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Durham Region Transit Report

To:	Durham Region Transit Executive Committee
From:	General Manager, Durham Region Transit
Report:	#2023-DRT-12
Date:	May 03, 2023

Subject:

E-Mission Zero – Highlights Electric Transit Buses

Recommendations:

That the Transit Executive Committee recommends

That this report be received for information.

Report:

1. Purpose

1.1 The report provides general information on electric transit buses, including key highlights and operational and technical data.

1.2 The report also provides a summary of the Canada Infrastructure Bank's (CIB's) credit agreement and overview of the Infrastructure Canada – Zero Emissions Transit Fund (ZETF) funding program

2. Background

2.1 In March 2021, Council approved the Corporate Climate Action Plan (CCAP) with targets to reduce corporate GHG emissions by 100 per cent by 2045. This includes the transition of corporate fleets, such as public transit vehicles, to low carbon alternatives. Furthermore, the 2022 Annual Corporate Climate Change

Action Plan reported that Transit accounted for 10 per cent of the Region's total corporate GHG emissions in 2020.

2.2 In August 2021 the Region launched the E-Mission Durham program focused on a cleaner, low-carbon future by supporting and empowering Durham residents in making the transition to lower and zero emission vehicles. As part of these efforts, DRT's E-Mission Zero program aims to adopt zero emission vehicles in its fleet to help reduce overall GHG emissions from the transportation sector in Durham.

2.3 DRT's E-Mission Zero strategy includes a suite of emission-reducing initiatives intended to deliver a more sustainable network of vehicles, infrastructure and facilities over the next 25 years.

2.4 In June 2022, Council approved the DRT E-Mission Zero Fleet Electrification Plan to transition the Transit fleet vehicles to zero emission technologies by 2037, with the procurement of only electric buses starting in 2024

2.5 The CIB has developed a Zero Emission Buses Initiative, a $1.5 billion dollar program, with the objective of accelerating zero emission bus (ZEB) adoption across Canada, offering low interest debt financing to cover a portion of the capital costs associated with electric buses.

2.6 The CIB program is offered in coordination with Infrastructure Canada's Zero Emission Transit Fund (ZETF) grant program to bridge the funding gap for buses and charging infrastructure

2.7 In March 2023, Durham Region executed a credit agreement with the CIB for low-interest financing for up to $62 million, to support the purchase of 98 electric buses

3. Previous Reports and Decisions

3.1 On June 29, 2022, Regional Council received report #2022-F-17 E-Mission Zero - DRT Fleet Electrification Plan and referred to Durham Region Transit's long-term servicing and financing strategy to be presented in advance of the 2023 Business Plans and Budget.

3.2 On March 1, 2023, Regional Council approved report #2023-F-5 Transit Service and Financing Strategy.

4. Electric Bus Highlights

4.1 On an battery electric bus (BEB), the traditional internal combustion engine (ICE) and transmission is replaced with an electric motor, powertrain system controllers and batteries.

- Cost: The purchase price of a 12-metre electric transit bus currently ranges between $1.4 million to $1.6 million, or approximately twice the cost of an equivalent ICE diesel bus. The capital cost of electric transit buses is expected to reduce over time as battery technology improves and their costs decline.
- Range: BEB's currently operate up to 350 kilometers on a full charge. However, range is affected by a variety of factors, including battery size and bus duty cycle
- Efficiency: BEB's are two and a half to five times more efficient than an equivalent ICE diesel bus, resulting in a lower operating cost per kilometer.
- Factors impacting range and fuel economy: Range and efficiency of BEB's are affected by many variables including road conditions, driver behaviours, vehicle speed, frequency of stops/starts, topography, weight, weather, on-board systems such as Heating Ventilation and Air Conditioning (HVAC) and auxiliary heating units, and more
- Charge time: BEB's require between three to four hours to fully charge, depending on the battery size and charging equipment. BEB's can be charged using a plug-in charger or overhead pantograph charger that vary in function and power output (between 150kW to 450kW)
- When considering life cycle carbon emissions, BEB's buses are currently the cleanest buses available. Each battery electric bus is estimated to avoid approximately 70-100 tonnes of carbon emissions annually.
- Maintenance costs: BEB's contain few mechanical parts, which have been shown to reduce maintenance costs by approximately 20 to 30 percent compared to an equivalent ICE diesel bus.
- Noise: BEB's deliver a quieter ride for customers, with noise levels measured at 5db(A) to 14 db(A) at low speeds compared to an equivalent ICE diesel bus.
- Annual operating data and savings (estimated based on 60,000km's and 2023 rates):
    - Maintenance and servicing savings per BEB[1]: $21,000

[1] Average maintenance costs of $1.02/km for diesel buses and $0.67/km for electric buses

- Diesel fuel avoidance per BEB[2]: 28,800 liters or $47,800
- Electricity costs per BEB[3]: $11,600
- Net fuel savings per BEB: $36,200

4.2 Although annual savings are expected, significant upfront capital investments are required to purchase the buses and install the electrical infrastructure and charging equipment required to power the fleet.

4.3 Key challenges reported by agencies operating BEB's have included limited range on a single charge, charging time and impact on range and efficiency due to cold temperatures.

4.4 Detailed technical specifications for electric buses from Canadian BEB manufacturers (Nova Bus and New Flyer) are attached to this report.

5. Financing and Funding

Canada Infrastructure Bank

5.1 Durham Region has executed a credit agreement with the Canada Infrastructure Bank (CIB) for low-interest financing for up to $62 million, which will be available to be drawn upon until December 31, 2027

5.2 The credit facility size was determined using CIB's financial model that calculates a baseline of forecasted operating savings for electric buses compared to diesel buses over the full life cycle of the buses, based on a set of mutually agreed upon parameters by both parties (ie. annual mileage, fuel economy, electricity prices and maintenance costs).

5.3 The financing is offered at an interest rate of 1% interest annually, charged only on the money drawn from the credit facility.

5.4 The parties agreed on a multi-year Zero Emission Bus (ZEB) implementation schedule (98 electric buses deployed between 2024-2026), which ensures the financing is available for multiple draws over the implementation period.

5.5 The repayment term is 12 years for each draw down on the credit facility, based on the lifecycle of the ZEBs. The credit term is scheduled to end in Jan 31, 2039.

[2] Diesel bus fuel economy of 0.48L/km and 2023 diesel fuel cost of $1.66/L
[3] Electric bus fuel economy of 1.61kwh/km and 2023 electricity cost of 0.12$/kwh

5.6 The CIB's investment will contribute a portion towards the difference between the capital acquisition cost of a traditional ICE diesel bus and a BEB, with repayment of the loan based on the operating savings realized by DRT. The CIB and DRT share in the risk of the actual cost savings being less than forecast

5.7 DRT will be required to budget for the operating costs of the allotted number of diesel buses through the term of this agreement.

Infrastructure Canada – Zero Emissions Transit Fund

5.8 Infrastructure Canada launched the $2.75 billion Zero Emission Transit Fund (ZETF) in 2021. A five-year national program through 2026, ZETF provides grant funding to public transit and school bus operators across Canada towards the purchase of zero emission public transit and school buses and associated infrastructure. The fund is part of the Federal government's commitment to help purchase 5,000 zero emission buses over the next five years.

5.9 With the support of the Finance department, DRT has submitted an application to Infrastructure Canada for capital grants to support the electrification program, including the construction of the new transit facility – 2400 Thornton N.

5.10 The maximum grant contribution from Infrastructure Canada is up to fifty per cent (50 per cent) of the total eligible costs.

6. Relationship to Strategic Plan

6.1 This report aligns with/addresses the following strategic goals and priorities in the Durham Region Strategic Plan:

A. Environmental Sustainability
   a. Goal 1.1 - Accelerate the adoption of green technologies and clean energy solutions through strategic partnerships and investment
   b. Goal 1.4 - Demonstrate leadership in sustainability and addressing climate change

B. Economic Prosperity
   a. Goal 3.4 - Capitalize on Durham's strengths in key economic sectors to attract high-quality jobs

7. Conclusion

The transition to a zero-emission transit fleet is crucial to the Region achieving its emission targets specified in the Corporate Climate Action Plan, and provides an

opportunity for DRT to modernize its transit operations and infrastructure. While some data has been generated by the industry, BEB's are a young technology in North America and DRT will experience many key learnings over the first few years of implementing the new technologies.

8. Attachments

Attachment #1: Nova Bus LFSe+_Specifications

Attachment #2: Xcelsior Charge NG_Specifications

Respectfully submitted,

Original Signed By:

Bill Holmes
General Manger, DRT

Recommended for Presentation to the Committee

Original Signed By:

Elaine C. Baxter-Trahair
Chief Administrative Officer

Attachment #1: Nova Bus LFSe+_Specifications

LFSe+

Powered by BAE Systems

Powerful
Robust
Versatile

The long-range battery electric vehicle the industry has been looking for.

NOVABUS

bring life to your city

For more information, visit
novabus.com

Attachment #1: Nova Bus LFSe+_Specifications

Highlights

Measurements

Length	40' (12.19m)
Width	102'' (2.59m)
Height	10' 8'' (3.30m)
Interior height	93 inches excluding rear axle, 74 inches over rear axle
Wheelbase	244 inches (Front to rear axle)

Propulsion

Motor	BAE Systems HDS200
Rated power	200 kW
Rated torque	5200 N·m

Seating capacity

Seating capacity	Up to 41 passengers
Loading capacity	Up to 59 passengers (6 batteries configuration) Up to 68 passengers (4 batteries configuration)

Body features

Structure	Stainless steel
Outside shell	Fiberglass and thermoplastic skirt panels

Turning radius

Turning radius	40' 10'' (12.45m)

Main components

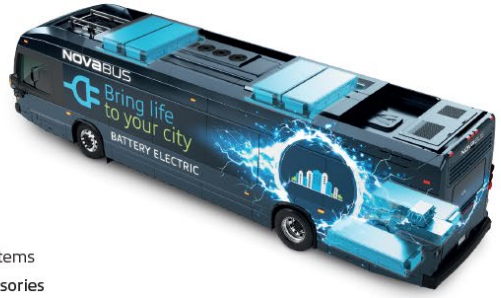
Flooring	Maintenance-free composite floor
HVAC	Mobile Climate Cotrol Eco 136e electric
Cooling system	Nova eCooling system
Axles	ZF RL-82A (Front), ZF AV-133 (Rear)
Brakes	Regenerative braking with ABS all-wheel disc brakes
Electrical system	Volvo multiplex system (VBEA)

1 800 350-6682 | novabus.com

March 2021

Powered by BAE Systems

To deliver on our promise to provide the most efficient and reliable long-range electric-powered buses, we have equipped our new LFSe+ model with BAE Systems' innovative electric technology.



Key features

- **Proven HDS200 motor** from BAE Systems
- Zero emissions with **all electric accessories**
- Modular battery options capable of storing **up to 564 kWh of onboard energy**

In June 2018, the electric vehicle of the LFS platform became the first electric bus to receive a passing score for a full test at Altoona.

Nova Bus has earned the highest reputation for overcoming the challenges of modern city transportation by manufacturing robust products that have become known as the industry workhorses: the LFS range of buses.

Dual charging options

	Overhead	Plug-in
Charging system	SAE J3105	CCS type 1, J1772
Charging power (maximum)	450 kW	150 kW
On-route charging	6 minutes for a 35 kWh boost	n/a
Depot charging	**Less than 3.25 hours** for a full charge using either the overhead or plug-in charging option at the depot.	

NOVABUS / LFSe+

Powered by BAE Systems

Attachment #2: Xcelsior Charge NG_Specifications

Xcelsior CHARGE NG™ is New Flyer's next generation battery-electric, zero-emission bus. It is lighter, simpler, has longer range with better energy recovery and is smart city capable – making it the most advanced electric bus on the market.

Available in 3 Lengths

Three distinct technology advancements to deliver a high-performance bus.

High-Energy Batteries

Next generation high-energy batteries.

Battery Packaging

Advanced protective battery packaging designed for easy installation and streamlined maintenance.

Traction Propulsion System

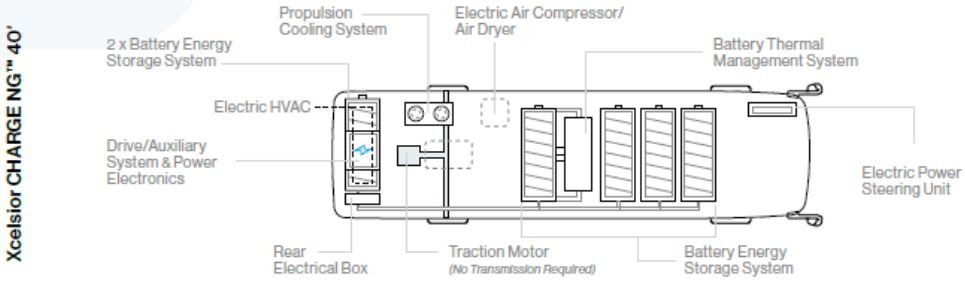
A new lightweight electric traction propulsion system with up to 90% energy recovery.

newflyer.com/NG

Attachment #2: Xcelsior Charge NG_Specifications

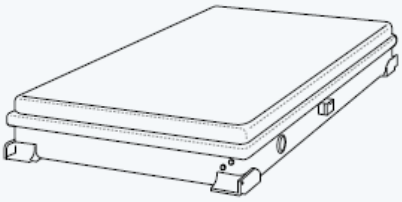
How it works.

The Xcelsior CHARGE NG™ uses an electric motor powered by energy stored in rechargeable batteries.



Technology advancements.

1 More efficient and streamlined battery enclosure.



A standardized waterproof battery enclosure is mounted on the rooftop and in the propulsion compartment using a "plug and play" approach, lending simplicity and efficiency in design, install, maintenance and manufacturing.

Rooftop application uses a modular approach with a simplified mounting system comprised of two rails running the length of the bus.

The same standardized battery enclosure is also mounted in the propulsion compartment on a rack. With this approach, the same battery enclosure can be mounted in any position on the bus.

Simpler

- One simple and standardized approach for better quality, consistency, and accuracy.
- If a battery needs to be replaced, the module can be removed and replaced with a new/backup module. The module needing troubleshooting can be serviced in the shop while the bus with the new/backup module onboard returns to service.
- With every battery having the same enclosure, service manuals are the same for every single bus model and length.
- Service parts are reduced by 90% going from 250 to less than 50 parts.

Waterproof

- With an ingress protection rating of IP67, the battery enclosure is 100% waterproof if submerged in water, which greatly reduces the likelihood of water leaking into the battery enclosure.
- With an ingress protection rating of IP69 for dust, high temperatures, and high-pressure washing, there is 100% protection from intrusion of dust or water particles. This is ideal for demanding operating conditions, and situations where sanitization and rigorous cleaning is undertaken.

More Efficient

- Modules are better insulated resulting in better management of battery temperature for optimal performance.

Easier to Service

- The casings are built using a reinforced composite fiber that is non-conductive.
- Service technicians can simply and safely plug in or unplug the battery module with less exposure to high-voltage electricity.

Lighter

- The standardized battery enclosure is lighter in weight, increasing the maximum passenger capacity on the bus by 4 additional standees.

2 High-grade Siemens traction system.

ELFA 3 is Siemens' next generation traction system that introduces a more efficient design with compact inverters and embedded drive controllers.

Safer

It's easier and safer to maintain with shorter cable runs and touch-safe high voltage connections.

Smaller

It's smaller and lighter allowing for increased passenger capacity.

More Efficient

- Minimal rack requiring no covers.
- Shorter cable runs offer decreased risk of issues or faults, improved electromagnetic compatibility (EMC) and greater power efficiency.
- Delivers up to 90% energy recuperation.
- Delivers smooth, quiet, emission-free driving (with no engine noise, no idling, and zero local emissions).
- Better torque accuracy.

3 Next generation, high-energy batteries.

The batteries are made of world-class energy storage systems (ESS), engineered for safe, robust, and reliable use in transit.

The battery chemistry is Lithium Nickel Manganese Cobalt (NMC), providing the best balance of energy, power, safety, and life.

More Energy

- 13% more energy available.
- Greater capture of regenerative energy (during braking at top state of charge).

Extended Range

Range is extended by 13% without compromising quality.

CONNECT 360

Connect 360™ is included on every new Xcelsior CHARGE NG™. Learn more at **nfigroup.com/connect**.

- **Additional range** capability with improved driver performance.
- **Decision-making information** to optimize charging strategies.
- **Intelligence** on how to preserve battery energy throughout the day.
- **Reduced operating cost** and maximum fleet utilization.

Connect 360™, operated by NFI Connect™, is a customizable performance dashboard that provides smart analytic reporting to expand insight and intelligence for managing your Xcelsior CHARGE NG™ battery-electric bus.

Attachment #2: Xcelsior Charge NG_Specifications

Charging.

New Flyer buses are interoperable with charging equipment that supports all heavy-duty electric vehicles. You can customize your Energy Storage Systems (ESS) and charging solutions so you can develop the right ESS and infrastructure solution for your needs.

Xcelsior CHARGE NG™ is interoperable with charging systems available from:

SIEMENS ABB chargepoint. heliox

On-Route Charging

The on-route rapid charger provides the means for the Xcelsior CHARGE NG™ to stay in service 24 hours daily. To charge, the bus stops underneath the charger and the pantograph makes contact with the charge bars.

Plug-In Charging

Plug-in chargers are available as a supplement or alternative to on-route rapid chargers and can be used for overnight, mid-day and on-route charging. Depot charging for a full charge requires 3.8 hours for a 520 kWh ESS.

The 40′ Xcelsior CHARGE has a range of up to 258 miles (520 kWh)* on a single charge, but with on-route charging, range is unlimited.

* Range per FTA Altoona test protocol - HVAC off.

Length	ESS (kWh)	Range (Miles)
35′	345	182
	435	224
40′	345	178
	435	221
	520	258
60′	520	152
	605	175

Attachment #2: Xcelsior Charge NG_Specifications

Functionality + accessibility.

Kneeling

SmartRider™ enables kneeling to variable heights and minimizes the slope difference between a low-floor ramp and the bus floor.

Self-Leveling

SmartRider™ ramp achieves a 1:6 slope ratio with a self-leveling feature that can withstand up to 1000lbs.

Capacity

Industry-leading passenger carrying capacity with up to 88 total (40 seated and 44 standees).

NFI Infrastructure Solutions™

NFI Infrastructure Solutions™ is a service dedicated to providing safe, reliable, smart and sustainable charging and mobility solutions.

Learn what Infrastructure Solutions can do for you at **nfigroup.com/IS**

What our Infrastructure Solutions team provides.

Supports mobility projects from start to finish.

Focuses on energy management optimization.

Provides infrastructure planning and development.

Provides cohesive transition of bus fleets to zero-emission electric technology.

Attachment #2: Xcelsior Charge NG_Specifications

Measurements	35′ XE35	40′ XE40	60′ XE60
Length	36' 3" (11.06m) Over bumpers; 35' 6" (10.80m) Over body	41' 0" (12.50m) Over bumpers; 40' 2" (12.24m) Over body	60' 10" (18.54m) Over bumpers; 60' 0" (18.29m) Over body
Width	102" (2.6m)	102" (2.6m)	102" (2.6m)
Roof Height	11' 1" (3.3m) Over charging rails	11' 1" (3.3m) Over charging rails	11' 1" (3.3m) Over charging rails
Step Height	14" (356mm)	14" (356mm)	14" (356mm)
Front Step Height (Kneeled)	10" (264mm)	10" (264mm)	10" (264mm)
Interior Height – Floor to Ceiling	79" (2m) Over front and rear axle; 95" (2.4m) Mid-coach	79" (2m) Over front and rear axle; 95" (2.4m) Mid-coach	79" (2m) Over front and rear axle; 95" (2.4m) Mid-coach
Tire Size	305/70R22.5	305/70R22.5	305/70R22.5
Wheelbase	226.75" (6.8m)	283.75" (7.2m)	229" (6.8m) Front / 293" (7.4m) rear
Propulsion			
Motor	Siemens electric drive system; Standard or optional high gradeability motor	Siemens electric drive system; Standard or optional high gradeability motor	Siemens electric drive system; ZF AVE130 In-wheel motor center drive axle
Rated Power	160 kW	160 kW	320 kW
Rated Torque (*Based on 1:5.67 ratio axle)	1,033 lb-ft	1,033 lb-ft	2,066 lb-ft
Passenger Capacity *Based on 4-string (35'/40') & 6-string (60') ESS configurations, with ELFA 3 Siemens Traction System			
Seats	Up to 32*	Up to 40*	Up to 61 (with one exit door)*
Standees	Up to 36*	Up to 44*	Up to 62 (with one exit door)*
Accessibility			
Doors	2	2	2 or 3 (option for up to 5 doors)
Wheelchair Accessibility	32" (813mm) Wide, 1:6 slope; Flip out NFIL ramp, front door	32" (813mm) wide, 1:6 slope; Flip out NFIL ramp, front door	32" (813mm) wide, 1:6 slope; Flip out NFIL ramp, front door
Wheelchair Locations	2 - Front location, rear location also available (other options available)	2 - Front location, rear location also available (other options available)	2 - Front location, rear location also available (other options available)
Approach Angle			
Approach/Departure/Breakover Angles	9°/9°/12°	9°/9°/9°	9°/9°/12° (front) 9° (back)
Turning Radius (Body, with aluminum wheels; *Varies with wheel type)			
Turning Radius	39' (11.9m)*	43.6' (13.3m)*	42' (12.8m)*
Main Components			
Floor	Marine grade plywood floor; Optional composite floor; Composite rear interior step; Tarabus, Altro, RCA floor covering	Marine grade plywood floor; Optional composite floor; Composite rear interior step; Tarabus, Altro, RCA floor covering	Marine grade plywood floor; Optional composite floor; Composite rear interior step; Tarabus, Altro, RCA floor covering
Electrical System	Parker Vansco	Parker Vansco	Parker Vansco
Propulsion Cooling System	Electric cooling fans	Electric cooling fans	Electric cooling fans
HVAC	Thermo King TE15 (rear)	Thermo King TE15 (rear)	Thermo King RLFE (front) TE15 (rear)
Axles	MAN VOK 07 Front disc brakes; MAN HY-1350 Rear disc brakes; Single reduction axle	MAN VOK 07 Front disc brakes; MAN HY-1350 Rear disc brakes; Single reduction axle	MAN VOK 07 Front disc brakes; ZF AVN 132 Center disc brake; MAN HY-1350 Rear disc brakes; Single reduction axle
Energy Storage System			
Long Range (Rapid charging available)	345 kWh, 435 kWh	345 kWh, 435 kWh, 520 kWh	520 kWh, 605 kWh

NEW FLYER

Attachment #2: Xcelsior Charge NG_Specifications

NEW FLYER.

xcelsior CHARGE NG™

newflyer.com/NG

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Learn more about this technology at the Vehicle Innovation Center
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