Low-Carbon Smart Mobility (LCSM) Supercluster Consortium

Supergrappe D’Innovation en Mobilité Durable et Intelligente (SIMDI)

Brought forward by the Canadian Urban Transit Research & Innovation Consortium (CUTRIC)

www.cutric-crituc.org
Budget 2017 proposes to establish Innovation Canada, a new platform led by Innovation, Science and Economic Development Canada as a one-stop-shop for Canada’s innovators that will coordinate and simplify the support available to Canada’s innovators by:

- Leading the creation of Canada’s economic growth strategies
- Initiating a whole-of-government review of business innovation programs
Up to $950 million over five years: competitive basis, for business-led Superclusters with high potential to accelerate economic growth.

Focuses on highly innovative industries such as advanced manufacturing, agri-food, clean technology, digital technology, health/bio-sciences and clean resources, as well as infrastructure and transportation.

Of the $950 million, $800 million will be drawn from the Budget 2016 provision for innovation networks and clusters and $150 million will be drawn from the public transit and green infrastructure allocations provisioned in the 2016 Fall Economic Statement.
Supercluster Characteristics
2017

- Strong connection among different actors
- Improve quality of Canadians life
- Diverse and skilled talent pools
- Opportunities to grow
- Risk sharing

Low Carbon Smart Mobility Innovation Supercluster Consortium -- Supergrappe D’Innovation en Mobilité Durable et Intelligente
Canadian Low-Carbon Smart Mobility Supercluster Consortium

VISION

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

To support commercialization trials and relevant research, development, and demonstration (RD&D) projects through industry-led collaborations that bring innovative design to Canada’s low-carbon smart mobility eco-system.
To develop and apply next-generation mobility and transportation technologies within and across Canada

To grow the low-carbon and "smart" technology eco-system in the country, leading to domestic job growth and economic development over the long-term

To export IP and know-how to the global marketplace in low-carbon smart mobility
Pillar #1
Zero-emissions & low-carbon propulsion systems with fueling & charging system integration

• Supporting battery electric (BEV), plug-in hybrid electric (PHEV), hydrogen fuel cell electric (FCEV), compressed/renewable natural gas (RNG) & dimethyl ether (DME) technologies for light- and heavy-duty vehicle platforms

• LOI: ~$45 Million
Pillar #2
“Smart” vehicles and “smart” infrastructure

• Solutions in automated, autonomous and connected vehicle systems

• Sensors, signaling, and control systems that advance the autonomy and digital connectivity of “smart” vehicle systems (on roads & rail) and infrastructure

• LOI: ~$40 Million
Pillar #3
Big data advanced mobility

- Optimization of public and private fleet networks (transit, integrated and urban mobility)
- Big data use in descriptive, analytic, and predictive mobility solutions
- Artificially intelligent data-driven systems
- LOI: ~$10 Million
Cybersecurity in mobility

- Securitization of low-carbon and smart mobility systems, including autonomous and connected vehicles as well as real-time communications for mobility applications
- LOI: ~$10 Million
Pillar #5
Light-weight materials & manufacturing

• Development of advanced materials, such as composites, polymers, advanced metals, and multi-material designs for light-weight vehicles

• LOI: TBD
Fragmented, insufficient & inappropriate funding options for low-carbon mobility innovation projects: federal

<table>
<thead>
<tr>
<th>APC (Automotive Partnership Canada)</th>
<th>NSERC CRDs</th>
<th>SSHRC</th>
<th>ASIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDTC</td>
<td>NRCan Energy Innovation Programming</td>
<td>Western Development (WD)</td>
<td>FedDev</td>
</tr>
<tr>
<td>NRC-IRAP</td>
<td>PTIF Phase I</td>
<td>PTIF Phase II</td>
<td>FCM Green/Sustainable Funding</td>
</tr>
</tbody>
</table>

Low Carbon Smart Mobility Innovation Supercluster Consortium -- Supergroupe D’Innovation en Mobilité Durable et Intelligente
CUTRIC Federal Funding Ask was $185M/4yrs (2017-2021)

$150M Supercluster Funds

Low Carbon Smart Mobility Innovation Supercluster Consortium -- Supergrappe D’Innovation en Mobilité Durable et Intelligente
Supercluster project funding distribution options

Does your company or organization wish to carve out funding for innovation projects and activities within the LCSM supercluster bid?

YES

1. Does your company have an active collaborative project having started in fiscal year 2017-2018, or planned to start in fiscal years 2018-2022, for which it is seeking a $1 : $1 contribution match?

YES

2. Does your company have an internal Technology Roadmap identifying investments that are planned to occur between 2017-2022 in projects that relate to the LCSM supercluster’s five pillars of innovation, for which it would like to seek a $1 : $1 match (assuming projects are collaborative)?

YES
Examples of industry sectors & stakeholders integrated into current CUTRIC projects

Manufacturers
- New Flyer
- Motor Coach Industries
- Nova Bus
- Volvo
- Bombardier
- ABB Group
- Siemens
- BAE Systems
- Cummins
- Toyota
- FVT

Energy Providers
- Enbridge
- Ontario Power Generation
- Toronto Hydro
- Alectra
- BC Hydro
- Manitoba Hydro
- Hydro Quebec
- Air Products

Communications & Software
- Thales
- Trustpoint
- Blackberry/QNX
- IBM
- Ericsson
- Cisco

Public Transport Fleets as Testbeds
- ATUQ
- Toronto Transit Commission
- Translink
- Brampton Transit
- York Region Transit
- London Transit
- Waterloo Transit
- Calgary Transit
- Halifax Transit
- BC Transit

Automotive Suppliers in Advanced Propulsion
- Ballard
- TM4
- D&V Electronics
- Inmotive
- Linamar
- Magna

Research Organizations
- National Research Council
- Canmet Labs
- University of Victoria
- York
- Queens University
- University of Alberta
- University of British Columbia
- Universite du Quebec a Trois Rivieres

Other
- Brens
- Faromar
- GV Energy
- Transpod
- Avalon Ontario Cleantech Materials Group

Low Carbon Smart Mobility Innovation Supercluster Consortium — Supergrappe D’Innovation en Mobilité Durable et Intelligente
Insufficient & Inappropriate Funding Options for Low-Carbon Mobility Innovation Projects: Provincial

**British Columbia**
- Innovative Clean Energy (ICE) Fund
- BC Tech Fund

**Alberta**
- Alberta Innovates
- Climate Change and Emissions Management Corp.
- CUTRIC-Alberta

**Manitoba**
- Research Manitoba
- Vehicle Technology Centre

**Ontario**
- OCE Programming
- CUTRIC-Ontario
- ORF

**Quebec**
- InnovEE
- TechnoMontreal
- GIVEI
Low Carbon Smart Mobility Innovation Supercluster Consortium -- Supergrappe D’Innovation en Mobilité Durable et Intelligente
• Hydrogen Fuel Cell Technology
• Natural Gas Propulsion Innovation
• Vehicle Electrification & Grid Management

• Hydrogen Production Innovation
• Electric Retrofitting Innovation
• Autonomous Vehicles

• Heavy Duty Vehicle Manufacturing
• Composite and Lightweight Materials
• Vehicle Electrification & Grid Management

• Vehicle Electrification & Grid Management
• Hydrogen Fueling Innovation
• Big Data for Transportation
• Lightweight Materials

• Electric Powertrain Innovation
• Vehicle Electrification & Grid Management
• Hydrogen Production Innovation
• Big Data for Transportation
• Lightweight Materials
• Automated Vehicles & Connected Vehicles
• Cybersecurity for Transportation

CUTRIC Low-Carbon Smart Mobility Clusters
Low Carbon Smart Mobility Supercluster Projects Ready to Launch!

Project 1: Pan-Canadian Electric Bus Demonstration & Integration Trial

Project 2: Pan-Canadian Hydrogen Fuel Cell Vehicle Demonstration & Integration Trial

Project 3: National Smart Vehicle Demonstration Project

Project 4: Low-Vacuum Environment Ultra-High-Speed Transportation

Project 5: Ontario-Quebec Hydrail Connection: Zero-Emissions Passenger Rail

Low Carbon Smart Mobility Innovation Supercluster Consortium -- Supergrappe D'Innovation en Mobilité Durable et Intelligente
Project 1: CUTRIC Pan-Canadian Electric Bus Demonstration & Integration Trial Transit Planning & Environmental Objectives

**Problem**
Need for high up-time (18-24h)

**Solution**
Opportunity/on route charging

**Problem**
Demand Charges

**Solution**
Energy Storage with Super-Capacitors

**Problem**
Driver Precision

**Solution**
Automated Vehicle Controls

**Problem**
Renewable Energy Slumps

**Solution**
On-Route Charging and Energy Storage

**Problem**
Recycling Fees and Battery Waste

**Solution**
Small Batteries and Right Sizing EVs for routes
Project 1: CUTRIC Pan-Canadian Electric Bus Demonstration & Integration Technology Trial Outcomes Phase I, II, III

Low Carbon Smart Mobility Innovation Supercluster Consortium -- Supergrappe D’Innovation en Mobilité Durable et Intelligente
Project 1: CUTRIC Pan-Canadian Electric Bus Demonstration & Integration Trial: Stakeholders: Phase I

GHG Reductions

Transit as Innovators

Jobs in Canada
Project 1: CUTRIC Pan-Canadian Electric Bus Demonstration & Integration Trial Technology
Outcomes: Phase 2

(1) OppCharge Interoperability
(2) J3105 Overhead Charging Standard
(2) Energy storage at charger
(2) At garage charging integration
(3) Automated charging of vehicle
Project 1: Pan-Canadian Electric Bus Demonstration & Integration Trial With Energy Storage: Phase II
Project 2: Pan-Canadian Hydrogen Fuel Cell Vehicle Demonstration & Integration Trial

300 kg of hydrogen/day/site
Project 3: National Smart Vehicle Demonstration Project

National AV pilot platform using low-speed electric vehicles and high automation to overcome challenges associated inefficient campus and industrial park fleet systems

- Facilitate a transition from a point-to-point conventional fleet systems to a trunk-and-feeder system
- Address first km/last km concerns and low-rider levels during specific hours of the day
- Test cameras, visual detection software, communications security, and artificial intelligence of AV systems
Integrated National Smart Vehicle Demonstration for Commercial Viability
Current National Smart Vehicle Landscape

- **ACTIVE-AURORA**
- Alberta’s Industrial Heartland Autonomous Electric Shuttle Pilot
- **ACTIVE-AURORA**
- Calgary Shuttle Pilot
- **ABB**
- Thales R&D Facility at the Parc du Technologique
- Kanata Autonomous Vehicle Innovation Centre
- Stratford’s Connected City

Low Carbon Smart Mobility Innovation Supercluster -- Supergrappe d’innovation en mobilité durable et intelligente
Project 3: National Smart Vehicle Demonstration Project

Current Stakeholders:

- BAE Systems
- SEON
- CYCURA™
- EASY MILE
- FLEET FREEDOM
- PW Transit Canada
- Nova Bus
- Stantec
- City View
- DICAN
- UBC
- Calgary
- UQTR
- NAVYA
- FP Innovations
- LeddarTech
- Bombardier
- University of Alberta
- ABB
- Phaeton
- TrustPoint Innovation
- The City of Edmonton
- Cradlepoint
- KARSAN
- Pantonium
Project 4: Low-Vacuum Environment Ultra-High-Speed Transportation
Project 4: Low-Vacuum Environment Ultra-High-Speed Transportation

**TECHNOLOGY OVERVIEW**

**Vehicle subsystems**
- Axial compressor: to bypass air flow
- Cabin air system: similar to aircraft air system
- Linear magnetic propulsion drive
- Active magnetic levitation
- Pressurization and thermal management

**TransPod advantages**
- Aircraft-based control system
- Reduced tube infrastructure cost, from innovative tube design
- Advanced power-transmission system for high-speed
- Artificial intelligence-based stability mechanism
Project 4: Low-Vacuum Environment Ultra-High-Speed Transportation

APPLICATION: PASSENGER TRANSPORTATION

Economy Class

Business Class

Luxury Class

Safer

• The technology doesn’t require any human intervention to operate, reducing accidents caused by human error.
• A reduction in the use of cars and other forms of transportation will have a direct impact on saving lives.

More convenient

• Hyperloop pods are expected to arrive at frequent intervals, making it easy to go to the departure stations whenever you need to.
• No more worrying about missing your flight, or being bumped. More trips mean more flexibility.

Social impact

• Improved work-life balance. Less time in traffic means more time for the important things in life.
• Solves affordable housing, aging infrastructure and other urban issues.
Project 5: Ontario-Quebec Hydrail Connection: Zero-Emissions Passenger Rail
National Alliances In Progress

- **British Columbia**
- **Ontario**
- **Quebec**
- **Manitoba**
- **United States**

- **CHFCA**
- **Ontario Centres of Excellence**
- **Innov'EE**
- **Vehicle Technology Center**
- **Center for Transportation and the Environment (CTE)**

*Low Carbon Smart Mobility Innovation Supercluster Consortium -- Supergrappe D’Innovation en Mobilité Durable et Intelligente*
Next Steps

June 15 - July 7
Draft letters of commitment sent to members & core stakeholders

July 7-14
Revisions of letters. One-on-one clarification meetings. Project specific webinar updates.

July 14-20
Full proposal completion; shared with signatories.

August-October

Fall 2017
Contact

Manitoba and Western Provinces
Lana Sanderson lana.sanderson@cutric-crituc.org

East of Manitoba
Joshua Goodfield joshua.goodfield@cutric-crituc.org
Techno-economic modeling of an electric bus demonstration project in BC Translink Route #100

- Pouya Amid
- Mojtaba Lajevardi
- Anaissia Franca
- Curran Crawford

01 March 2017

Revised version 2: 28th June 2017
Outline

• Routes and duty cycles
• E-bus energy consumption and charging power calculations
• Charging infrastructure modeling
• Modeling comparative diesel bus fuel consumption
• Electricity costs estimations and simulation results for each route
Routes and duty cycles

• Routes’ statistics & topography
• Elevation profile
• Duty cycles development
• Example duty cycles
## Routes’ Statistics

<table>
<thead>
<tr>
<th>Length of Route (Km)</th>
<th>Estimated time (min)</th>
<th>Number of major bus stops</th>
<th>Number of all bus stops</th>
<th>Number of traffic lights</th>
<th>Number of stop signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>40</td>
<td>5</td>
<td>44</td>
<td>25</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Translink # 100 (East ward)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
</tr>
</tbody>
</table>
Route’s topography

- Used Google Earth to define the path (.kml files)
- Calculated the distances between the nodes
Elevation profile

- Used DEM database\(^1\) to obtain the raw data for elevations
- Used filtration/smoothing to obtain realistic road grades (multiple steps of Savitzky-Golay filter)

\(^1\) - https://nationalmap.gov/elevation.html
Duty cycles development

- Light duty cycle
  - Constant velocity, no stop

![Speed profile for light duty cycle - Translink 100](image)
Duty cycles development

• Medium duty cycle
  • Stop for all scheduled (major) bus stops
  • Additional stops at 50% of other stops: randomly selected from all the traffic lights, stops signs, passenger walks and other (unscheduled) bus stops
Duty cycles development

- Heavy duty cycle
  - Stop for all bus stops (scheduled/unscheduled), traffic lights, stop signs and additional stopping for pedestrians
Example duty cycles

- Some useful statistics about duty cycles

<table>
<thead>
<tr>
<th>Name of route</th>
<th>Type of duty cycle</th>
<th>Average speed (km/hr)</th>
<th>Average moving speed (km/hr)</th>
<th>Average Acceleration (m/s²)</th>
<th>Max Acceleration (m/s²)</th>
<th>Average Deceleration (m/s²)</th>
<th>Max Deceleration (m/s²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Translink bus # 100 (East)</td>
<td>Light duty cycle</td>
<td>24.47</td>
<td>24.66</td>
<td>0.22</td>
<td>0.23</td>
<td>0.22</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>Medium duty cycle</td>
<td>25.19</td>
<td>26.10</td>
<td>0.40</td>
<td>0.61</td>
<td>0.38</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>Heavy duty cycle</td>
<td>20.36</td>
<td>21.34</td>
<td>0.66</td>
<td>0.73</td>
<td>0.76</td>
<td>0.83</td>
</tr>
<tr>
<td>Translink bus # 100 (West)</td>
<td>Light duty cycle</td>
<td>24.55</td>
<td>24.66</td>
<td>0.22</td>
<td>0.23</td>
<td>0.22</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>Medium duty cycle</td>
<td>22.42</td>
<td>23.40</td>
<td>0.42</td>
<td>0.63</td>
<td>0.42</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>Heavy duty cycle</td>
<td>20.42</td>
<td>21.35</td>
<td>0.66</td>
<td>0.76</td>
<td>0.76</td>
<td>0.85</td>
</tr>
</tbody>
</table>
Ebus energy consumption and charging power calculations

• Modeling methodology
• Energy consumption
# Energy consumption – Route 100 (200 kWh)

**Translink**

<table>
<thead>
<tr>
<th>Duty Level</th>
<th>kWh per km</th>
<th>Total kWh used</th>
<th>SOC at route end</th>
<th>kWh per km</th>
<th>Total kWh used</th>
<th>SOC at route end</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ideal</td>
<td>High Power NMC</td>
<td>High Energy NMC</td>
<td></td>
</tr>
<tr>
<td>Light duty</td>
<td>0.92</td>
<td>14.04</td>
<td>93%</td>
<td>83%</td>
<td>88%</td>
<td>0.73</td>
</tr>
<tr>
<td>Medium duty</td>
<td>1.64</td>
<td>24.97</td>
<td>87.5%</td>
<td>77.5%</td>
<td>82.5%</td>
<td>1.44</td>
</tr>
<tr>
<td>Heavy duty</td>
<td>2.17</td>
<td>33.11</td>
<td>83.4%</td>
<td>73.4%</td>
<td>78.4%</td>
<td>2.05</td>
</tr>
</tbody>
</table>

Note: Ideal battery initial SOC = 100%, High Power battery initial SOC = 90%, High Energy Battery initial SOC = 95%
# Energy consumption – Route 100 (76 kWh)
## Translink

<table>
<thead>
<tr>
<th></th>
<th>East direction</th>
<th></th>
<th>West direction</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kWh per km</td>
<td>Total kWh used</td>
<td>SOC at route end</td>
<td>kWh per km</td>
</tr>
<tr>
<td></td>
<td>Ideal</td>
<td>High Power NMC</td>
<td>High Energy NMC</td>
<td>Ideal</td>
</tr>
<tr>
<td>Light duty</td>
<td>0.90</td>
<td>13.71</td>
<td>81.9% 71.9% 76.9%</td>
<td>0.71</td>
</tr>
<tr>
<td>Medium duty</td>
<td>1.59</td>
<td>24.21</td>
<td>68.1% 58.1% 63.1%</td>
<td>1.40</td>
</tr>
<tr>
<td>Heavy duty</td>
<td>2.13</td>
<td>32.46</td>
<td>57.3% 47.3% 52.2%</td>
<td>2.03</td>
</tr>
</tbody>
</table>

Note: Ideal battery initial SOC = 100%, High Power battery initial SOC = 90%, High Energy Battery initial SOC = 95%
Charging infrastructure modeling

Estimation for the charging times
Estimation of power drawn from the grid
### Electricity demand—Route 100 (200 kWh)
Translink, 450 kW charger

<table>
<thead>
<tr>
<th></th>
<th>East direction</th>
<th>West direction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Charging time (min)</td>
<td>Energy from the grid (kWh)</td>
</tr>
<tr>
<td>Light duty</td>
<td>1.87</td>
<td>15.44</td>
</tr>
<tr>
<td>Medium duty</td>
<td>3.33</td>
<td>27.47</td>
</tr>
<tr>
<td>Heavy duty</td>
<td>4.41</td>
<td>36.42</td>
</tr>
</tbody>
</table>
Electricity demand– Route 100 (76 kWh)  
Translink, 450 kW charger

<table>
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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Charging time (min)</td>
<td>Energy from the grid (kWh)</td>
</tr>
<tr>
<td>Light duty</td>
<td>1.83</td>
<td>15.08</td>
</tr>
<tr>
<td>Medium duty</td>
<td>3.23</td>
<td>26.63</td>
</tr>
<tr>
<td>Heavy duty</td>
<td>4.33</td>
<td>35.70</td>
</tr>
</tbody>
</table>
Modeling comparative diesel bus fuel consumption
Modeling fuel consumption

• Road load calculation is the core task in this computation process

• The road load is the result of the vehicle interaction with the surrounding environment

• Parametric model of engine efficiency used to compute the fuel consumption under various operational conditions
Simulating fuel consumption under light, medium, and heavy duty cycles for Translink route 100
# Fuel consumption - Route 100 Translink

<table>
<thead>
<tr>
<th>Route 100</th>
<th>Light-Duty</th>
<th>Medium-Duty</th>
<th>Heavy-Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel used per run (L)</td>
<td>8.93</td>
<td>13.14</td>
<td>19.92</td>
</tr>
<tr>
<td>Fuel efficiency of diesel equivalent (L/100km)</td>
<td>27.90</td>
<td>40.85</td>
<td>61.80</td>
</tr>
<tr>
<td>On-road CO2 reduction per year (kg) *</td>
<td>146,654</td>
<td>215,248</td>
<td>325,860</td>
</tr>
<tr>
<td>Diesel cost per year @ diesel (1$/L)</td>
<td>$67,296</td>
<td>$93,586</td>
<td>$121,590</td>
</tr>
<tr>
<td>Diesel cost per year @ diesel (1.16$/L)</td>
<td>$78,064</td>
<td>$108,559</td>
<td>$141,044</td>
</tr>
<tr>
<td>Diesel cost per year @ diesel (1.34$/L)</td>
<td>$89,773</td>
<td>$124,843</td>
<td>$162,201</td>
</tr>
</tbody>
</table>

*Only on-road CO2 emission was considered and upstream diesel emission was neglected*
Electricity costs estimations

BC Hydro rates
Charging costs
Number of run for each route

- Looked at bus’ schedules, determined hours of service per weekdays, Saturday and Sunday
- Assumed a 10 minute break between each run plus the charging time
- Calculated maximum number of runs per day
- Generated a charging schedule to know at what time the buses recharge their batteries
BC Hydro rate

- Because chargers use > 150 kW, subjected to large general service customers
- Basic charge (per day) $C_B$: $0.2429$
- Demand charge (per month) $C_D$:
  \[
  \$11.21 \times (450\, \text{kW} \times \frac{t_{\text{charge}}}{15\, \text{min}})
  \]
- Energy charge (per month) $C_E$:
  \[
  C_E = (E_{\text{month}}) \times 0.0550
  \]

$E_{\text{month}}$ is the amount of kWh consumed per month
BC Hydro rate

• Discount: 1.5% on entire electricity bill $C_{Elec\,Bill}$
• Rate ride: 5% on entire electricity bill $C_{Elec\,Bill}$
• GST and PST: 12% on the final bill
• Transformer owner discount (per kW): $-0.25

• The total price of electricity per year $C_{Tot}$ is:

\[
C_{Elec\,Bill} = 365 \times C_B + (C_D + C_E) \times 12
\]
\[
C_{Tot} = C_{Elec\,Bill} \times (1 - 0.015) \times (1 + 0.05) \times (1 + 0.12) - 0.25 \times 450
\]
## Charging costs – Route 100 Translink (200 kWh) assume 2 chargers

<table>
<thead>
<tr>
<th></th>
<th>Light</th>
<th>Medium</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly MWh estimated</td>
<td>219.0</td>
<td>369.51</td>
<td>456.16</td>
</tr>
<tr>
<td>Basic cost (CAD $)</td>
<td>$177</td>
<td>$177</td>
<td>$177</td>
</tr>
<tr>
<td>Demand cost (CAD $)</td>
<td>$14,205</td>
<td>$26,635</td>
<td>$36,522</td>
</tr>
<tr>
<td>Energy charge (CAD $)</td>
<td>$12,045</td>
<td>$20,323</td>
<td>$25,089</td>
</tr>
<tr>
<td>Electricity cost (CAD $)</td>
<td>$26,427</td>
<td>$47,135</td>
<td>$61,788</td>
</tr>
<tr>
<td>Total charging cost for a year (CAD $)</td>
<td>$30,499</td>
<td>$54,487</td>
<td>$71,460</td>
</tr>
<tr>
<td>Diesel cost for a year (CAD $) @ diesel (1.16$/L)</td>
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</tr>
<tr>
<td><strong>Benefits (CAD $) @ diesel (1.16$/L)</strong></td>
<td>$47,565</td>
<td>$54,072</td>
<td>$69,584</td>
</tr>
<tr>
<td><strong>Benefits (CAD $) @ diesel (1.34$/L)</strong></td>
<td>$59,274</td>
<td>$70,356</td>
<td>$90,741</td>
</tr>
</tbody>
</table>
### Charging costs – Route 100 Translink (76kWh)

**assume 2 chargers**

<table>
<thead>
<tr>
<th></th>
<th>Light</th>
<th>Medium</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly MWh estimated</td>
<td>212.4</td>
<td>358.5</td>
<td>457.8</td>
</tr>
<tr>
<td>Basic cost (CAD $)</td>
<td>$177</td>
<td>$177</td>
<td>$177</td>
</tr>
<tr>
<td>Demand cost (CAD $)</td>
<td>$13,882</td>
<td>$25,828</td>
<td>$35,957</td>
</tr>
<tr>
<td>Energy charge (CAD $)</td>
<td>$11,682</td>
<td>$19,718</td>
<td>$25,179</td>
</tr>
<tr>
<td>Energy cost (CAD $)</td>
<td>$25,741</td>
<td>$45,723</td>
<td>$61,313</td>
</tr>
<tr>
<td>Total charging cost for a year (CAD $)</td>
<td>$29,705</td>
<td>$52,581</td>
<td>$70,910</td>
</tr>
<tr>
<td>Diesel cost for a year (CAD $) @ diesel (1.16$/lit)</td>
<td>$78,064</td>
<td>$108,559</td>
<td>$141,044</td>
</tr>
<tr>
<td>Diesel cost for a year (CAD $) @ diesel (1.34$/lit)</td>
<td>$89,773</td>
<td>$124,843</td>
<td>$162,201</td>
</tr>
<tr>
<td><strong>Benefits (CAD $) @ diesel (1.16$/lit)</strong></td>
<td>$48,359</td>
<td>$55,708</td>
<td>$70,134</td>
</tr>
<tr>
<td><strong>Benefits (CAD $) @ diesel (1.34$/lit)</strong></td>
<td>$60,068</td>
<td>$71,992</td>
<td>$91,291</td>
</tr>
</tbody>
</table>
Thank you!