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Addendum 1: KPI Summary Report (Separate Attachment)
The Canadian Urban Transit Research & Innovation Consortium (CUTRIC) continues to lead and support key collaborative projects focused on reducing greenhouse gas emissions from multi-platform transportation fleets and services, while creating a strong, jobs-rich economy through the design, development, manufacture and integration of low-carbon smart mobility technologies across Canada.

Our organization aims to make Canada a global leader in low-carbon smart mobility technologies across heavy-duty and light-duty platforms including advanced transit, transportation, and integrated mobility applications. We strive to support the commercialization of technologies through industry-led collaborative research, development, demonstration, delivery, and integration (RDD&I) projects that bring innovative design to Canada’s low-carbon smart mobility eco-system.

This year, CUTRIC has refined its governance policy structure, developed new partnerships, expanded its strategic planning for domestic and global growth for commercialization opportunities, and developed new key projects. In doing so, the organization has grown its national footprint and membership base. Fostering strong collaborative relationships in the mobility sector is becoming more essential than ever to progress Canada as a global leader in building a 21st century low-carbon economy.

Thank you for taking the time to read this report in our effort to maintain the highest level of transparency and to inform interested parties of our operations.
Walter Kino  
Vice Chair  
(Ontario)

Sue Connor  
Chair  
(Ontario)

Peter Crockett  
Treasurer  
(Ontario)

Anna Murray  
Audit Committee Member  
(Ontario)

Bem Case  
Audit Committee Member  
(Ontario)

Christophe Guy  
Director  
(Quebec)

Emmanuelle Toussaint  
Nomination & IP Committee Member  
(Quebec)

Janice Mady  
IP Committee Member  
(Ontario)

Jennifer McNeill  
IP Committee Member  
(Manitoba)

Marc Secanell Gallart  
Nomination Committee Member  
(Alberta)

Michael Ledgett  
Honorary Legal Counsel  
(Ontario)

Sarah Buckle  
Nomination Committee Member  
(British Columbia)

Shanna Knights  
Director  
(British Columbia)

Stephanie Medeiros  
IP Committee Member  
(Québec)

Steve Kay  
Director  
(Ontario)

Tim Dickson  
IP Committee Member  
(Ontario)
ORGANIZATIONAL STRUCTURE

Josipa Petrunic  
(Director and CEO)

Dr. Anahita Jami  
(Research and National R&D Program Manager)

Anaissia Franca  
(Research Strategy Manager)

Kristina Mlakar  
(National Operations Manager & Project Lead)

Dr. Yutian Zhao  
(Researcher and National Projects Development Officer)

Parvathy Pillai  
(Hydrogen Fuel Cell Electric Vehicle Program Lead & Ontario Projects Development Officer)

Catherine Gosselin  
(Québec Technology Outreach Officer, Québec Affairs)

Dr. Abhishek Raj  
(Lead- Electric Bus Program & Research and Project Development Officer)

Garret Duffy  
(GIS Analyst Contractor)

Adriana Shu-Yin  
(Membership Success Officer and Contracts Administrator)

Lana Sanderson  
(Senior Project Coordinator)

Shervin Bakhtiar  
(GIS Analyst & Outreach Officer)

Cristina Guzman  
(Research Fellow)

Michael Keran  
(Accountant)
About CUTRIC

The Canadian Urban Transit Research and Innovation Consortium (CUTRIC) is an innovation consortium that seeks to make Canada a global leader in low-carbon smart mobility technologies focused on advanced transit, transportation, and integrated mobility applications. Comprising 120 private industrial, transit agency, academic institutional, and utility provider members, CUTRIC supports the commercialization of technologies through industry-led collaborative research, development, demonstration/delivery, and integration projects that bring innovative design to Canada’s low-carbon smart mobility ecosystem.

CUTRIC has a framework in place that will assist the Government of Ontario’s innovation efforts vis-à-vis the research, development, demonstration, and integration (RDD&I) of zero- and low-emissions transportation technologies that are digitally connected and cybersecure. This framework promotes an entrepreneurial and creative society that supports the growth of world-leading clusters through partnerships between industry and academia across the country. It also supports the growth of small- to mid-sized enterprises and aims to accelerate clean technology adoption across the nation.

CUTRIC is working to establish Canada as a world leader in zero- and low-emissions transportation technologies inclusive of heavy-duty vehicles (bus, trains, and trucks) and light-duty vehicles (automobiles), as well as integrated and shared mobility tools and applications in urban centres.
HIGHLIGHTS (Fiscal Year April 1, 2016- March 31, 2019)

Total Value of Approved CUTRIC Funded Projects (TRL 2-6) (Cash and In-Kind): $40,586,636

Total Value of CUTRIC Contribution: $7,513,862

CUTRIC Membership Growth

120 Members (as of April 2019)
VISION, MISSION & OBJECTIVES

VISION
To make Canada a global leader in zero- and low-emissions transportation technologies, including advanced bus, train, automotive and integrated mobility technologies.

MISSION
To support research, development, demonstration and integration (RDD&I) through industry-academic project-based collaborations that bring innovation, design, and manufacturing to Canada’s transportation supply chain.

OBJECTIVES
To support industry-academic collaborations in the development of next-generation technologies for Canadian transportation systems. These advancements will help drive forward innovation in transportation across Canada, leading to job growth, economic development and significant Greenhouse Gas (GHG) reductions.
FOUR PILLARS OF INNOVATION

1. Zero- And Low-Emissions Propulsion Technologies And Systems Integration

Including battery electric and hybrid electric propulsion technologies, hydrogen fuel cell electric propulsion technologies, compressed and renewable natural gas propulsion technologies (including hydrogen and natural gas fuel combinations), and dimethyl ether (DME) propulsion technologies, as well as grid-based “smart” management tools that balance electric fleet charging and/or hydrogen refuelling.

2. “Smart” Vehicles and “Smart” Infrastructure

Technologies for autonomous and connected vehicles on roads and on rail (Intelligent Transportation Systems), including sensors, signals, and control systems that enable vehicle-to-vehicle and vehicle-to-X standardized and interoperable communications.

3. Big Data For Mobility Analytics And Mobility As A Service Application

Including initiatives to optimize public and private fleets through the use of descriptive, analytic, and predictive data assessment, and the integration of artificially intelligent decision-making systems that guide fleet managers in real-time.

4. Cybersecurity in Advanced Mobility Applications

Including secure communications for autonomous and connected vehicles given the susceptibility of new vehicle systems to malicious attack.
PROJECTS

Categories:

1. CUTRIC Funded Research & Development (R&D) Projects Approved (TRL 2-6)
2. Commercialization Projects (TRL 7-8)
3. Consultation and Research Projects
4. Other Initiatives
CUTRIC FUNDED R&D PROJECTS (TRL 2-6)

1. CUTRIC FUNDED R&D PROJECTS APPROVED (TRL 2-6)

**PROJECT 160009: Pre-commercialization Development Project of Induction Heated Catalyst (IHC)**

Electrically heated catalysts constitute a universally applicable tool for temperature management in the exhaust after treatment system. Not only does it significantly increase the effectiveness of exhaust after treatment (reduction in HC, CO, and NOx, exhaust emissions), but it also offers potential for CO2 reduction at the same time, therefore saving fuel, in comparison with conventional measures such as engine-based catalyst heating. The electrically heated catalyst offers high flexibility as it inputs energy where it is needed locally. The electrical supply can also work independently of the operating point of the engine. GHG impact varies depending upon original equipment managers (OEMs) powertrain application strategies.

**Project Partners:**

Industry:
1. ATES Inc.
2. ABB Group
3. Systematix Inc.

Academic:
1. CANMET Materials Lab
2. Sheridan College

This project was successfully completed in December 2017.
A simulation tool was developed to support electric-bus deployment projects by predicting operational benefits, total CO2e savings, and charging requirements. The model is based on the original code developed via collaborations through the Pan-Canadian Electric Bus demonstration & Integration Trial: Phase I. The main inputs of the model include physical characteristics of the bus, route topography, ridership, powertrain efficiencies, route scheduling, and driving speeds. The model can calculate e-bus energy consumption, as well as battery state-of-charge, time required to charge, and total electricity consumed.

**Project Partners:**

**Industry:**
1. CUTRIC
2. ABB Group
3. City of Brampton
4. New Flyer
6. Nova Bus
7. Siemens
8. TransLink
9. York Region

**Academic:**
1. Queen's University
2. University of Ontario - Institute of Technology
3. University of Victoria

This project was successfully completed in December 2017.
PROJECT 160015c/160017b: High-Powered Electric Vehicle Charging with Energy Storage Integration: Optimization Analysis & Techno-Economic Predictive Analysis

In order to assist public fleets (including transit agencies and utility/local distribution companies) to overcome the barriers of uncertainty and high risk associated with new electrified propulsion technologies integration, CUTRIC developed a consortium of industry partners to lead research into various aspects of electrified propulsion systems, vehicle-to-grid integration, and cybersecurity allied to e-buses.

This Project will:

1. Develop innovative physics-based predictive modeling of e-buses, e-chargers, and energy storage devices (batteries, flywheels, etc.) using proprietary information from manufacturers;
2. Develop an effective program management framework to cater to the requirements of a multi-stakeholder consortium comprising multiple competing OEMs, transit agencies, utilities and research institutions in common intellectual property (IP) development.
3. Develop a risk register along with the mitigation strategies;
4. Procure necessary hardware and software licenses for data collection, transmission, warehousing and subsequent analytics.

Several new core technology outcomes associated with this project will emanate from the Project.

Module 1: Feasibility Assessment and Predictive Analysis
Core technology emanating from Module 1 relates to the consortium-developed TRiPSIM© (Transit Route Performance Simulator) modelling tool which has been developed within this project over the past year (starting in 2017), and which will continue to be developed over the course of this project and commercialized to generate new revenues for the consortium of partners. TRiPSIM© is being built using Python as a coding language. The TRiPSIM© tool offers refined manufacturer-vetted and utility-vetted predictive modelling outputs that demonstrate how various e-buses and e-chargers operate in-situ based on variable route topologies, passenger profiles, stop-start needs, and other route requirements. The tool has been built with direct powertrain inputs from manufacturing partners, who have aided the development process; manufacturing partners have aided researchers in developing a predictive tool based on their actual powertrain information rather than hypothesized or generalized powertrain components, rendering it a highly unique and industry-leading tool. The simulation tool enables advanced decision-making by transit agencies and other fleet owners of future e-bus fleets. This tool can be extended to model hydrogen fuel cell vehicles in the future.
Module 2: Cloud-based Software Analytics
Core technology emanating from Module 2 relates to a cloud-based software analytics tool that the consortium is developing to collect and assess data in real-time from high-power, overhead charging systems (450kW+) and electric buses (ranging from 76kWh to 200 kWh), which accommodate emerging international standards for pantograph connectors and modular power levels compatible with various OEM bus platforms. The meta-level shared (cloud-based) platform will merge real-time data from competitive OEM data loggers to perform meta-level analysis for transit agencies.

Module 3: National Academic Advisory Committee (NAAC), Academic Research Assessment of E-Buses and E-Chargers
Core knowledge and technology outputs emanating from Module 3 relate to the following academic outputs:
Analytical knowledge emanating from cyber-security protocol analysis for e-buses and e-chargers, which may lead to improved technology standards for these systems;
A 3D visualization tool that allows transit and fleet systems to design and develop urban informatics approaches to visualize dynamic, complex, multi-modal mobility with scalable data for future fleet electrification decision-making;
A prototype of an enhanced powertrain for the e-buses that would be of relevance

Module 4: Full Fleet Electrification for Toronto Transit Commission (TTC)
1. Core knowledge and technology outputs emanating from Module 4 relate to a set of guidance for decision-making related to TTC’s full fleet electrification goals; this guidance will be composed of modelling-based predictive and empirical analysis of the likely performance of multiple models of electric buses and charging systems (i.e. high-powered, low-powered, small batteries, large batteries, and hydrogen fuel cell buses) across the TTC’s entire fleet of buses and service routes in Ontario;
2. These outputs will involve a refined TRiPSIM® modelling tool, which was developed in Module 1 over the course of 2017-2018 primarily; the refined TRiPSIM® tool currently in development enables comparative analyses of varied e-bus and fuel cell ebuses and their allied charging and/or fueling systems in the near-term future. This tool will integrate:
   i) energy consumption estimations,
   ii) environmental costs and benefits;
   iii) electricity and fuel costs and benefits and;
   iv) resiliency costs and benefits (fleet resiliency) for public fleet systems specifically.
Project Partners:

Industry:
1. CUTA
2. ABB
3. BC Transit
4. Brampton Transit
5. Burlington Transit
6. eCAMION
7. Halifax Transit
8. New Flyer Bus
10. Nova Bus
11. Ontario Power Generation
12. Proterra
13. Siemens
14. Tokmakjian Group
15. Toronto Hydro
16. Toronto Transit Commission
17. TransLink
18. Viriciti
19. Winnipeg Transit
20. York Region Transit

Academic:
1. Ontario College of Art & Design (OCAD) University
2. Queen's University
3. University of Ontario - Institute of Technology
4. University of Windsor
PROJECT 160018b: Automated and Connected Electric Vehicle Integration: Optimization Analysis & Techno- Economic Predictive Analysis, using TRiPSIM© Modelling Tool

The Automated and Connected Electric Vehicle Integration: Optimization Analysis & Techno- Economic Predictive Analysis project will help municipalities across Ontario predictively assess and understand the feasibility of deploying and operating low-speed electrified autonomous shuttles (e-LSAs) within local municipal systems and specifically with regards to first-mile/last-mile solution building. This will improve mobility options for Ontarians and Canadians more broadly, and it will increase the breadth of shared mobility and transit services while driving forward job growth in the electrified, autonomous and connected vehicle ecosystems. The objective of the project is to predictively assess optimization and techno-economic parameters of e-LSA operation along selected routes within municipal jurisdictions in Ontario, utilizing the TRiPSIM© modelling tool. The outcomes of TRiPSIM© modelling will highlight the benefits of a longterm implementation and monitoring of a series of national on-road demonstration trials using e-LSAs across a proposed set of municipal jurisdictions.

The project objectives are:

1. Modelling work for e-LSAs across 12 municipalities in Canada as emanating from an awarded ACATS contract by Transport Canada. This part of the project relates to a set of tools for decision-making guidance which will be composed of modelling-based predictive and empirical analysis of the implementation of multiple manufacturer models of e-LSAs. These outputs will help the consortium refine the TRiPSIM© tool currently in development in Project 160015c/160017c. This tool will integrate i) energy consumption estimations; ii) environmental costs and benefits; iii) electricity costs and benefits and; and iv) resiliency costs and benefits (fleet resiliency) for e-LSAs specifically.

2. National Academic Advisory Committee (NAAC) to perform Academic Research Assessment of e-LSAs. The core knowledge and technology outputs emanating from this module relate to key and critical research performed by seven leading academic institutes in Canada to address cybersecurity and privacy of CAV networks; user perception and experience; safety assurance testing; Transit Signal Priority for CAVs; and winter vehicular sliding conditions.
Project Partners:

Industry:
1. CUTA
2. ABB Group
3. BAE Systems
5. Belleville Transit
6. Bombardier
7. Burlington Hydro
8. City of Cochrane
9. City of Edmonton
10. City of Montreal
11. City of Ottawa
12. City of Surrey
13. City of Toronto
14. City of Vancouver
15. City of York
16. Durham Region Transit
17. EasyMile
18. eCAMION
19. Enbridge Gas Distribution Inc.
20. FPInnovations
21. Green Power Bus
22. GoMuve
23. Grand River Transit
24. Hydrogenics
25. Kingston Transit
26. Logistics
27. London Transit
28. Metrolinx
29. MiWay
30. New Flyer Industries
31. Next Hydrogen
32. Nova Bus
33. Oakville Transit
34. Pacific Western Transit
35. Pantero
36. St. Catherine's Transit
37. Société de transport de Trois-Rivières
38. SP North America
39. Stantec
40. St. Albert Transit
41. St. Catherine's Transit
42. Systematix
43. Tech K.O
44. Thales
45. Transit Windsor
46. Velometer Mobility
47. Winnipeg Airport Authority
48. Woodstock Transit
49. 2GetThere

Academic:
1. Canadian Nuclear Laboratories (CNL)
2. Centennial College
3. St. Clair College
4. Carleton University
5. Queen's University
6. Red River College
7. Université du Quebec - Trois Rivieres
8. University of Calgary
9. University of Toronto
10. University of Waterloo
11. University of Windsor
PROJECT 160028: Development of Low-Cost, High Performing and Durable PEM Fuel Cells (Phase I)

Urban transit emissions have the highest impact environmentally and socially, especially on the health hazard of the urban population. This study focuses on zero-emission fuel cell technology that can be used in: fuel-cell power/propulsion systems; battery electric power/propulsion systems with fuel cell as ranger extenders; and electric power/propulsion systems with battery-fuel cell electric hybrids. The research focuses on proton-exchange membrane (PEM) fuel cell technology and the technical challenges involving cost and durability under variable load operations.

Advanced high performance/low life-cycle cost PEM fuel cell technology will be achieved via approaches that develop and combine advanced catalyst(s) layers with highly active and stable materials. Additionally, increased tolerance to fuel impurities, through developing contaminant-resistant catalysts, is a key enabler for lower cost systems and deployment of fuel cells in a broader global market. The advanced technologies include: (1) hybrid Pt/active support catalyst; (2) high activity shaped Pt nanoparticles; and (3) non-precious metal catalysts. Core technology outcomes include composition, design, structural optimization, and fabrication of catalysts, catalyst inks, catalyst layers and membrane-electrode assemblies (MEAs).

The potential for indirect GHG reductions is enormous, as fuel cells are zero-emission power sources with high energy efficiency. The outcomes of this project will contribute to “greening” the urban transit and transportation sector, by producing fuel cell technology capable of replacing the traditional internal combustion engines, thereby greatly reducing emissions from urban transportation activities. Currently, transportation represents 23 per cent of the total GHG emissions in Canada (and approximately the same on a global scale), or approximately 200 MT per year of CO2 equivalent for Canada alone, hence the potential for this technology to substantially reduce Canada’s GHG emissions is significant.
Project Partners:

Industry:
2. StarPower ON Systems Inc.

Academic:
1. University of Waterloo
2. Western University

Ballard Catalyst Researchers

Ballard FC Stack Products
PROJECT 160033: Social-Semantic Analysis of Social Media Interactions to Assess Customer Satisfaction in Transit Agencies

The aim of this proposed study is to advance the discipline of social media analytics and its application to public fleet decision makers. The project starts by integrating incoming social media feeds vis-a-vis public fleets and merges all incoming data into one cloud-platform. This platform will enable (in the future) an artificially intelligent response mechanism for fleet action, including dispatching additional vehicles or communicating with consumers regarding their challenges on the street in hailing, riding or commuting by public vehicles in a public mobility system. The immediate outcome of this social media analytics tool is a better capture of customer views and opinion dynamics, customer satisfaction and operational support. This can help public or private fleet operators at two main levels:

1. Enhancing agency ability to model and assess customer satisfaction levels much faster and;
2. Supporting the development of more effective two-way communications between agency and riders

Project Partners:

Industry:
1. Calgary Transit
2. SP North American Co.

Academic:
1. University of Toronto
2. York University
3. University of Calgary
In this project, an integrated vehicle system analyses of fuel cell electric vehicles (FCEVs) (transit buses) will be conducted. There are module specific, independent, third party principal applicants involved in this project to ensure neutrality of the research and accounting procedures. The Ontario Society of Professional Engineers (OSPE) will serve as the principal applicant for Module 1, 2, 6 and 7; the academic/research stakeholders (York University, Centennial College and Canadian Nuclear Laboratories) will serve as the principal applicants for the academic module (Module 3); the CUTRIC consortium will serve as the principal applicant for Module 4; and Newmarket-Tay Power Distribution (NMTPD) will serve as the principal applicant for Module 5.

In Module 1, OSPE entrusts the consortium to utilize its own in-house capacities in modelling to study route optimization, powertrain performance and conduct economic feasibility analysis and techno-economic predictive analysis. OSPE will oversee the consortium’s work in Module 2, wherein the consortium will be doing program management and in situ/empirical data analysis of vehicles on the road and fuelling systems. In Module 3, the academic stakeholders will be conducting an in-depth analysis with respect to hydrogen systems design and integration with bus transit operations and evaluate the existing codes and standards for medium and heavy duty applications, consider optimization of H2 cost reduction techniques for transit agencies and will also study the increasing significance of hydrogen as an integrated energy storage and fuelling resource. CUTRIC will be investigating the potential of alternate propulsion, specifically hydrogen, in the rail sector in Module 4 to inform Transport Canada of the potential innovation and emission elimination opportunities that exist. In Module 5, NMTPD attempts to understand the potential merits and demerits of utilizing electricity as a direct propulsion tool by its use in overhead...
chargers powering battery electric buses and as an indirect tool producing hydrogen from water that not only propels buses, but can also serve as an energy storage medium. In Module 6, OSPE entrusts the consortium to conduct a nationwide study on the representation of women in STEM and analyse the role and level of involvement that women have as leaders in the technology innovation and transportation sector. In Module 7, OSPE envisions that the consortium will utilize its strong knowledge, expertise, and knowledge dissemination prowess in designing and delivering multiple professional development modules/courses that enable the advancement of professional knowledge and skills in technology, innovation, transportation, and management, among others.

The main deliverables expected out of this project (170056b) are as follows:

1. Project charter and business case for 170056b
2. Completely developed Fuel Cell Electric Bus (FCEB) modelling algorithm
3. A comprehensive literature review of the global FCEB innovations and key findings from the consortium-led project development meetings
4. A federal or provincial funding application to fund a large-scale demonstration and deployment of FCEBs
5. Training multiple highly qualified personnel (HQPs)
6. Report on analyses of data collected from on road vehicle deployments
7. Comparative analysis findings report on validated modelling outputs based on data collected
8. A detailed analyses-based report of women representation in STEM and technology innovation and transportation
9. Multiple course modules with professional development unit (PDU) embedded

Module 1 relates to Pillar One in CUTRIC’s Pillars of Innovation: “Low and Zero Emissions.” To achieve the successful demonstration and integration of novel FCEBs, transit agencies and fleets in general require access to robust predictive modelling. Module 1 incorporates critical and auxiliary vehicle power train parameters and fuelling specifications to produce highly accurate modelling outputs that calculate the energy requirement for each FCEB per route, per passenger, and per kilometre of service area; the modelling tool, TRiPSIM©, also calculates the FCEBs specific state of charge (SOC), battery degradation and auxiliary load as it performs its daily service. TRiPSIM© also offers transit agency partners the ability to accurately estimate the price of electricity, the time to charge up, the uptime/downtime of the FCEBs and the CO2E reduced in each route run. The modelling tool is validated regularly by manufacturing partners in the project to ensure the consortium’s research team is integrating the most up-to date data inputs and that the research team is not making erroneous assumptions about unit design or performance. These design choices will be further validated by the real-time data.

Module 2 relates Pillar One and Two in CUTRIC’s Pillars of Innovation: “Low and Zero Emissions” and “Big Data in Mobility”. This module focuses on collecting data from loggers installed in FCEBs.
The loggers will provide real-time streamed data points in raw data form that can be assessed to determine the operation performance of FCEBs that constitute part of the Pan-Canadian Hydrogen Fuel Cell Electric Vehicle Demonstration & Integration Trial: Phase I. In addition, the Module establishes a national Program Management framework for the on-road Trial; a framework that can be replicated elsewhere over time to ensure the effective and meaningful sharing of relevant and critical data sources across e-vehicle deployments among and within public fleets (and potentially private fleets in heavy-duty vehicles in the future). Key tasks associated with the Program Management portion of this Module include i) finalizing a Project Steering Committee Charter and governance structure; ii) defining roles and responsibilities for each partner; iii) establishing an IP and data sharing framework to securely share proprietary outcomes from the in-trial analysis; iv) establishing a risk registry; v) collecting and analyzing operational data from FCEBs in real-time. This module will develop a new cloud-based data analytics sharing platform for OEMs and transit systems to share real-time data analyses and error reporting from vehicles and charging units on the road. The effective use of this data collection and sharing tool will support Canada’s national shift towards electrification across all heavy-duty vehicles in the future, i.e. trucks and coaches. The data collected will be used to validate the modelling outputs from Module 1 and to conduct a comparative analysis on the predicted vs real values.

**Module 3** relates to multiple CUTRIC Pillars of Innovation, including Pillar One: “Low and Zero Emissions”, and Pillar Two: “Big Data in Mobility”. Module 3 is comprised of several independent academic research teams and projects; each of which support one aspect of FCEB optimization or integration identified as critical by OEM partners and transit agency partners in this project. Research teams at these institutions will assess different aspects of FCEB deployments and fuelling infrastructure identified as critical for long-term innovation by the consortium partners. These include:

a. Needs and Gap Analysis: Canadian Standards for Heavy-Duty Fuel Cell Vehicles, Fuelling and Storage and investigating the tools for effective navigation of policy level red tape to make hydrogen technology integration feasible in Canada
b. Optimization of H2 Cost Reduction Techniques for Transit Agencies in Ontario that would make hydrogen technology more attractive for transit agencies who wish to take the path
c. Distributed Hydrogen Generation - Integration Strategy that could make an economic business case for bringing fragmented hydrogen generation programs in Ontario to support the creation of a larger and more robust opportunity for innovation

**Modules 4 and 5** relate to “Zero & Low Emissions” pillar as they attempt to bring low-carbon propulsion based technological innovation to the rail sector and to transit fleets. Additionally, calculating the possible value of providing electricity as the fuel to produce hydrogen for fuel cell buses through an electrolyser if it were set up in the region which is being served by Newmarket-Tay Power Distribution is a key aspect that is being studied in this module.

**Modules 6 and 7** are allied to the work that gets performed under the “Zero & Low Emissions” pillar as it attempts to quantify and qualify the role of female leaders and enhance the potential for knowledge dissemination through PDU based course module development.
Project Partners:

Industry:
1. Ontario Society of Professional Engineers (OSPE)
2. Ballard Power Systems Inc.
3. Hydrogenics
4. Enbridge Gas Distribution Inc.
5. Tech K.O
6. CarlSun 7Gfuels
7. BC Hydro
8. New Flyer
9. York Region Rapid Transit (YRRT)
10. Belleville Transit
11. Durham Region Transit
12. Grand River Transit
13. Kingston Transit
14. London Transit
15. Woodstock Transit
16. St. Catherine’s Transit
17. Milton Transit
18. MiWay
19. York Region Transit
20. Burlington Hydro
21. Capital Area Transit Coordinating Committee
22. Newmarket-Tay Power

Academic:
1. Canadian Nuclear Laboratories (Academic)
2. St. Clair College
3. York University
4. Centennial College
5. Red River College
The Electric Vehicle Enclave (EVE) Autonomous Vehicle Infrastructure Demonstration Pilot is a state-of-the-art project showcasing infrastructure-based autonomy in a complex residential environment. This project is designed to tackle some of the key challenges for autonomous vehicle penetration. Today’s state-of-the-art in autonomous vehicles is highly limited to highway driving and is not optimized for adverse weather conditions and high-risk areas where there is heavy congestion or pedestrian activity. Additionally, the state of the industry is highly reliant on onboard processing, control, and sensing for the autonomous vehicles, resulting in a high cost per car.

In this project, S2E Technologies combines infrastructure-based controls and sensing with an optimized onboard unit assembly. S2E will minimize the need for hardware on the vehicles, while at the same time gaining from the constant monitoring and robustness of sensors on the infrastructure. The actual demonstration area will be at the residential neighbourhood of EVE Park, but this system is designed to be flexible and adaptable for all high-risk pedestrian areas. Once this technology is proven at this site, S2E will package the concept and commercially deploy it in school zones, urban, road construction, and other residential areas.

Moreover, since S2E is integrating the sensors and processing in the infrastructure, the same infrastructure will communicate with a possible community-wide autonomous shuttle and autonomous utility vehicles (for landscaping, snow removal, package delivery, and waste management).

In this first pilot, the objective is to provide an autonomous valet service for a community in London, Ontario, called EVE Park. EVE Park is a net-zero energy neighbourhood of 60 townhomes in West 5, a master-planned community in London, Ontario. The project will be part of West 5’s DC 100 per cent renewable micro-grid. Hence, all of the vehicles will be renewably-charged. EVE Park is an innovative neighbourhood, where residents prioritize sustainability, technology, and sharing lifestyles. It is a great platform for testing new technologies and business models.

As part of their living experience, residents will access this electric car-share fleet, where the cars would operate autonomously (Level 4/5) within the communities private roads; alternatively, residents can be driven at Level 3 capabilities off-site on public roads. Residents can summon cars from the automatic (rotary) parking tower from their mobile application and it would drive autonomously through the neighbourhood to pick them up. Similarly, after being dropped off, the residents would exit the vehicle for the vehicle to go park itself. This concept introduces several critical components, including: (1) central system computing; (2) logistics information systems; (3) infrastructure components; (4) path-planning; (5) vehicle calibration; and (6) cybersecurity measures.
To address each of these technical elements, the first part of the project will be dedicated to systems design, research, and prototyping with multiple academic teams.

The research will be evaluated by the industry and public sector teams. The objective of the research and prototyping stage is to establish functional specifications, system requirements, full system designs, contingency plans, and prototypes for the six components. Once complete, S2E will develop prototype systems on both the University of Waterloo (UW) and the NRC London campuses.

The UW prototype will test the vehicle navigating on a predetermined route that is mapped and equipped with hardware on the local infrastructure. It will evaluate the sensor calibration, navigation requirements, controls, simulation validation, V2X communication, cybersecurity measures, and many other elements outlined in the deliverables document. On the NRC campus, S2E will deploy a parking tower system to evaluate the parking SCADA system, mobile application integration, communication with the car, and electric vehicle charging elements (wireless, vehicle-to-grid, and automatic connection of charger to car robotics).

From these prototypes, S2E will develop the final design for the residential development. It is anticipated that after the installation, there will be multiple data collection, measurement, re-calibration, and evaluation studies. From both of the prototypes and the demonstration project, there will be a well-tested commercial offering ready for deployment.

**Project Partners:**

**Industry:**
1. S2E Technologies
2. Elix Wireless
3. Ellis Don

**Academic:**
1. University of Waterloo
2. Western University
PROJECT 180084: Design and Real-Life Verification of Light-Weight Solar Anti-Idling System in Urban Transit Vehicles and Service Fleets for Reduction of GHG Emissions

This project focuses on the optimization of the system design. The main purpose is to accomplish commercialization of an “anti-idling” solution for public transit buses. Therefore, the project entails aspects of design, cost considerations, and safety concerns. A universal anti-idling solution is not possible because the pattern of idling varies with the type of vehicles as well as operating and environmental conditions. Therefore, the applicant is developing two core technologies to achieve a light-weight anti-idling system with an adaptable and modular architecture:

1. Optimizing specifications and sizing of modular components - particularly the photovoltaic and battery pack. This achieves the maximum efficiency for delivering the proper energy and power ratings.

2. Deploying energy management mechanisms to feed excessive energy to other loads in the optimal configuration (energy, power ratings, DC or AC).

Project Partners:

Industry:
1. Microgreen Solar Corporation
2. eCAMION

Academic:
1. University of Waterloo
2. Western University
3. Centennial College
4. University of Toronto
PROJECT 180085: Shared Electric Work Fleets for Universities and Colleges with a System of Resource and Location Optimization using Machine Learning

The project’s objective is to demonstrate the world’s first shared, electric work fleets with on-demand rides, tools, supplies and assets. Pilot projects will take place at several universities and colleges in Ontario. The study aims to test shared work fleets with university and college partners that have field staff (i.e., plumbers, electricians) through several pilot projects. Post-secondary school staff who participate in the pilots will switch from driving their own work vehicles with their own equipment (i.e., ladders and shop vacuums) to an “Uber-like” model where pickups and drop-off’s can be requested from smartphones. In addition to pickups and drop-offs of the technician, assets (ladders, shop vacuums) and supplies (nails, nuts and bolts, etc.) can also be picked up or dropped off and accessed via “smart” Bluetooth-enabled lockers in the vehicles that open by technicians pressing a button on their smartphone.

Project Partners:

Industry:
1. HiHo Mobility
2. ElectricTractor Inc.

Academic:
1. Ryerson University
4. University of Calgary
Since September 2018, Pantonium has provided newly developed technology to enable an
intelligent on-demand bus service in Belleville, Ontario. The technology deployed to Belleville is
currently an alpha version. Several new features and capabilities are slated to be added to the
system based on feedback of the initial pilot as well as Belleville’s future goals for public transit
expansion - specifically to a whole new area of Belleville municipality called Ward 2, which has
never has access to public transit before. Finally, a third overall objective of this project is to
deploy this technology to another municipal public transit agency that is similar to Belleville. This
second site deployment will happen in Woodstock, Ontario. In parallel with the project in Belleville.
This will be a test of the scalability and applicability of this software to other geographic areas.

In summary this project will:
1. Generate original research and validate data generated by Pantonium’s On-Demand Transit
   (ODT) Software;
2. Further innovate and iterate on the technology platform to make a commercializable product;
3. Expand the project in Belleville to new service areas and deploy the technology to a new
   municipality.

These are the queries that are planned to be addressed by this proposed project for 2019:

• How has the initial intelligent on-demand transit pilot impacted transit in Belleville?
• What was the baseline efficiency of the transit service before the on-demand pilot?
• Will native applications (iOS and Android) improve the service adoption rate and user
  experience?
• What other features added to the software help improve the service?
• How can the on-demand service be scaled to cover more of Belleville Transit’s area of
  responsibility?
• Has on-demand transit allowed users to better achieve their daily demand for activity
  participation (e.g., has the system allowed new trips to be made that were previously not
  conducted due to poor transit supply?)
• What is the nature of the activities that are being conducted using the new technology? Do
  these differ to the activities conducted by traditional transit users? How does this vary spatially
  (i.e., in areas with and without existing transit supply) and by different social strata?
• Can Pantonium quantify the social return on Belleville’s investment in the new technology?
• What would be the potential social return on investment in other jurisdictions in Canada (or
  abroad?)
• What has been the impact on greenhouse gas emissions? Has the availability of on-demand
  transit reduced the number of car-based trips?

Pantonium wants this project to combine the expertise of university researchers, transit operators
and technology developers to validate and expand upon the current Belleville project to assist
Pantonium commercialize and scale up its on-demand transit system.
The study would begin by researching and understanding the historical transit framework and ridership travel patterns for the region. Then there would be a report made on the current deployment of Pantonium’s software, which is a limited scale pilot. This will include rider and driver feedback on the whole user experience from both their perspectives, along with feedback from the transit agency’s management, city council and also the perspective of Pantonium’s support and project management team.

Overall the goal is to help Belleville determine the best way to utilize this system over a longer time frame and at a greater scale. This will aid Pantonium to build a commercialized and tested product.

Objectives:
• Scaling an intelligent on-demand bus service for public transit from its current limited pilot stage.
• Decreasing overall transit costs by reducing the number of empty buses operating.
• Developing and deploying a native application for iOS and Android phones to compliment current web application and handle payments.
• Functional improvements based on lessons learned and feedback from the Pilot phase.
• Developing analytics to measure the impact of on-demand transit on public transit operations.

Deliverables:
• Native mobile application for riders, allowing payments and improved user interface, access to real-time information, and a smoother trip booking process.
• Upgraded mobile application for drivers to increase ease of use, remove unnecessary features and notifications.
• Reporting features for administrative users to allow data and statistical to be generated on operations.
• Multiple service area management features for administrative application.

This project falls directly under CUTRIC’s Theme #3: Big Data for mobility analytics and Mobility as a Service applications, as the technology specifically involves the optimization of public requested trips (through web, mobile, phone) into dynamic vehicle routes and schedules based on the analysis of data in real-time. The project could also be defined as Theme #2: Smart vehicles and "smart" infrastructure technologies for autonomous and connected vehicles on roads and on rail (Intelligent Transportation Systems), as the whole technology platform being deployed is an “Intelligent Transportation System,” and the concept of EverRun, which is an autonomously functioning control system for public transit, is defined as “Intelligent Infrastructure.”

**Project Partners:**

**Industry:**
1. Pantonium Inc.
2. Belleville Transit

**Academic:**
1. Ryerson University
4. University of Toronto

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PROJECT 190122: Next-Generation Integrated Battery-Based Electric Bus Charging System

In the proposed project, the consortium will develop a novel bus charging technology that is backed up by a battery energy storage system. In the proposed project, eCAMION will lead a consortium composed of two academic partners and a potential deployment partner.

The overall project query is to create a cheaper and more effective electric bus charging system, with reduced capital and operating costs. As part of the research query, eCAMION will design and develop an inverted pantograph bus charger backed up by a Li-Ion energy storage system. The system will consist of multiple elements:

- AC/DC power electronics converters to interface with the grid
- Li-Ion energy storage system
- DC/DC power electronics converters to supply the charge to the bus
- J3105-compliant inverted pantograph and the mast hosting it
- Communication interface between power electronics equipment and buses

eCAMION will benchmark two competing semiconductor technologies for the power electronics converters – conventional IGBTs and new GaN or SiC switches. The proposed system with 480-kW charging capability will have an estimated price of $500k, as compared to roughly $1M cost for existing products.

Project Partners:

Industry:  
1. eCAMION  
2. Durham Region Transit

Academic:  
1. Centennial College  
2. University of Toronto
2. COMMERCIALIZATION PROJECTS (TRL 7-8)

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

Project Summary

The Pan-Canadian Electric Bus Demonstration and Integration Trial is a national, multi-phase project that supports the development of critical technologies for standardized electric vehicles and associated charging infrastructure. The novelty of the trial is the demonstration of interoperability (for the first time in the world) among electrical charging and electric bus platforms, developed by different OEMs. This project offers a global first in that multiple competitive OEMs are integrating their transit technologies at high power on the same routes. This standardized approach provides harmonization among various electric buses and charger models and manufacturers, which would ease the burden of the transit agencies in terms of expanded options for procurement and reduced risks for non-compliance to standardized forms in the future. The demonstration of interoperability is an essential step towards charging of electric trucks and other medium to heavy vehicles and this project enables Canada to be the first jurisdiction in the world to do so. The major activities in the project include project development and management; R&D; data collection and analytics; stakeholder identification and management; development of training curricula; conducting on-road demonstration of electric buses and charging infrastructure. The scope is divided into three phases. The key aspects of each of the three phases are described below:

i) Phase I
- Demonstration of “plug-and-play” interoperability between electric buses and 450 kW overhead charging platforms, developed by competing manufacturers, through their standardization to OppCharge protocol.
- Finalization of performance standards for electric buses and overhead charger operations and warranty conditions for procurement of electric buses and high-powered overhead chargers with stakeholders (transit/utilities/OEM).
- Predictive modeling on specified routes and post-factum data collection and analytics for optimizing future deployment of electric buses and overhead chargers.
- Expediting and facilitating the development of the SAE J3105 standard related to heavy duty electrification by deploying and integrating state-of-the-art technologies from multiple e-bus and e-charger manufacturers that are in need of standardization for optimal operational performance.
- Developing a public transit data trust to collect and safeguard the data generated through various collection mechanisms throughout the duration of the project (Phases I-III). A legal framework around this public data trust would be developed which will identify the modalities of data collection, access and privacy. This will establish a data repository with independent, public stewardship and which would be accessible to other public, not-for-profit and private sector organizations.
ii) Phase II
- Exploring strategies for achieving optimal demand management through the integration of energy storage and “smart” throttling control functionality with the overhead chargers.
- Reducing charging times by opting for higher power chargers (450-600 kW) for quicker turnaround or rapid transit applications.
- Standardizing the overhead electric chargers using the SAE J3105 standard.
- Standardizing the plug-in electric chargers using the SAE J3068 or the SAE J1772 standard.
- Exploring optimization of the standardized plug-in, depot charging process for transit agencies interested in electrification through garage-based charging.
- Developing the framework of a novel Public-Private-Partnership based business model titled *Innovation P3*© for leveraging the technical expertise of CUTRIC members in building, operating, maintaining and financing transit assets and infrastructure.
- Predictive modeling on specific routes and post-factum data collection and analytics.

iii) Phase III
- Introducing elements of automation in the charging process through autonomous vehicle technology and platooning, thus streamlining the charging while minimizing any bus-charger coupling issues.
- Automated platooning of the electric bus at the overhead charger for faster alignment with the overhead charger and automated charging episodes based on vehicle state of charge.
- Potential platooning applications for Bus Rapid Transit.

2. Leading Stakeholders
Brampton Transit, York Region Transit, Newmarket-Tay Power Distribution Limited, TransLink, Burlington Transit, Durham Region Transit, Siemens, ABB, New Flyer Bus, Nova Bus, Proterra, University of Ontario Institute of Technology (UOIT), York University, OCADU, University of Windsor, Red River College, St. Clair College, Centennial College

3. Intellectual Property (IP) and Research Outcomes
   i) Standards for high-powered overhead chargers (J3105) and energy storage integration.
   ii) Modelling tool TRIPSIM ©, developed by CUTRIC, to model the energy consumption and operational performance of electric buses on key specified routes.
   iii) Detailed report in the performance of battery- and flywheel-based energy storage devices for complimentary operation with the high-powered overhead chargers.
iv) Detailed report on Cybersecurity and networking of electric chargers for automated charging of buses.

v) Novel data visualization tools to find unique ways to represent transit and utility data.

vi) Performance Measures Specifications for standardized electric buses and electric chargers in order to guide transit/utility agencies.

vii) Data generated during the Trial from the electric buses and chargers through a variety of loggers (OEM installed, transit agency installed and the neutral, third party data loggers) and stored in the developed Public Data Trust.

viii) Innovation P3 © framework to enable Cities/ Transit Agencies/Utilities to engage in a P3 styled partnership with domain experts.

4. Funding to University Partners

Please refer to Table 1 below.

Table 1: Details of CUTRIC Funding to Universities under E-Bus Project

<table>
<thead>
<tr>
<th>University</th>
<th>Project Title</th>
<th>Principal Investigator/s</th>
<th>CUTRIC Funding</th>
<th>HQP’s employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Ontario Institute of Technology</td>
<td>Energy storage integration analysis with 450 kW+ charger</td>
<td>Dr. Hossam Gaber</td>
<td>$186,000</td>
<td>5</td>
</tr>
<tr>
<td>Queen’s University</td>
<td>E-Powertrain optimization for heavy duty bus applications: High power absorption capabilities for buses charging at 450 kW+ with various battery capacities (76-660 kWh)</td>
<td>Dr. Suzan Eren Dr. Pravin Jain</td>
<td>$180,000</td>
<td>6</td>
</tr>
<tr>
<td>University of Windsor</td>
<td>Investigation of cybersecurity issues in using electric vehicle fleets with battery exchange infrastructure</td>
<td>Dr. Mitra Mirhassani</td>
<td>$192,999</td>
<td>3</td>
</tr>
<tr>
<td>OCADU</td>
<td>Visualization analysis of E-Bus routes and facilities</td>
<td>Dr. Sara Diamond</td>
<td>$81,000</td>
<td>4</td>
</tr>
</tbody>
</table>

5. CUTRIC’s Bids for Funding/Financing E-Bus Project
Please refer to Table 2 below.

Table 2: Details of the Various Funding and Financing Programs that CUTRIC Intends to Leverage for E-bus Project

<table>
<thead>
<tr>
<th>Funding/ Financing Agency</th>
<th>Name of the Program</th>
<th>Amount</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Resources Canada</td>
<td>Electric Vehicle Infrastructure Demonstration Fund Phase I</td>
<td>$5,000,000</td>
<td>Won</td>
</tr>
<tr>
<td>Natural Resources Canada</td>
<td>Electric Vehicle Infrastructure Demonstration Fund Phase II</td>
<td>$5,000,000</td>
<td>Won</td>
</tr>
<tr>
<td>Environment and Climate Change Canada, Government of Canada</td>
<td>Low-Carbon Economy Fund (Unsolicited bid for Ontario based transit agencies)</td>
<td>$13,800,000</td>
<td>Applied (Awaiting final result)</td>
</tr>
<tr>
<td>FedDev Ontario</td>
<td>Regional Innovation Ecosystem Program</td>
<td>$10,000,000</td>
<td>In process of application</td>
</tr>
<tr>
<td>Canada Infrastructure Bank (CIB)</td>
<td>Financing in tandem with CUTRIC’s Innovation P3© initiative</td>
<td>TBD (To be leveraged for E-Bus Phase II procurement)</td>
<td>Currently in discussion with CUTRIC members and CIB</td>
</tr>
<tr>
<td>Innovation, Science and Economic Development Canada</td>
<td>Strategic Innovation Fund Stream 5</td>
<td>TBD (To be leveraged for E-Bus Phase II procurement)</td>
<td>Yet to open</td>
</tr>
</tbody>
</table>

6. Contact Info for Project Lead and Co-leads:

Project Lead: Josipa Petrunic (josipa.petrunic@cutric-crituc.org)

Project Co-Lead: Abhishek Raj (abhishek.raj@cutric-crituc.org)
Pan-Canadian Hydrogen Fuel Cell Vehicle Demonstration and Integration Trial: Phase I

1. Project Summary
The Pan-Canadian Hydrogen Fuel Cell Demonstration and Integration trial is a national, multi-year project that supports the development of hydrogen fuel cell (HFCs) technologies for fuel cell electric vehicles (FCEVs). The aim is the deployment and on-road demonstration of at least 10 FCEBs and one class 8 truck employing the participation of transit agencies, OEMs, research and academic organizations along with the support from municipal, provincial and federal governments.

This project will support the municipal/corporate plans on FCEB engagement, aid in route selection, locating fueling stations and in designing fuel supply networks. The use of hydrogen fuel cell technology would be significant in reducing public transportation-based greenhouse gas emissions and hydrogen generation using rapid response electrolysis could provide an effective solution for storing surplus power available on the grid and balancing it. The project is currently in its advanced planning phase wherein the scope, budget and timelines for procurement are being finalized.

2. Leading Stakeholders -
Industry Partners: New Flyer Industries, Ballard Power Systems, CARLSUN 7GFUEL, Hydrogenics
Transit Partners: MiWay

3. Intellectual Property (IP) and Research Outcomes
1. Researching the effects of seasonal changes (e.g., heat, humidity) on FCEB efficiency and cost, as well as impacts on bus operation, storage, and efficiency.
2. Assessment and validation (in that order) of operational performance and maintenance intervals, with additional monitoring for the performance degradation of FCEB fuel cells.
3. Minimizing the risk of fuel supply interruption through CUTRIC’s novel proposal of creating a ‘support network’ of transit agencies, which could be a world-first administrative innovation.
4. Modeling electric bus performance, including FCEB performance, along various transit routes with diverse topographical features, passengers, and fueling needs.
5. Conducting a needs and gap analysis of Canadian Standards for Heavy-Duty Fuel Cell Vehicles, fueling and storage and investigating the policy level red tapes that need to be navigated to make hydrogen technology integration feasible in Canada.

5. Contact Info for Project Lead
Parvathy Pillai (parvathy.pillai@cutric-crituc.org)
National Smart Vehicle Demonstration Project and Integration Trial: Phase I

1. Project Summary
The National Smart Vehicle Demonstration and Integration Trial: Phase I will integrate autonomous, low-speed, electrified vehicle shuttles (e-LSAs) within up to six Canadian municipal jurisdictions in first-mile/last-mile applications. The cost per city is estimated to be $2 million - $4 million, with a total Phase I cost of approximately $12 million - $24 million.

The OEM Working Group phase of the project began in Fall 2018 and will conclude by the end of 2019. A National Academic Advisory Committee (NAAC) operates parallel to the OEM Working Group following the same timeline. CUTRIC aims to secure funding for the Project through the Strategic Innovation Fund (SIF) - Stream 5: National Ecosystems by the end of 2019, with on-road launch of e-LSAs expected in 2020.

2. Leading Stakeholders

Interested municipalities: Vancouver, Surrey, Cochrane, Winnipeg, York Region, Brampton.

3. Intellectual Property (IP) and Research Outcomes
1. Demonstrating the application of e-LSAs as first-mile/last-mile solutions complementary to existing public transit services.
2. Integrating standardized DSRC systems for vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication.
3. Ensuring robust levels of cybersecurity across vehicles and infrastructure.
4. Integrate standards for interoperable charging infrastructure across competing e-LSA manufacturers.
5. Determining a single fleet operating system - either an existing transit operating system or a third-party system - for multiple manufacturer e-LSAs.

4. Contact Info for Project Lead and Co-leads:
Project Lead: Kristina Mlakar (kristina.mlakar@cutric-crituc.org)
3. CONSULTATION AND RESEARCH PROJECTS

Oxford County Feasibility Study: EVSE Data Mapping & Analysis in Support of Oxford County’s Electric Vehicle Accessibility Plan (EVAP)

This project bolsters Oxford County’s desire to become a 100% renewable energy jurisdiction by incorporating an electric vehicle accessibility plan. CUTRIC is partnering with the County to assist in the planning process to achieve the Plan’s goals to map, analyze, and strategically locate electric vehicle supply equipment.

OPTA Carbon Pricing Policies

Benefits and Challenges for the Transit Sector: This collaborative project highlights the impacts of Ontario’s emerging cap-and-trade program and the impacts it will have on the transportation industry, including municipal transit agencies. The output is a greenhouse gas emissions modelling based report card to rank transit agencies in order to justify funds for better environmental performance.
4. OTHER INITIATIVES

1. Transport Canada Rail Innovation Initiative

Transport Canada awarded a contract to CUTRIC to establish a series of Rail Innovation Focus Group Consultation sessions populated by knowledgeable transportation experts from the academic world, industry, government and non-government organizations, and transportation operators. The purpose of the focus group consultation sessions are to provide Transport Canada with promising avenues of rail-based transportation technology research that will promote environmentally sustainable rail transportation from: 1) new propulsion systems for locomotive and rail infrastructure; 2) improved energy efficiencies; 3) and optimized operational efficiencies; 4) alternative materials. CUTRIC will form a report with a well-considered and evaluated list of top-ten most promising rail technologies as an outcome of the sessions and the report will be sent to Transport Canada at the end of 2019.

2. Power Providers Transit Electrification Working Group

The Power Providers Working Group for Transit Electrification is trying to establish a systematic national dialogue reviewing and assessing the opportunities, challenges and solutions associated with the growing role for utilities across Canada with regards to electrification of transportation, including electric vehicle supply equipment for both high-powered and low-powered electric transit systems, as well as hydrogen fuel cell electric transit systems.

The working group will learn about the latest technology innovations related to electric bus and fuel cell electric bus technologies, including integrated energy storage systems, while exploring utility business models that may work within certain jurisdictions or under specific conditions to enable utility business development in this space.
The working group will produce a set of recommendations that achieve unanimity of support by designated voting representatives of CUTRIC member utility organizations, and allied organizations working within the electricity marketplace.

So far, the PPWG working group has had three sessions which reviewed policies in California, showed CUTRIC’s modeling results to utilities and confirmed the final version of the charter. In the future, the group will discuss related technologies, such as:

• High-powered and low-powered charging systems.
• Energy storage integration at the site of transit stations and garages in support of charging systems.
• Communications standardization between e-buses, e-chargers and grid operators.
• Cybersecurity standardization across e-buses, e-chargers and grid operators.
• Hydrogen on-site generating systems; smart electrolysis system that generates hydrogen using electricity overnight.
• Other topics as relevant due to industry developments in real-time.

Also, the group will discuss related policies:
• Development of a new tariff structure to address high or inhibitive demand charge structures that offset the cost benefits of electrification in some communities.
• Development of new low-cost flat rate programs for transit system operational predictability.
• Assessment of potential carbon credit offset opportunities based on engagement in ubiquitous electric transit initiatives with energy storage and renewables integration leading to transportation emissions reduction.
• Other topics as relevant due to industry developments in real-time.
3. Innovation P3© Initiative

CUTRIC’s Innovation P3 © initiative is an effort to integrate private sector experience in financing, infrastructure development, technology development and adoption, running operations and maintenance services to the requirements of the low-carbon mobility sector in order to develop a long-term, self-sustaining business model which would reduce the burden on public exchequer and would result in faster adoption and deployment of latest zero-carbon transportation technologies. While there have been numerous Public-Private-Partnership (P3) projects in Canada to date, most of them have been primarily focused on developing fixed assets with very minimal technology integration. Similarly, while Canada can boast of a diverse and experienced industry profile, limited efforts have been taken to utilize the range of expertise that these industries have on offer; especially in order to tackle complex challenges including those faced by the transit sector which is one of the biggest contributors to GHG emissions in Canada and still need to cater to the burgeoning demand of extending mobility services to people.

The focus of this project would be to develop a P3 framework which would enable cities or transit agencies as clients to deploy low-carbon smart mobility projects by handing over the task to a Special Purpose Vehicle (SPV). This SPV would then distribute the various elements of the project to various entities comprising of public agencies, mobility platform manufacturers, utilities, energy suppliers, banks, financers etc., within or outside the SPV. Through a series of consultation sessions under the Innovation P3 © initiative, CUTRIC would develop a framework of economic models along with best practices to develop a robust Innovation P3 © design that can be easily adapted by the interested cities and transit agencies.

Some of the main benefits out of these trials could be: i) potential financial efficiency; ii) enhanced private sector investment; iii) faster development of standards; iv) better service delivery potential for mobility clients; v) expediting with technology learning curve; vi) internal IP development leading to IPO creating marketplace economics opportunities; vii) new business models (with different type of partners) development for integration services and; viii) expedited innovation.
## OUR MEMBERS

### Industry
- 2getthere
- ABB Group
- Advanced Technology Emissions Solutions (ATES)
- ATCO Electric
- Alstom
- BAE System
- Ballard Power Systems Inc.
- Bombardier Transportation
- Brens
- CarlSun 7GFuel
- Dentons Canada LLP
- DynaCERT Inc.
- EasyMile
- eCAMION
- Electric Tractor Inc.
- ELIX Wireless
- GreenPower Bus
- GV Energy Inc.
- Heliox
- HiHo Mobile
- Hydrogenics
- InvertedPower
- Logistics
- Microgreen Solar Corporation
- GoMUVE
- NAVYA
- New Flyer Industries
- Nova Bus/Prevost
- Pacific Western Transportation (PWT)
- Pantero Group
- Pantonium
- PMG Technologies
- Proterra Inc.
- S2E Technologies
- Siemens Canada
- SmartCone Technologies Inc.
- SP North America
- StarPower ON Systems Inc.
- Tech-K.O.
- Thales
- The Energy Conservation Group Corporation
- Tok Group
- ViriCiti

### Transit
- BC Transit
- Belleville Transit
- Brampton Transit
- Burlington Transit
- Calgary Transit
- Durham Region Transit
- Grand River Transit
- Halifax Transit
- Kingston Transit
- London Transit
- Le Service do Transport en Commun de Trois-Riviers (STTR)
- Milton Transit
- MiWay
- Red Deer Transit
- St. Catharines Transit Commission
- Thunder Bay Transit
- Toronto Transit
- Commission (TTC)
- TransHelp
- Transit Windsor
- TransLink
- Winnipeg Transit
- Woodstock Transit
- York Region Rapid Transit Corporation (YRRTC)
- York Region Transit

### Utilities
- BC Hydro
- Burlington Hydro
- Enbridge Gas Distribution
- ENMAX
- FortisBC
- Manitoba Hydro
- Newmarket-Tay Power Distribution
- Ontario Power Generation
- Toronto Hydro
 Academic

- Brock University
- Canadian Nuclear Laboratories (CNL)
- Carleton University
- Centennial College
- Concordia University
- Conestoga College
- Lambton College
- OCAD University
- Queen's University
- Red River College
- Ryerson University
- Sheridan College
- St. Clair College
- Université du Québec à Trois-Rivières
- University of Alberta
- University of British Columbia (Okanagan)
- University of Calgary
- University of Manitoba
- University of Ontario - Institute of Technology
- University of Toronto
- University of Victoria
- University of Waterloo
- University of Windsor
- Western University
- York University

 Government

- Capital Area Transit Coordinating Committee
- City of Red Deer
- City of Surrey
- City of Vancouver
- Oxford County
- Town of Cochrane
- Transport Canada
- York Region Rapid Transit Corporation

 Industry Consultancy & Construction

- EllisDon
- PinkSlip Group
- Sandler Consultancy
- Stantec
- IBI Group

 Non-for-Profit

- PIT Group (FP Innovations)
- Winnipeg Airports Authority

 MOU Partners

- Association du transport urbain du Québec (ATUQ)
- Austrian Institute of Technology (AIT)
- Canadian Urban Transit Association (CUTA)
- EnergieInstitut - The Energy Institute of the Johannes Kepler University
- Hydrogen Business Council
- InnovÉÉ
- Ontario Good Roads Association (OGRA)
- Ontario Public Transit Association (OPTA)
- Ontario Society of Professional Engineers (OSPE)
- Plug'n Drive
- Propulsion Quebec
Membership Breakdown

Industry Consultancy & Construction: 3%
MOU Partners: 8%
Government: 7%
Non-for Profit: 2%
Academic: 20%
Utilities: 7%
Transit Agency: 19%
Industry: 34%

CUTRIC Membership Growth

<table>
<thead>
<tr>
<th>Year</th>
<th>Membership Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>6</td>
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<tr>
<td>2016</td>
<td>44</td>
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<tr>
<td>2017</td>
<td>88</td>
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<tr>
<td>2018</td>
<td>108</td>
</tr>
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<td>2019</td>
<td>120</td>
</tr>
</tbody>
</table>
CUTRIC would like to thank all its members for their continued support and engagement.

CUTRIC-CRITUC

Toronto Office and General Mailing:
CUTRIC -Telsec Business Centres
Suite 1801, 1 Yonge Street
Toronto, ON, M5E 1W7

Montréal Office:
5333 Casgrain Ave #102,
Montreal, QC H2T 1X3

Email
info@cutric-crituc.org

Website
http://cutric-crituc.org/