Canadian Urban Transit Research & Innovation Consortium (CUTRIC)

Consortium de recherche et d'innovation en transport urbain au Canada (CRITUC)

www.cutric-crituc.org

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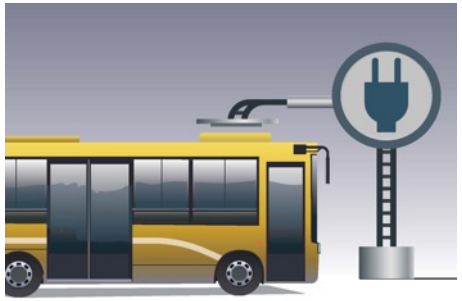
CUTRIC Vision & Pillars of Innovation

April 5, 2019

To make Canada a **global leader** in **low-carbon smart mobility technology innovation** across light-duty and heavy-duty platforms, including advanced transit, transportation, and integrated mobility applications.

Pillar #1



Zero-emissions & low-carbon propulsion systems with fueling & charging system integration

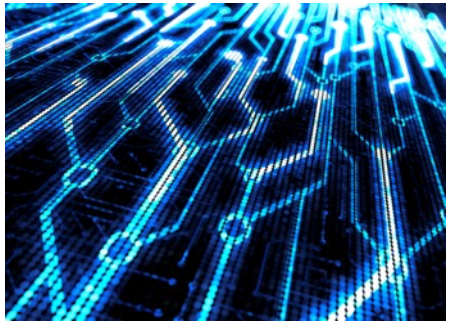
Pillar #2

"Smart" vehicles and "smart" infrastructure

Pillar #3

Big data advanced mobility

Pillar #4



Cybersecurity in mobility

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Areas of Activity

Project Management

Commercialize Projects with
Technology Readiness Level (TRL) from 7 to 9

Funding

Co-funding for R&D projects in Ontario -
TRL 2-6

Applied Industrial Research

Develop transit related Energy, Emission, and Economic models;
National and Global Industry Reviews;
EV infrastructure siting analysis

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Marquee Projects

Pan-Canadian Electric Bus Demonstration and Integration Trial: Phase I & II

Pan-Canadian Hydrogen Fuel Cell Demonstration & Integration Trial: Phase I

National Smart Vehicle Demonstration & Integration Trial: Phase I

Rail Innovation Focus Group

Natural Gas Mobility Innovation

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Pan-Canadian Electric Bus Demonstration & Integration Trial

Phase 1 ($45M)

2017-2020

Standardization & Interoperability for overhead charger

3 Transit: TransLink, Brampton, YRT

18 electric buses

7 overhead 450kW chargers

Phase 2 ($110M)

2018-2021

Finalize Standardization
SAE J3105 , J3068, J1772

Integrate Battery Storage

8-10 Transit
60 electric buses (40 ft and 60 ft)
12 overhead 450-600kW chargers

P3 options for financing

Phase 3

Full automation of charging system

Grid and charger cybersecurity

More transit agencies

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Technologies in E-Bus Phase II

Buses: 40 feet & 60 ft

Chargers: Overhead 450 kW+
SAE J3105

Depot :
SAE J1772/
J3068

Energy storage media:
Flywheel, Battery

Standardization of overhead e-chargers through SAE J3105 and depot chargers through SAE J3068 or SAE J1772

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Project Partners: Phase I

Transit Systems:

Brampton Transit

York Region Transit | VIVA

TRANSLINK

OEMs:

NOVA BUS
Driven by your city

NEW FLYER

ABB

SIEMENS

Utilities and other:

NEWMARKET Hydro

BC Hydro

VIRICITI

Canada
NRC·CNRC

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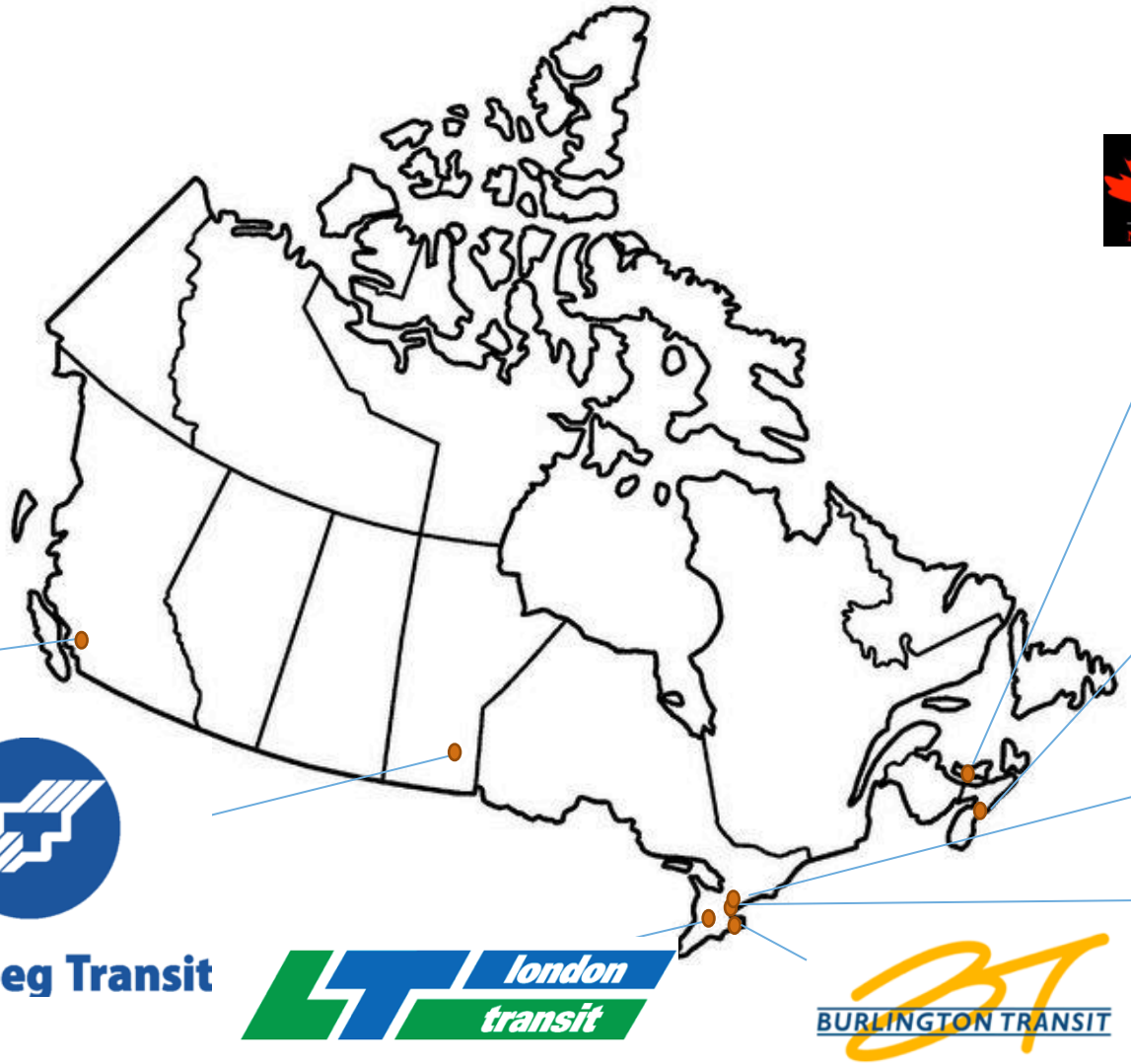
Transit Partners Interested in E-Bus Phase II



COACH ATLANTIC GROUP
NEW BRUNSWICK | NOVA SCOTIA | PRINCE EDWARD ISLAND | NEWFOUNDLAND

HALIFAX TRANSIT

YORK REGION TRANSIT

Brampton Transit

TRANSLINK

Winnipeg Transit

London transit

BURLINGTON TRANSIT

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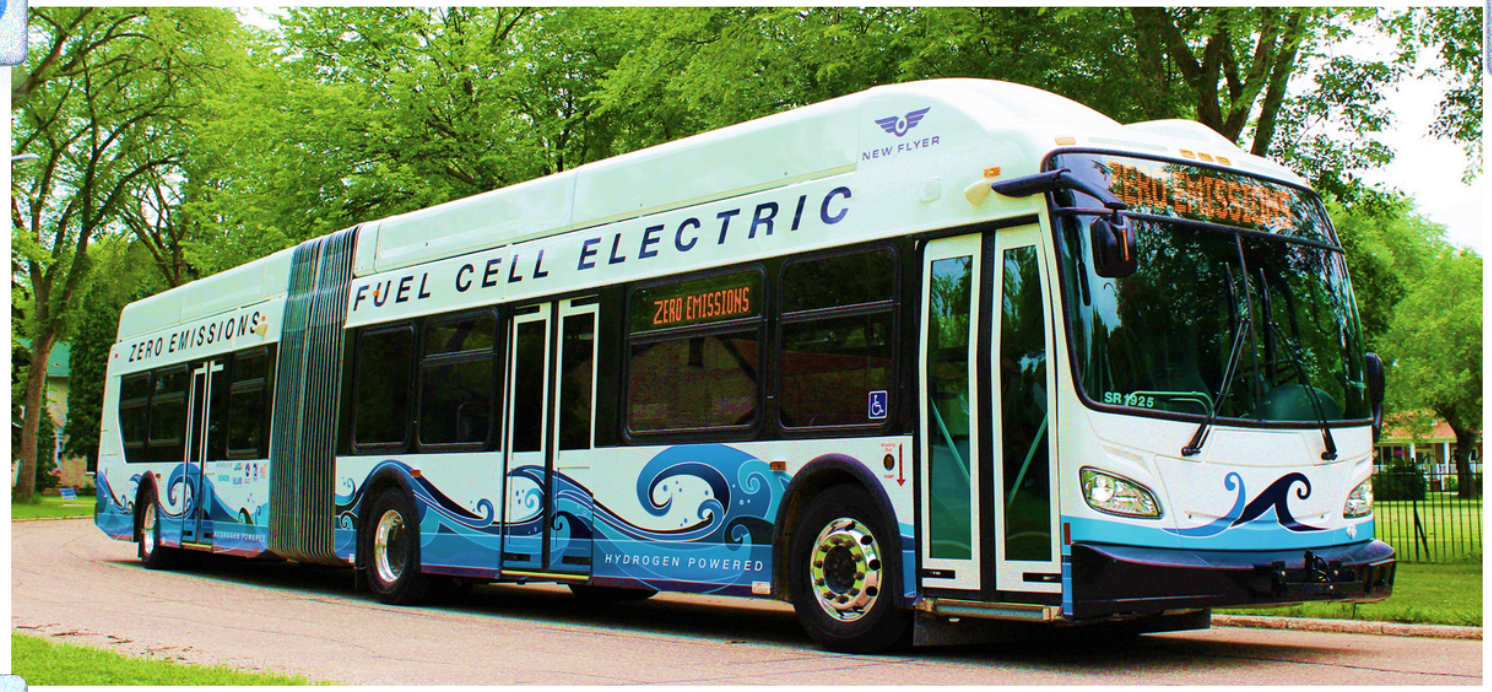
Pan-Canadian Hydrogen Fuel Cell Electric Vehicle Demonstration & Integration Trial: Phase I (FCEV Trial)



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FCEV Trial Opportunities – Current & Future

Environmental Opportunities

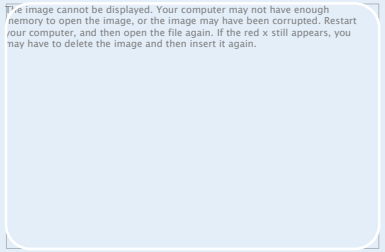
Sustainability mandates

E.g. YRT's *Vision 2051* sustainability mandate; City of Mississauga's *Climate Change Action Plan*

Economic Opportunities

Direct (selling electrons, resource optimization, developing IP)

Indirect benefits (job creation, growth & retention)



Global Relevance

Advancing technology readiness of FCEBs

Sister deployments

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FCEV Trial Phase I Objectives

- Develop hydrogen fuel cells technologies for fuel cell electric buses and trucks

- Support fuel cell technology integration among Canadian transit

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FCEV Integration Challenges

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Political Challenges

- Lack of a coordinated effort & consistent funding model
- Lacklustre policy leadership

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Economic Challenges

- High upfront costs
- Lack of comparative economic assessments

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Technological Challenges

- Lack of operating experience
- Extreme climatic conditions in Canada

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FCEV Trial Participants

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Advisors/ Observers

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YORK REGION TRANSIT \ VIVA

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National Smart Vehicle Demonstration & Integration Project: Phase I

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Smart Vehicle Project Overview

This project will integrate fully autonomous, connected, low-speed, electrified shuttles (e-LSA) in up to 12 Canadian municipal jurisdictions as first-mile/last-mile applications.

- Standardized V2V and V2I communication protocols
- Standardized cybersecurity protocol
- Interoperability of e-LSA charging equipment
- Central operating system across manufacturers

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Project Scope & Vision

Interested Cities:

- Vancouver, Surrey, Cochrane, Winnipeg, York Region, Windsor, Brampton, Toronto, Ottawa, Montréal, Québec City

Cost per city: $2 million - $4 million
Number of vehicles per route: 2-3 e-LSAs
Number of OEMs: Minimum 2 OEM products per route
Route length: ~1 km
Transit service option: No current bus services

Total project cost is estimated at **$30-40 Million (2019-2021)**

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Project Timeline

2017-2018: Five Technical Planning Sessions Completed

2019: Full project funding confirmed

2018 - 2019: Nine OEM Working Group & NAAC Sessions

2020-2023: On-road launch in up to 12 cities across Canada

e-LSA Manufacturers

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Navya

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2getthere

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EasyMile

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FPInnovations

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Current Industry Stakeholders

e-LSA OEMs:

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Charging System OEMs:

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Operators:

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Other:

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Renewable Natural Gas Mobility Innovation Project

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Introduction

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Renewable Natural Gas is refined Biogas
(Biogas = ~60% methane + ~40% carbon dioxide)

Benefits of Renewable Natural Gas (RNG)

- Cleaner than other fuels, like diesel
- Significant GHG emission reduction
- RNG generation enables effective waste management of commercial and residential organic waste, farm waste and landfill waste

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Project Overview: Environmental & Economic Modeling + Policy Development

Complete predictive life-cycle analysis of RNG transit buses in terms of emission & economic cost

Establish the break-even points for RNG integration in local jurisdictions

Create ongoing rebate program within provincial governments to bridge the price gap between CNG and RNG

Develop policy to advocate for **"RNG As a Transit Fuel"**

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Participants

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CUTRIC Rail Innovation Consultation & National Strategic Planning Initiative (2018-2020)

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Rail Innovation Consultation & National Strategic Planning Initiative

In partnership with Transport Canada, CUTRIC has proposed to:

1. Complete consultation sessions with rail industry stakeholders, academics, transit agencies, and rail operators across Canada, 2018-2020
2. Identify short-term and long-term rail innovation areas that would put Canada in a leading rail innovation position
3. Reduce GHG emissions from both passenger and freight rail

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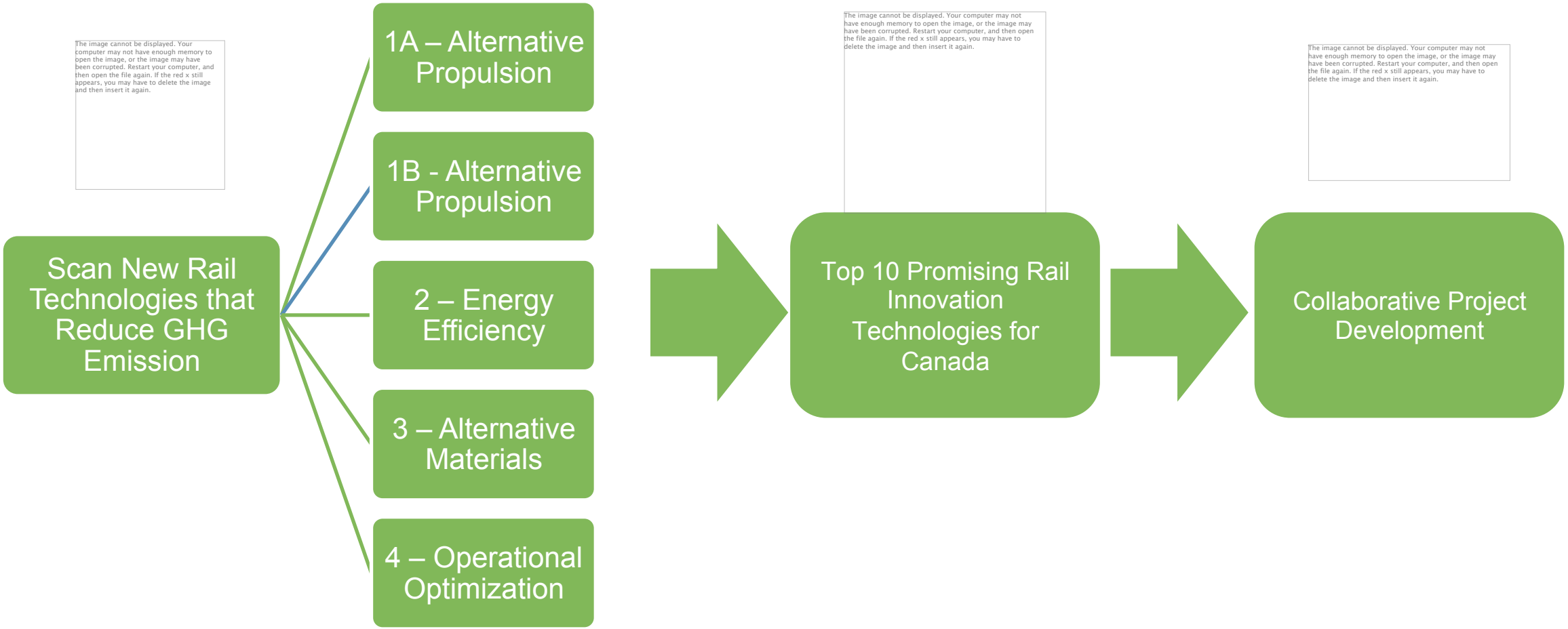
Rail Innovation Focus Group



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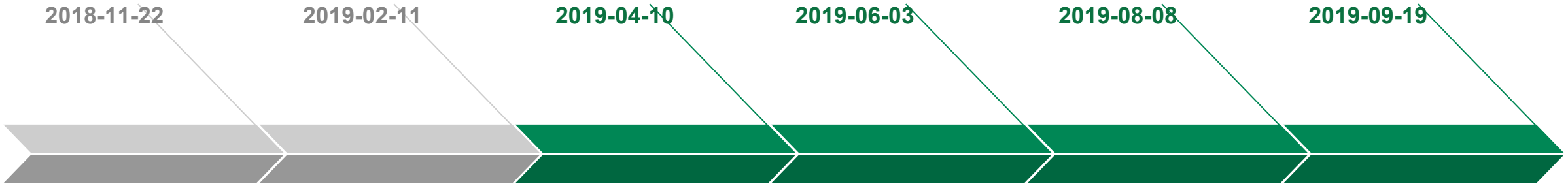
Rail Innovation Focus Group - Update



Session 1A

Alternative Propulsion

@Queen's University, ON

Session 1B

Alternative Propulsion

@Metrolinx, ON

Session 2

Energy Efficiency

@Ballard, BC

Session 3

Operation Optimization

@TBD, ON

Session 4

Alternative materials

@Bombardier, St Bruno, QC

Final Session

Present outcomes from all sessions

@Transport Canada, Ottawa, ON

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Rail Innovation Focus Group - Session 1 Outcomes

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1. A world-class **Rail Innovation Incubator Hub** could be setup in Canada to finance, test, develop and commercialize rail intellectual properties valuable to global market
2. Canadian Rail Industries have a strong desire to support domestic rail technologies integration
3. Canada could leapfrog the catenary electrification system into advanced non-catenary system
4. VIA Rail, GO Train and UP Express could integrate advanced alternative propulsion systems in near future procurement
5. The participants unanimously articulate the need of developing and demonstrating **H2 Fuel-Cell Electric Rail ("Hydrail")** technologies within Canada as one of the most beneficial ways to grow Canadian economy while addressing the needs for GHG reduction

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Marquee Projects

Pan-Canadian Electric Bus Demonstration and Integration Trial: Phase I & II

Pan-Canadian Hydrogen Fuel Cell Demonstration & Integration Trial: Phase I

National Smart Vehicle Demonstration & Integration Trial: Phase I

Rail Innovation Focus Group

Natural Gas Mobility Innovation

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Other activities

- Lobby federal and provincial governments
- Apply for federal and provincial funding
- Hosting national transit innovation conference
- Collaborate with innovative organizations in Europe and US
- Develop Innovative P3 model to fund capital intensive projects
- Promote gender equality in transit systems

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Contact Information

Pan-Canadian Electric Bus Demonstration & Integration Trial

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National Smart Vehicle Demonstration & Integration Trial

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Natural Gas Mobility Innovation Project

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Rail Innovation Consultation & National Strategic Planning Initiative

Dr. Yutian Zhao
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Thank you!

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Cost Breakdown for E-Bus Phase II

Province	Agency	Number of Buses	Price per unit (76- 450 kWh)	Total Cost (Bus)	Number of chargers (450-600 kW)	Price per unit	Total cost (Opportunity chargers)
British Columbia	TransLink	8	$ 1,200,000.00	$ 9,600,000.00	0	$1,300,000	$ -
	B.C. Transit	8	$ 1,200,000.00	$ 9,600,000.00	2	$1,300,000	$ 2,600,000.00
Manitoba	Winnipeg Transit	8	$ 1,200,000.00	$ 9,600,000.00	2	$1,300,000	$ 2,600,000.00
Ontario	Brampton	8	$ 1,200,000.00	$ 9,600,000.00	0	$1,300,000	$ -
	York Region Transit	8	$ 1,200,000.00	$ 9,600,000.00	1	$1,300,000	$ 1,300,000.00
	Burlington	8	$ 1,200,000.00	$ 9,600,000.00	2	$1,300,000	$ 2,600,000.00
	TTC	8	$ 1,200,000.00	$ 9,600,000.00	2	$1,300,000	$ 2,600,000.00
	London Transit	8	$ 1,200,000.00	$ 9,600,000.00	2	$1,300,000	$ 2,600,000.00
Nova Scotia	Halifax	8	$ 1,200,000.00	$ 9,600,000.00	2	$1,300,000	$ 2,600,000.00
Prince Edward Island	Charlottetown	4	$ 1,200,000.00	$ 4,800,000.00	2	$1,300,000	$ 2,600,000.00
Total		76		**$ 91,200,000.00**	15		**$ 19,500,000.00**

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Mississauga Hydrogen Ecosystem Vision

Project Phases

Phase I

- Electrified low-speed autonomous and connected shuttles as first-mile/last-mile applications, with standardized V2V, V2I, and cybersecurity protocols

Phase II

- On-demand e-LSAs and electrified autonomous and connected heavy-duty buses

Phase III

- Connected vehicle communication systems for Bus Rapid Transit (BRT) applications

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e-LSA Manufacturer Specs

Manufacturer	Rider Capacity	Battery Capacity (kWh)	Top Speed (km/hr)	Charging
2getthere	24	36.8	60	90 kW automated opportunity charging (DC)
FPInnovations	~20-24	TBD	TBD	~150kW or higher (DC)
EasyMile	15	OEM Provided	25-30	Plug in 5.7kW (AC)
Navya	15	33	25	8hrs (induction or plug @ 3.6kW) or 4hrs (plug 7.2kW) (AC)

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