configuration of a Hydrail System
2. the scale of a Hydrail System
3. how a Hydrail System could be implemented and operated, and
4. the Business Case for a Hydrail System

THE HYDRAIL SYSTEM

EARLY FINDINGS

To operate Hydrail as a direct alternative to current plans for traditional electrification, it is estimated to require 40 tonnes of hydrogen to be produced every day, on average;

- This would require 2.2 GWh per day of electricity, on average;
- This is equivalent to about 1% of the power that is produced in Ontario every day, on average, or
- About 15% of Ontario's average surplus daily energy and would make it the second largest consumer of energy in Ontario.

- If Hydrail is adopted to operate over the whole network, and replace all diesel trains, these numbers will be higher;

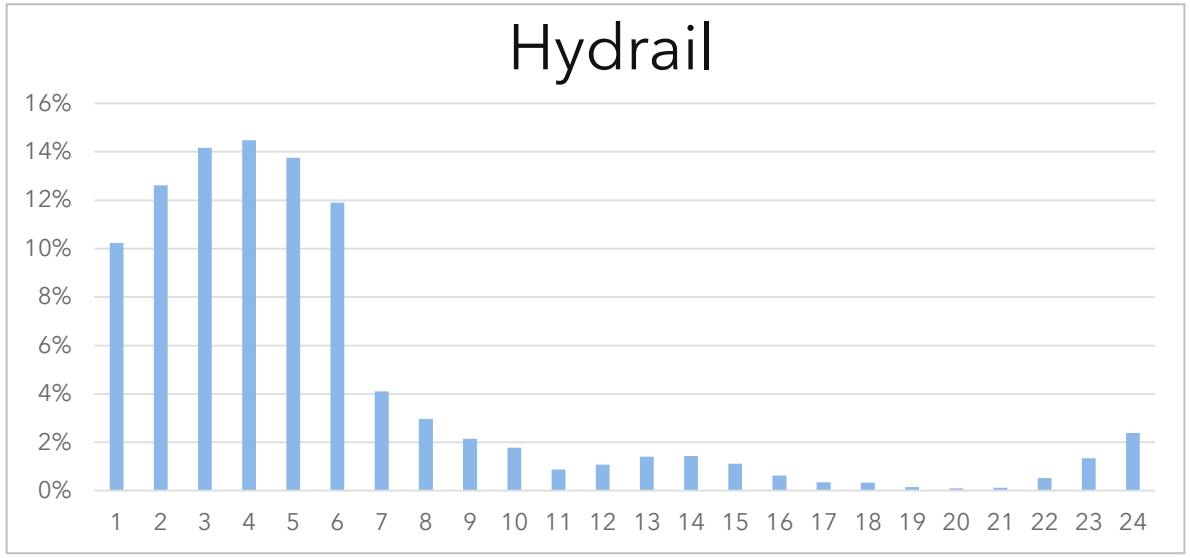
- The feasibility study analysis shows the key factors that would drive the system's application to the GO Rail work;

- Metrolinx is on track to complete the feasibility study report by the end of the year.

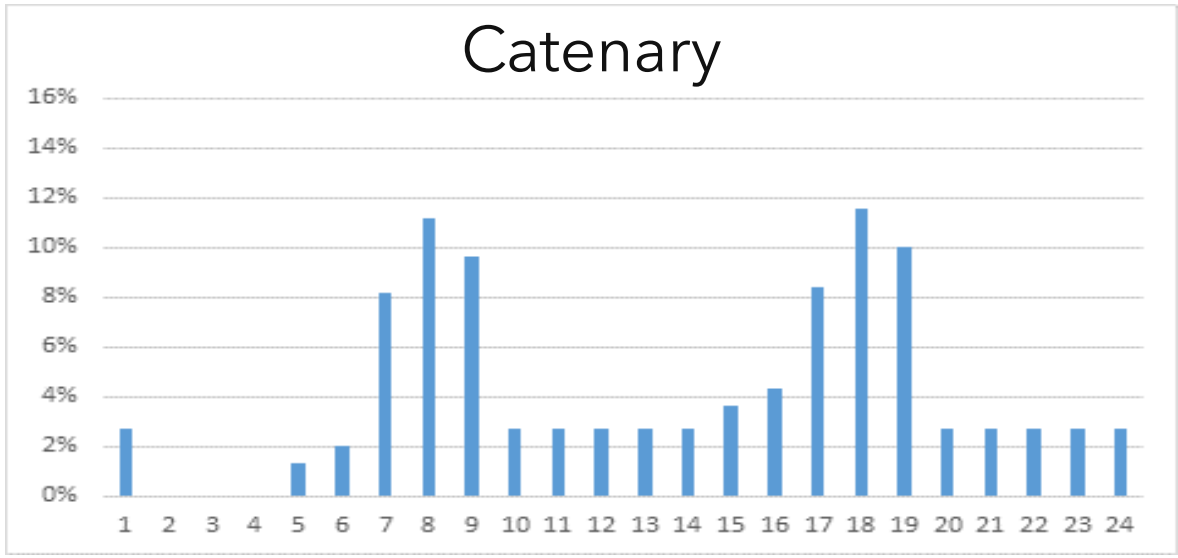
GRID DEMAND PATTERNS

The Hydrail system allows optimization of the timing of supply of electricity to produce hydrogen in relation to the forecasted hourly pattern of electricity prices.

To minimise cost, Hydrail's consumption of electricity would be predominantly overnight when Ontario produces surplus power



Electricity consumption for the overhead catenary system is concentrated during peak service hours



THE HFC EMU CONCEPT DESIGN

Undertaking the HFC EMU* Concept Design project reduces the uncertainty inherent in the assumptions that have been made in the Feasibility Study modelling by providing more details on HFC EMU vehicles.

The outputs of the EMU Concept Design will enable Metrolinx to:

- validate the assumptions in the Feasibility Study Report relating to performance, costs and delivery timescales of HFC EMU rail vehicles improving the accuracy of the comparative economic assessment between Hydrail and electrification;
- develop an RER RFP specification that could allow for alternative propulsion technologies;
- understand to a higher level of specificity the 'energy matters' schedule of the RFP, which will require the bidders to incorporate energy innovation and savings into the contract;
- act as an informed owner and thereby allow it to structure the procurement in a manner that allows for and drives innovation.

The RFP closed on November 10, 2017, and evaluations are complete and two (2) manufacturers will be working through the concept design process. The completion of the concept designs is targeted for Spring 2018.

**A Hydrogen Fuel Cell Electric Multiple Unit is a train powered by electricity from hydrogen on self-propelled carriages*

HYDRAIL SYMPOSIUM

The objective of the Symposium was to learn from global and Canadian businesses, government agencies, universities and individuals who have an interest in developing and implementing Hydrail in Ontario.

The Symposium took place on November 16 at the Design Exchange in Toronto;

- There were over 250 attendees;
- Phil Verster gave the welcoming remarks;
- Minister Del Duca was the keynote speaker during lunch hour;
- Other representatives from the Ontario government and the Federal government attended;
- High profile speakers from Canada, the US, China and Europe;
- Symposium was attended by the media and broadcast as a live Webcast; and,
- 20 members of the public attended.

Feedback from the attendees was very positive in terms of the quality of the event. A summary of the symposium presentations and dialogue is being drafted and will help to inform future uses of Hydrail technology along with the Feasibility Study Report.

HYDRAIL SYMPOSIUM – EMERGING THEMES

Themes of relevance to Hydrail in Ontario included:

- Jurisdictions with advanced hydrogen programs have been led by sustained government funding guided by enabling policy frameworks;
- Globally, a growing number of governments are actively developing and implementing policy frameworks to develop and encourage adoption of hydrogen applications;
- Guiding frameworks focus on economic development and energy market considerations;
- A similar process is underway in Canada at the federal level;
- The importance of ongoing communication to the public about the use of hydrogen, specifically safety and environmental benefits;
- Recent major hydrogen fuel cell implementations have been in areas where alternative battery based zero emission technologies were not viable due to long recharging times which limit asset utilization, e.g., forklifts;
- Transit implementations have primarily been in the bus sector, although Alstom's commuter train in Germany has advanced to the point of taking orders and CRRC is testing hydrogen LRT implementations.
- To date, no jurisdiction has implemented hydrail on a locomotive or bi-level carriage that would be compatible with RER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