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# Electric Buses

*Sustainable Zero-Emission Transit  
Innovation for the Long Run*



August 15, 2018

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# The NFI Group of Companies

## North America's Leading Bus Manufacturer

- **87 Years** of Bus Experience
- **> 5,900** Employees
- **32 Locations** throughout North America
- Manufacture approximately **4,200** buses and coaches, annually\*
  - Delivered **45%** of North American heavy-duty transit buses in 2016
  - Delivered **39%** of North American motor coaches in 2016
- Support **41%** of heavy duty transit buses in service
  - Supply **33%** heavy duty transit bus parts
  - Supply **40%** motor coach parts
- Publicly traded on TSX under the symbol NFI.TO



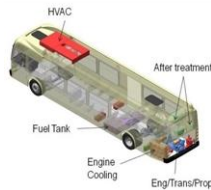
\* Equivalent Units, including ARBOC 2017 estimated deliveries

# Xcelsior Heavy Duty Transit Buses

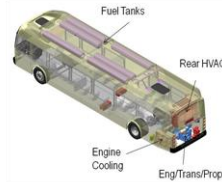
Transforming Your Community with Sustainable, Clean Transit Technology

## LOW EMISSIONS

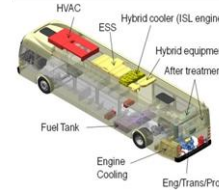
### Clean Diesel



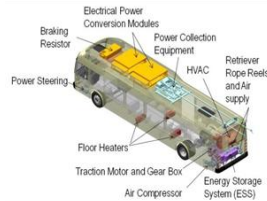
### Natural Gas



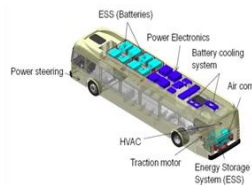
### Hybrid-Electric



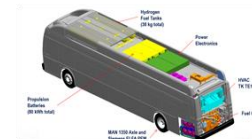
### Electric-Trolley



### **x**xcelsior **CHARGE**



### Hydrogen Fuel-Cell



## ZERO EMISSIONS

## Proven Heavy Duty Transit Bus

- > 10,000 Xcelsior buses delivered and on-order
- Broadest Range of Propulsion Options
- Only Platform with all 3 Types of ZEB
- Built for Accessibility
- Designed for Maintainability
- Flexible Battery Pack Design – Evolves with Battery Technology

# Advancing Innovation in Transit

## Our Zero Emission Technology Roadmap

### Pre-1993:

Conventional Fossil Fuels (Diesel, Gas)  
Early electric trolleys (1960s and 1970s)

### 1993: Electric Trolley

*Delivered to San Francisco MUNI*

### 1994: Compressed Natural Gas

*Delivered to San Diego Transit Commission*

### 1995: Hydrogen Fuel Cell Buses

*Delivered to Vancouver and Chicago*

### 2001: Diesel–Electric Hybrid

*Delivered to Orange County*

### 2012: e-Accessories

*Delivered to Minneapolis Metro*

### 2014: Launch of the Xcelsior® XE40 Electric Bus

*Delivered to Chicago Transit Authority  
Delivered to Winnipeg Transit*

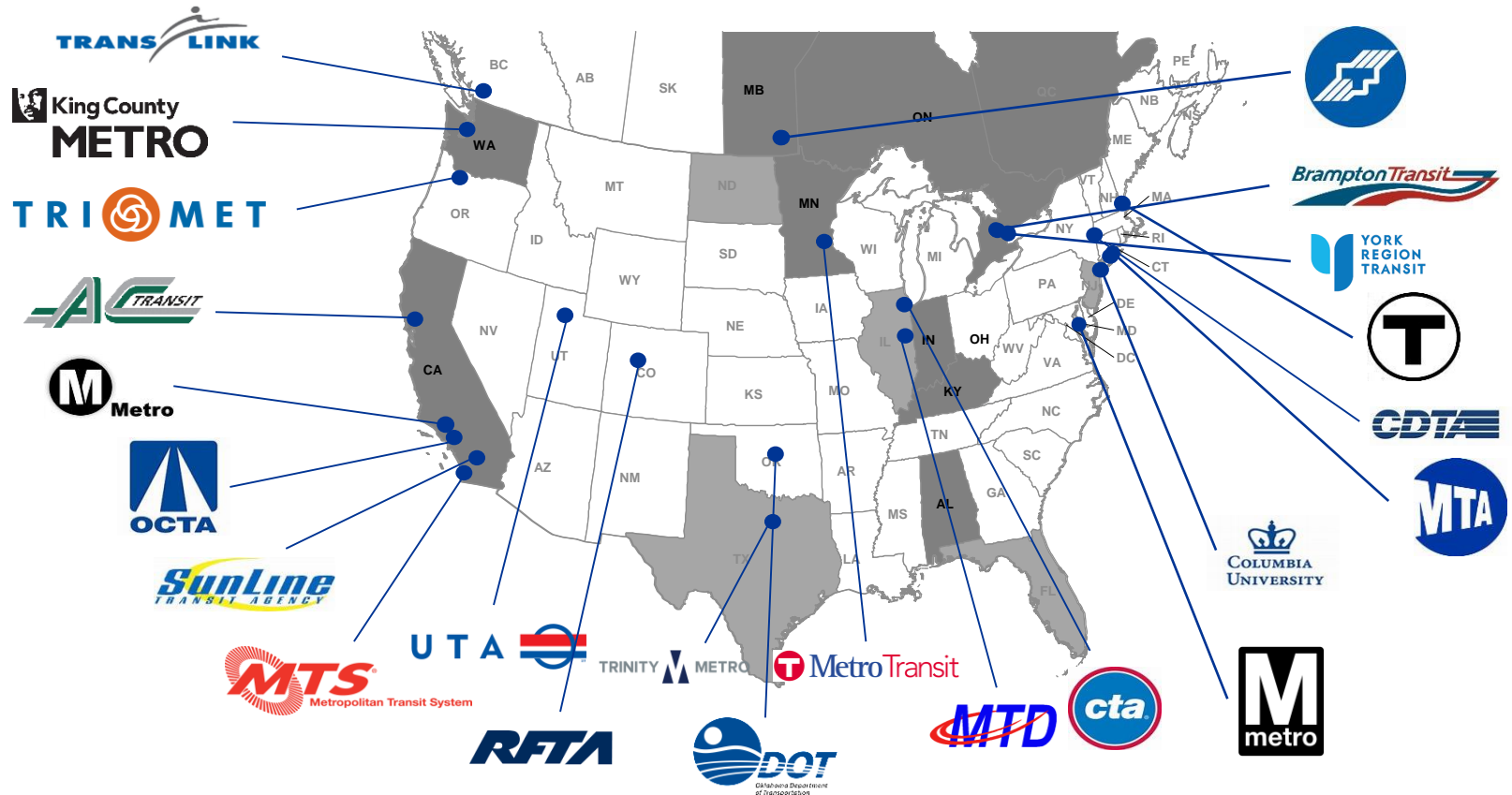
### 2015: Launch of the Xcelsior® XHE60 Fuel Cell Bus (Ballard)

### 2016 – 2017: Launch of the Xcelsior® XHE40 Fuel Cell Bus (Ballard and Hydrogenics)

### 2017: Xcelsior CHARGE™ Launch including Long -Range Batteries, High-Grade Package, Interoperable Depot and On-Route Charging



# New Flyer Electric Bus Programs Expanding Throughout North America





## New Flyer's Fuel Cell Electric Bus is Based on the Xcelsior® Platform



- More than 10,000 Xcelsior buses delivered
- Xcelsior Electric Bus integrates seamlessly with existing fleet equipment and maintenance programs
- Proven and reputable suppliers of Electric components and suppliers
- Smart, environmentally sustainable, operating cost savings
- Flexible battery pack design - evolves with technology advancement

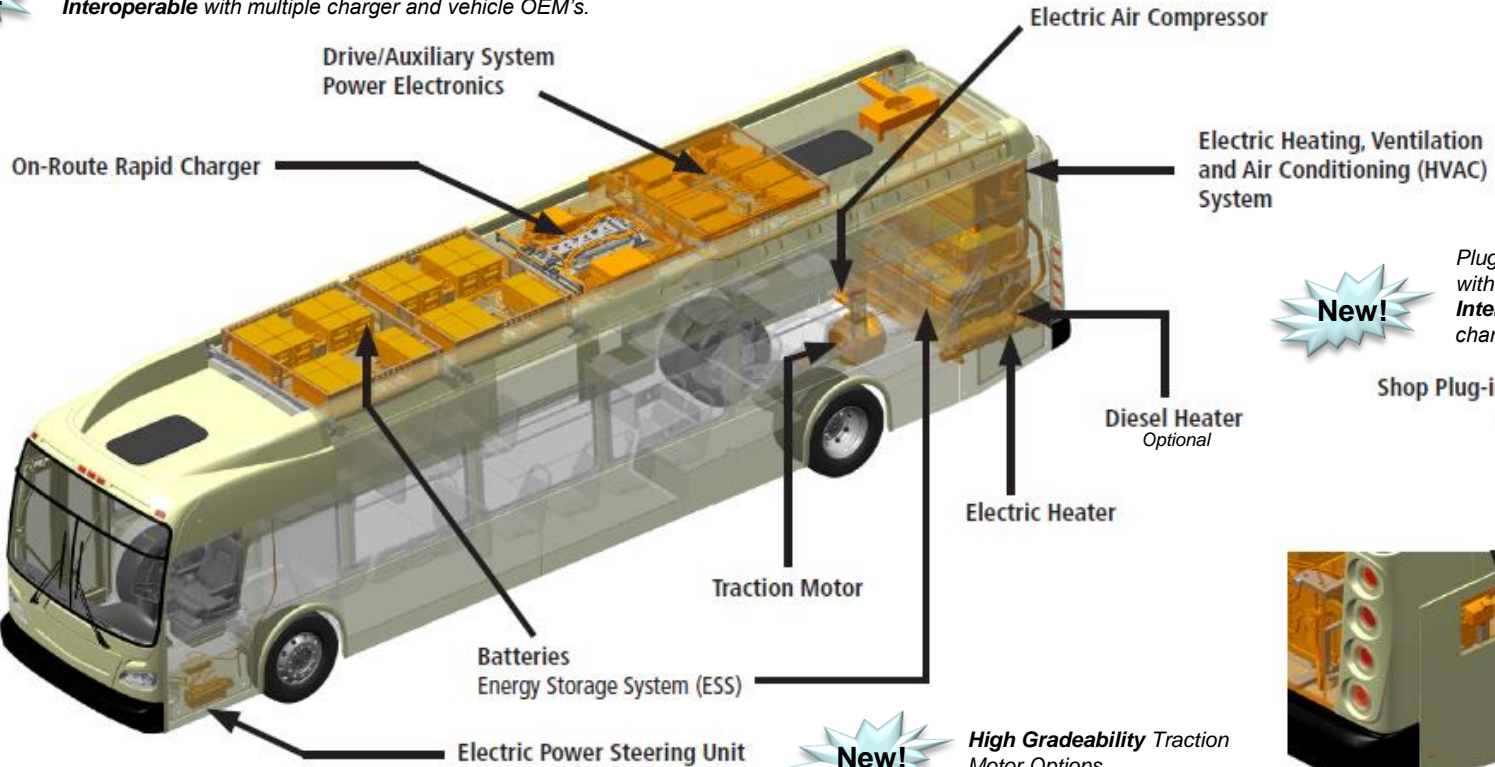


# XE40 Design Highlights

# **xcelSior** CHARGE™

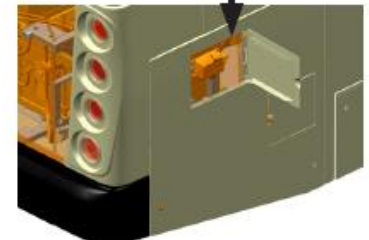


*On-Route Charging Compliant with OppCharge  
Interoperable with multiple charger and vehicle OEM's.*



*Plug In Charging Compliant with SAE Standards  
Interoperable with multiple charger and vehicle OEM's.*

Shop Plug-in Charging Port



*Extended Range and Rapid Charge Energy Storage Configurations*



*High Gradeability Traction Motor Options*

# **xcelSior** CHARGE™

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## **XE35/XE40**

Long Range &  
Rapid Charge



## **XE60**

Long Range &  
Rapid Charge



- XcelSior CHARGE™ is Interoperable, conforming to emerging industry standards
  - SAE J3068 and SAE J1772 compliant depot charging equipment can be used to charge buses, coaches, trucks and cars from other manufacturers
  - Opportunity charging accomplished with **OppCharge compliant fast** charging equipment. Efforts to align with the forthcoming **SAE J3105** (Overhead Fast Charge – Standard under development)
- New Flyer charging equipment available from globally recognized suppliers



# Battery-Electric Bus Range

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- Battery Technology is Improving – Practical Limit for Long-Range buses is 175-225 miles
  - Equating to more energy on-board and greater range
- FTA Altoona tests are conducted without HVAC Loads. **Actual range performance will vary considerably.**
  - HVAC impact to range depends on route speeds, duty cycle and weather conditions. HVAC energy can exceed propulsion energy under some conditions
- Today's Best EV Batteries remain considerably heavier than diesel and CNG fuel/storage systems.
- Batteries deteriorate over time (same phenomenon as a Smartphone battery)
- Battery Electric Bus Range (for the near term) will remain limited by
  - Gross vehicle weight limitations
  - Allowable axle loads
- Range planning for Electric Buses requires a thoughtful and conservative approach for replacing CNG and Diesel type buses – Do the homework and be conservative to ensure a successful one-for-one bus ZEB replacement

1. FTA National Fuel Cell Program – Active Program for (1) XHE60 Battery-Electric Bus with a Ballard Fuel Cell, stainless steel structure, and center driven axle technology for traction challenged applications.



2. California Energy Commission (CEC) – Design and Manufacture (1) XHE40 battery electric bus with a Hydrogenics fuel cell (SunLine Transit Agency)



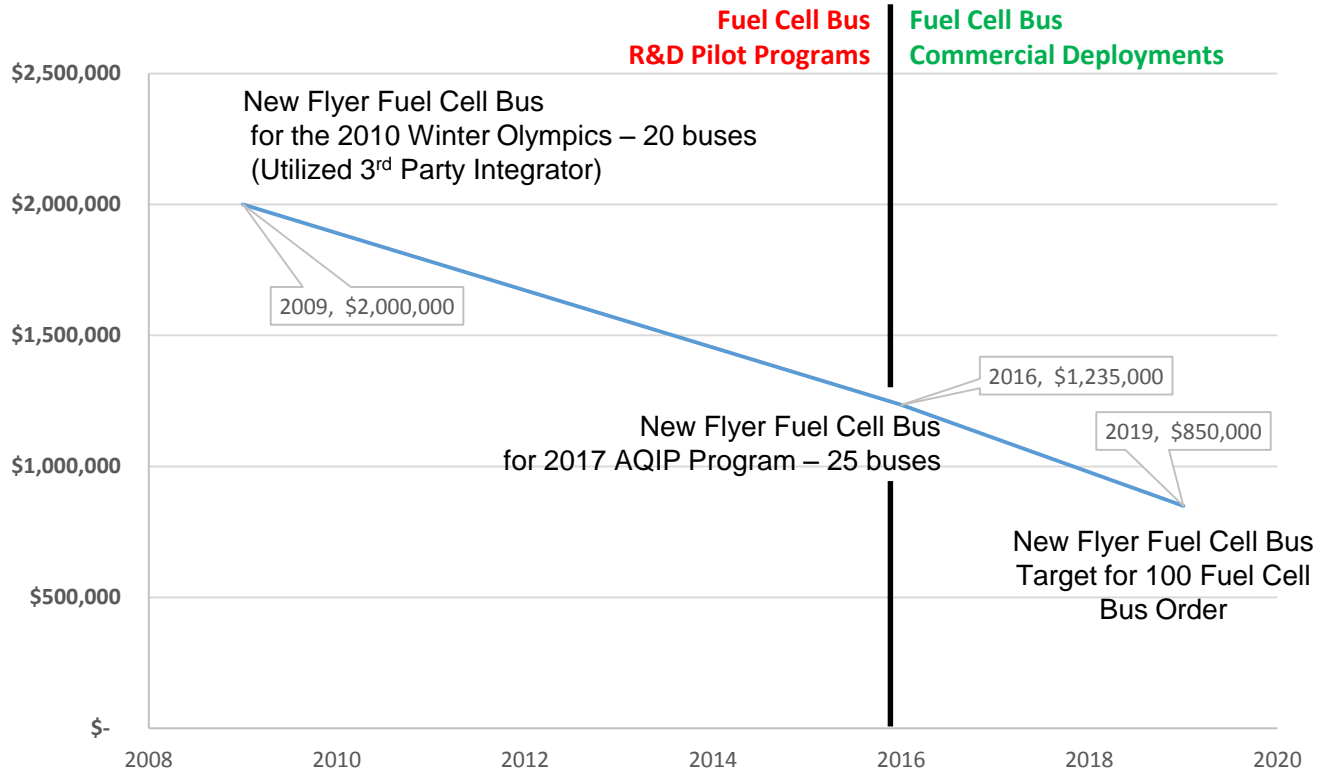
3. California Air Resources Board AQIP Program

- 10 XHE40 Fuel Cell Buses for AC Transit
- 10 XHE40 Fuel Cell Buses for OCTA
- 5 XHE40 Fuel Cell Buses for SunLine





# Fuel Cell Bus Costs Are Declining with Technology Advancements and Manufacturing Volume

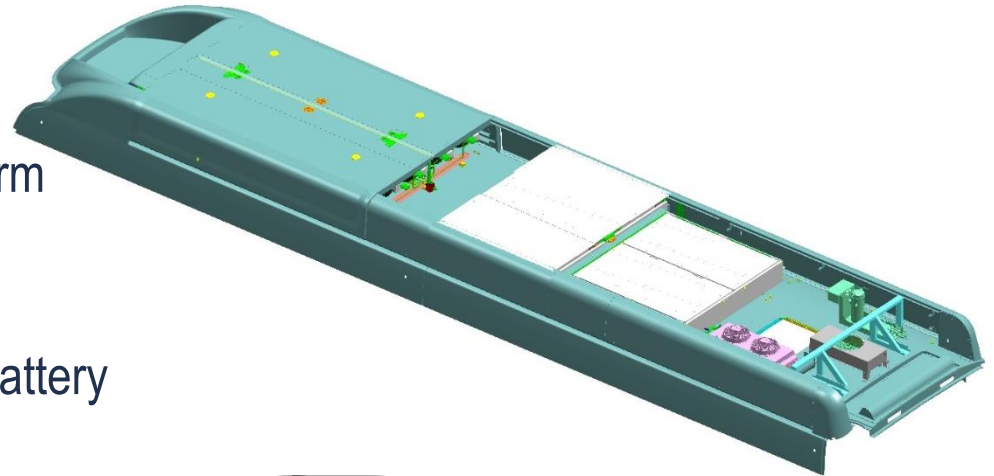




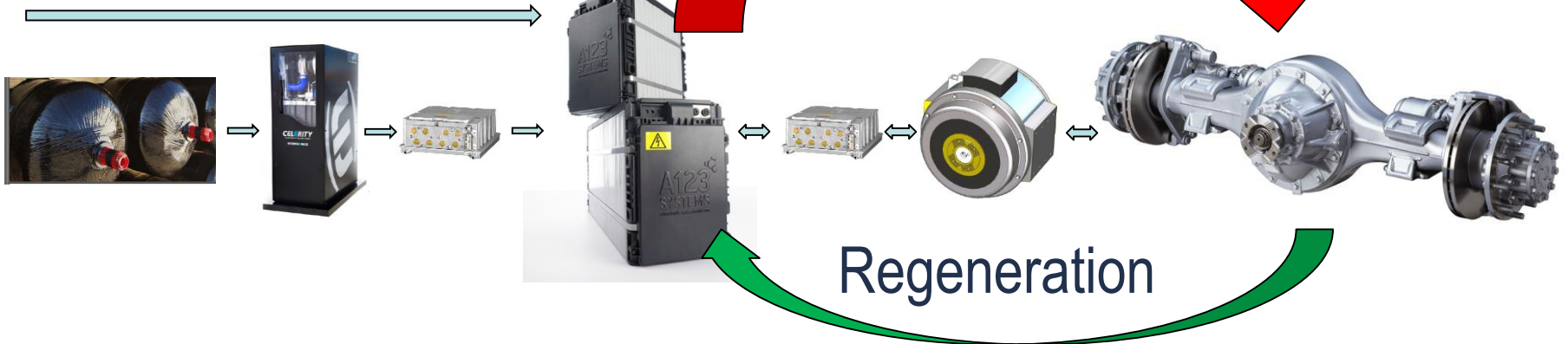
NEW FLYER

## Fuel Cell Bus – System Architecture

- Battery Dominant Hybrid
  - Battery provide bus with short term power and energy
    - Highly efficient +95%
  - Fuel Cell acts like steady-state battery charger
    - Operates in optimal efficiency zone



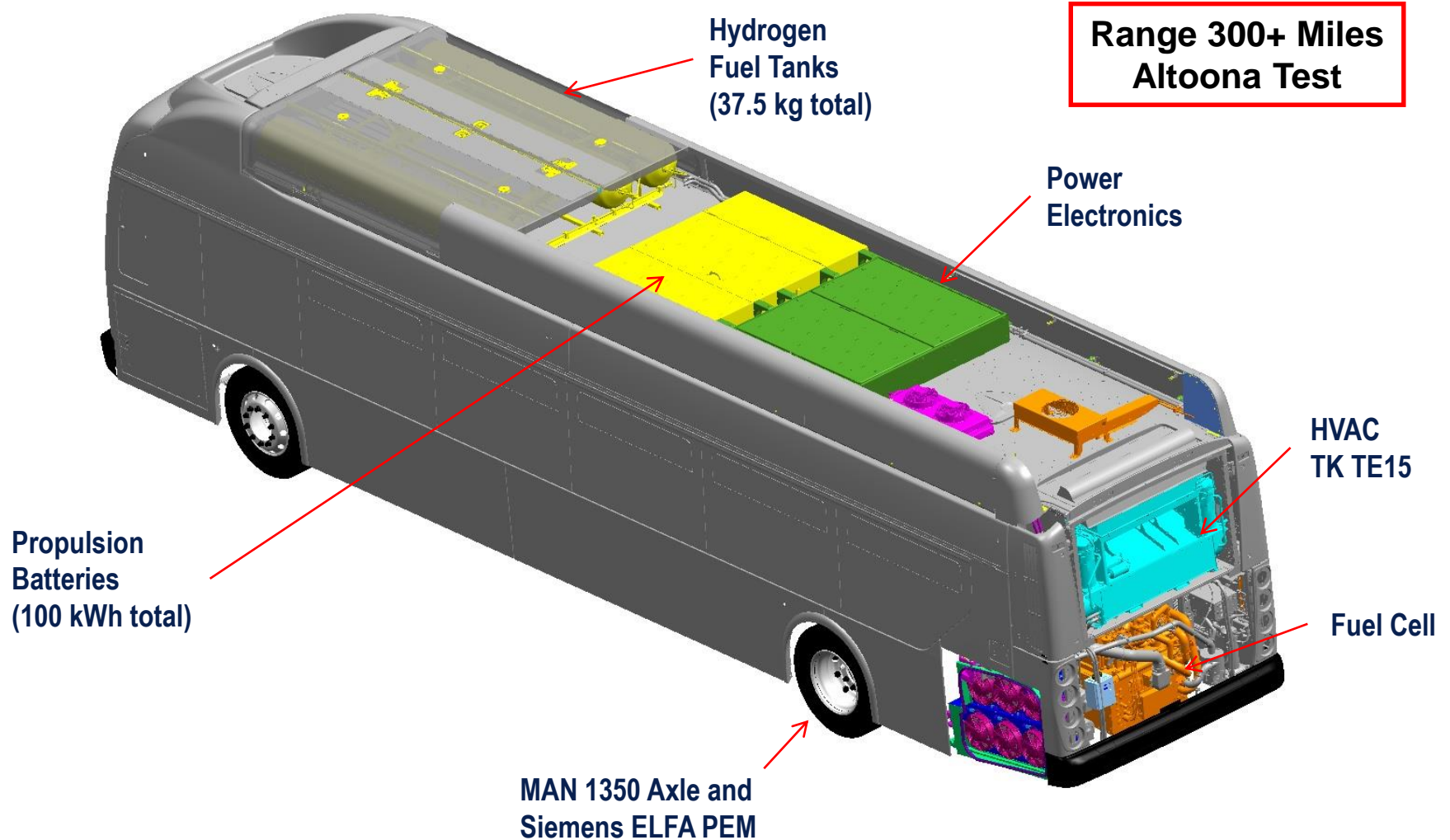
### Battery Charging





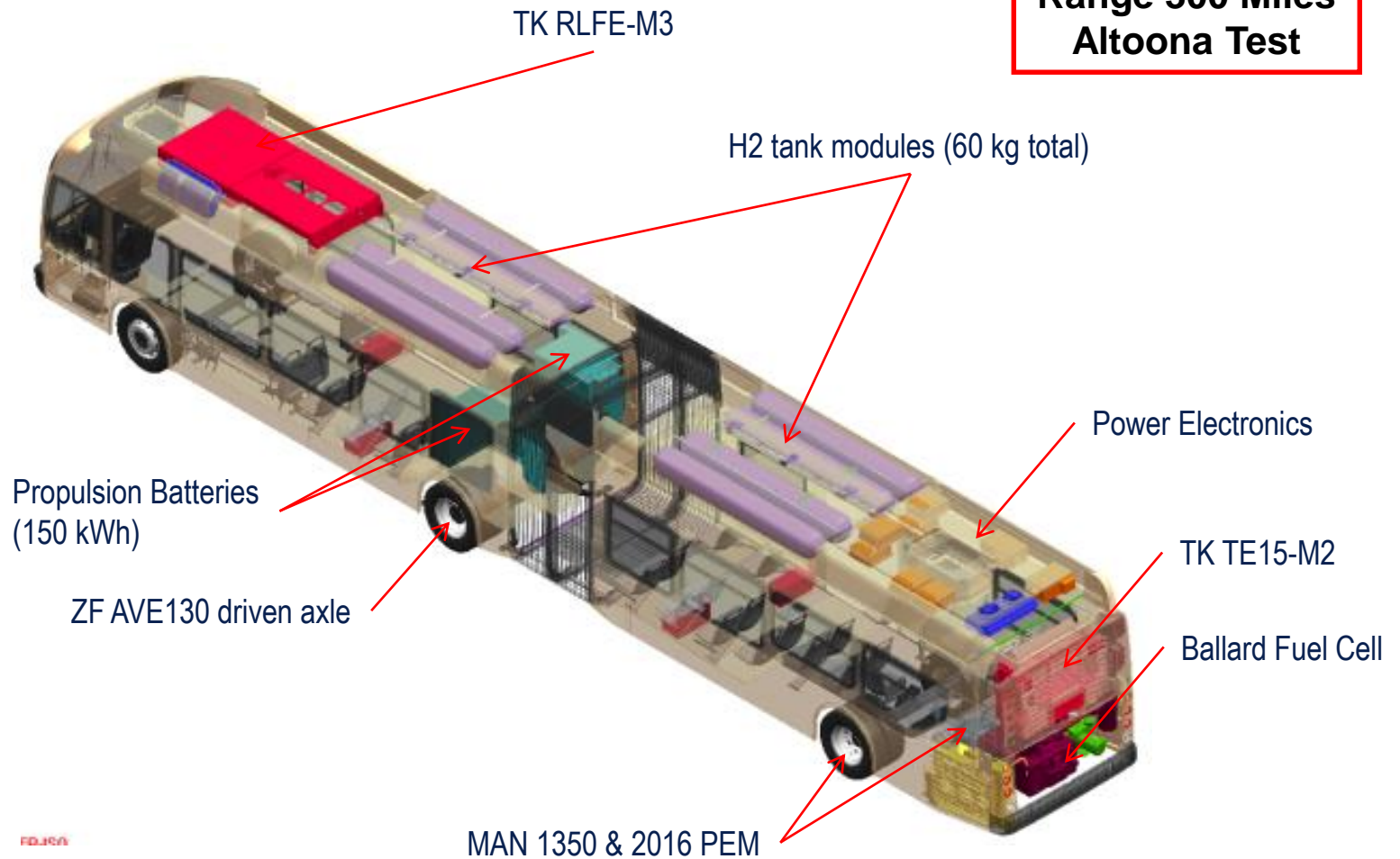
**NEW FLYER**

# Xcelsior XHE40 Fuel Cell Bus





**Range 300 Miles  
Altoona Test**



FDL160

# Advancing Zero-Emission Solutions in Transit

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With aid of an optional fuel cell from Ballard Power Systems, the New Flyer 60-foot Xcelsior *CHARGE* has a range over 300 miles, the ability to transport over 100 passengers, with regenerative braking amassed from three highly efficient electric motors using power management from Siemens that recharge lithium-ion batteries sourced in the U.S.

Track Testing Completed at Altoona



# XHE40 Fuel Cell Electric Bus for Orange County Transportation Authority (OCTA)

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**Final Delivery Preparation  
Anniston, AL  
August 2018**

- **Cryo-Compression** applied technology for transit applications lead by Lawrence Livermore National Laboratory appears viable:
  - Fueling a bus at 350 bar (5,000 psi) at super cold temperature, to increase density in insulated storage tubes on the bus and utilizing liquid pumping and underground storage tanks to pump hydrogen from a liquid state to a gaseous state directly into the bus:
  - Extending the range by double or more — **400 to 500 miles between fills**
  - Rapid fueling to fuel hundreds of buses continuously at 5 to 6 minutes per bus: a single dispenser fueling as many as 50 to 75 buses in a five- to eight-hour fueling window
  - Under-grounding liquid tanks and liquid pumps to reduce the above-ground footprint for a 200- to 300-bus division to no more than 400 square feet of space



# It's **bright** ahead.

Innovation to RELY ON.

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- **Technology that Works.** Transforming Your Community with Sustainable Clean Technology
- **Investment in Our Communities:** Leading Transit with Investment in American Jobs
- **Progressive, but Prudent Innovation.** Supporting Smart Cities with Technology, Training and Collaborative R&D

## For More Information:

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