

SCAG  
**clean cities**  
COALITION



# Innovations in Clean Transit: Pilots & Partnerships

Darrell E. Johnson, Chief Executive Officer  
Jan. 26, 2021





# What is OCTA?

## Complete Streets

- Active transportation
- Signal synch
- OC Bridges
- City formula funding
- Local competitive grants funding



## Transit

- OC Bus and Paratransit
- OC Streetcar
- OC Flex microtransit
- Community-based transit
- Metrolink



## Highways

- OC Go / Measure M projects
  - HOV lanes
  - General-purpose lanes
- Tolled express lanes
- Motorist services

## Sustainability

- Zero-emission bus
- Climate resiliency planning
- Air-quality initiatives
- Innovative wildlife & habitat mitigation
- Water-quality grants



# OCTA's Environmental Programs





# OCTA's Zero-Emission Bus Pilots

## Zero-Emission Bus Plan:

- Technology neutral
- Guiding OCTA to 100% zero emission by 2040

## Hydrogen Fuel-Cell Electric:

- 10 buses in service
- Largest H2 fueling station for transit in the U.S.

## Battery-Electric:

- Purchasing 10 buses
- Expected to begin operating in late 2021



*Hydrogen Fueling Station*



*40-foot Hydrogen Fuel-Cell Electric Buses*

# H2 Pilot Partnerships and Funding

## FUNDING PARTNERS



## PROJECT PARTNERS



## FUNDING BREAKDOWN

|  |                       |
|--|-----------------------|
| <b>Total Cost:</b>   | <b>\$22.9 million</b> |
| California Air Resources Board / California Climate Investments: | \$12.5 million        |
| South Coast Air Quality Management District:                     | \$1.0 million         |
| OCTA:  | \$9.4 million         |

# A Zero-Emission Future



- **Committed to meeting 2040 zero-emission bus goal**
- **Rolling out zero-emission operator relief vehicles**
- **Introduced first all-electric vanpool vehicle**



# Build A Clean, Sustainable Public Transportation Future

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Southern California Association of Governments—

Innovations of Clean Transit Webinar Series

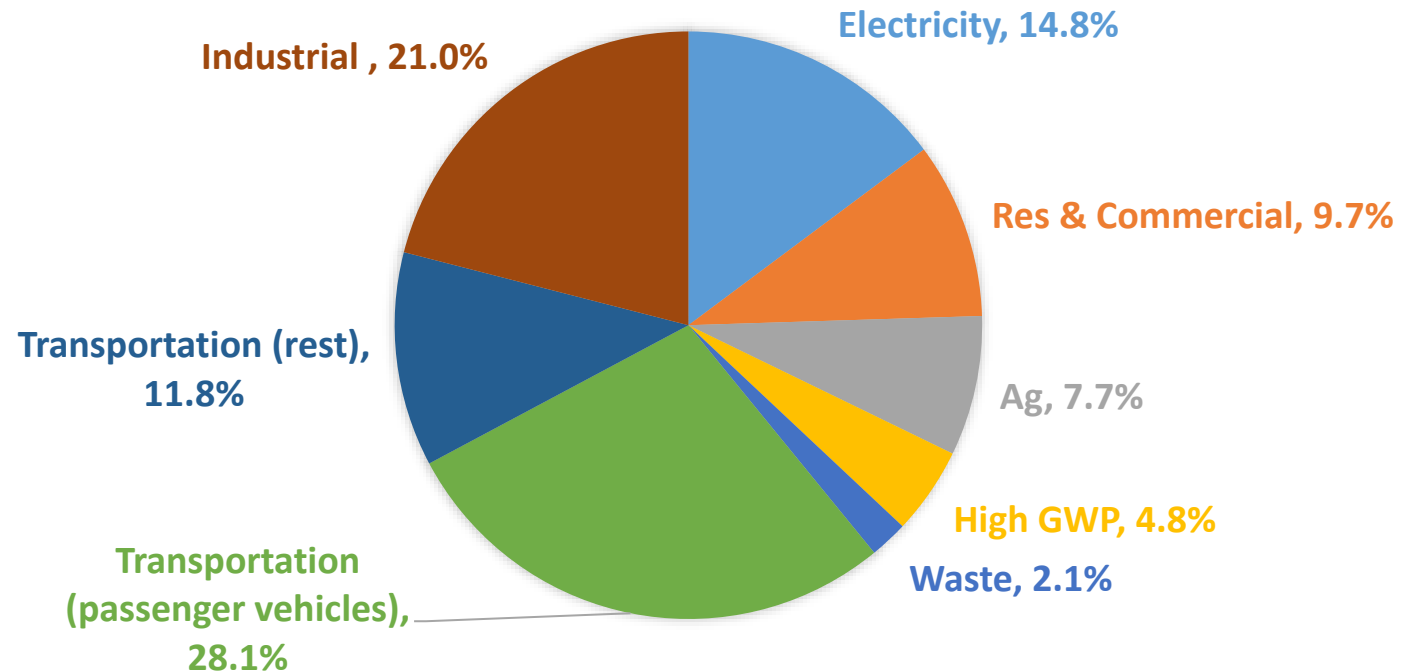
January 26, 2021





# Control Transportation Pollution Is Crucial

2018 GHG EMISSIONS BY SCOPING PLAN SECTOR  
(Source: <https://ww2.arb.ca.gov/ghg-inventory-data>)



# Public Transit Is Part of the Solution

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- Reduces passenger vehicle miles traveled
- Reduces traffic congestion and idling time
- Provides multimodal connections for improved convenience and better efficiency
- Ensures equitable access and provides demand response service
- **Generates great economic returns**
  - Public-private partnership can further increasing return in benefit

# Zero-Emission Technologies for Public Transit

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- Ensures affordable zero-emission technologies immediately available to all, especially low-income riders
- Provides direct health benefits to riders and local communities
- Utilizes the most fuel-efficient technologies for mass transportation



# State's Efforts Deploying Zero-Emission Buses

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- Holistic approach and complementary measures to ensure success
- Incentive funding
  - Provides pilot experience
  - Encourages early action
  - Helps flatten the learning curve
  - Offsets incremental costs
- Innovative Clean Transit (ICT) Regulation
  - Ensures health benefits
  - Provides a long-term market signal
  - ICT experience will pave the way for other zero-emission heavy-duty vehicles

# ICT Encourages Active Transportation and First- and Last-Mile Connectivity

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- Allows zero-emission passenger miles delivered through using bicycles, scooters, ZE LDV, etc. in lieu of purchasing ZEBs
- ZE passenger mile requirements
  - Large transit agency: 320,000 miles/yr/bus
  - Small transit agency: 180,000 miles/yr/bus
- Bicycle mileage receives a multiplier of 3

# Regional Collaboration on Clean Transportation

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- Individual transit agency's planning and commitment is key to success
- Regional collaboration could
  - Amplify the impact
  - Enhance connected trips and further reduce passenger vehicle usage
  - Broaden the integrated fare system for improved mobility and additional efficiency
  - Better design the transportation network and improve navigating



# Towards a Clean, Sustainable Public Transportation Future

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- Public transit can and should be the top choice to transport all people
- Public education is crucial to bring in new generations of riders
- Long-term investment is necessary to increase service frequency, boost ridership, and generate more connected trips
- Funding is essential to offset incremental costs in early years

# Contact Information and Resources

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- ICT Regulation  
<https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit>
- Funding Finder Tool <https://fundingfindertool.org/>?
- Contacts
  - Yachun Chow, Manager, Zero Emission Truck and Bus  
[yachun.chow@arb.ca.gov](mailto:yachun.chow@arb.ca.gov)
  - Shirin Barfjani, Lead Staff of the ICT Regulation  
[shirin.barfjani@arb.ca.gov](mailto:shirin.barfjani@arb.ca.gov)



# SCAG – OCTA, INNOVATIONS IN CLEAN TRANSIT WEBINAR



# Love's Family of Companies



## TRILLIUM IS BACKED BY THE LOVE'S FAMILY OF COMPANIES.



**50+**  
YEARS  
of heavy-duty vehicle  
fueling experience

**23,000 +**  
EMPLOYEES  
committed to excellent  
customer service

**765+**  
VEHICLES  
owned and operated (through  
Gemini Motor Transport)

# Trillium: Alternative Fueling Solutions Provider



## NEW TO ALTERNATIVE FUELS? WE CAN HELP.

25 +

YEARS

of fleet fueling  
experience

200 +

FACILITIES

nationwide dispensing  
clean fuel

100 +

MILLION DGE

of clean fuel  
delivered per year

65 +

PUBLIC-ACCESS

fueling facilities (Trillium &  
Love's)

150 +

EMPLOYEES

growing the clean  
fuel market

100 +

MECHANICS

in-house to perform  
proactive maintenance

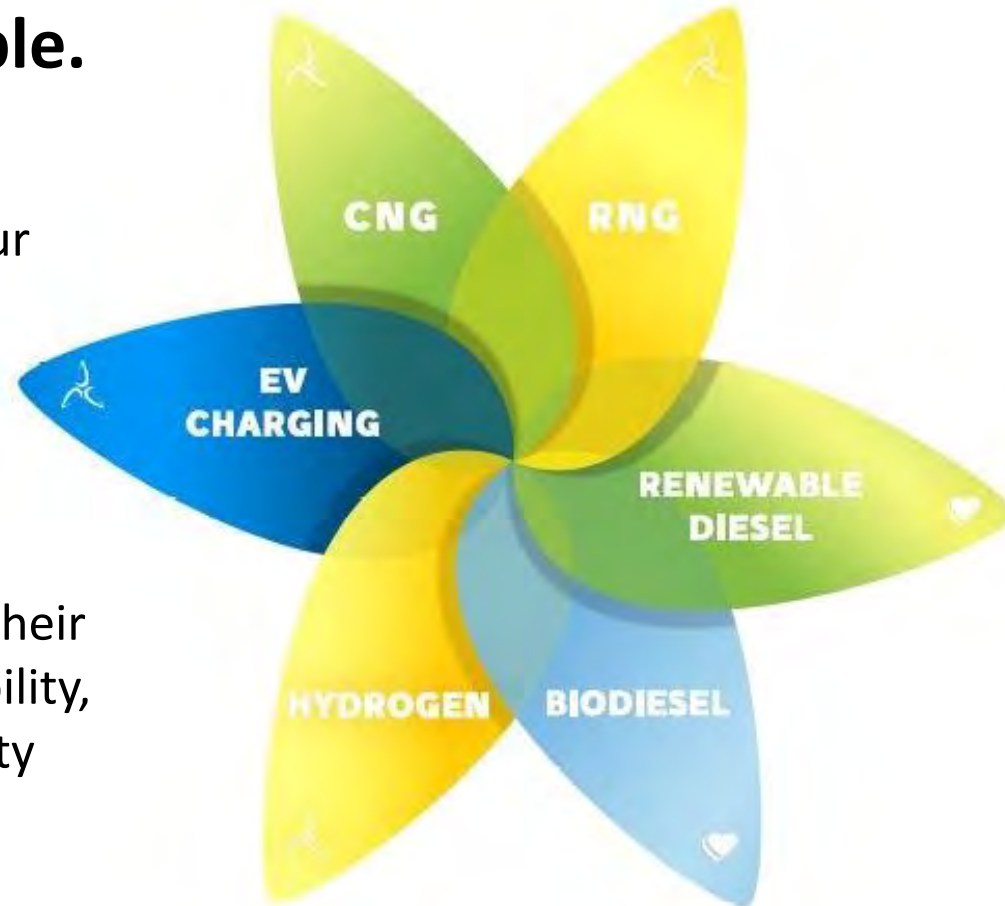
# One Partner, Any Fuel



## It really can be that simple.

Through our Love's Family of Companies, Trillium can supply your station with any clean fuel as your fleet's needs evolve and grow.

Trillium works with customers to identify the clean fuel and power supply sources that work best for their fuel station – balancing cost, reliability, deployment timelines, sustainability goals, location, and scale.



# Customer-Centered Approach to Fueling



Trillium can partner with you at any stage of your station development to help you maximize efficiency, cost savings, and operating performance.

Our 24/7 service model has helped us achieve the highest customer satisfaction in the industry and 99.9% uptime for our stations.





# Trillium + OCTA



Trillium and OCTA have had a long-standing relationship. We've built and maintain 3 of their compressed natural gas stations including the CNG station at their Santa Ana, CA bus depot.





# Orange County Transit – Delivered Liquid H2



- 30 kg per vehicle in 6+ minutes
- From 2 dispensers simultaneously
- Up to 1,500 kg/day
- 3 days of storage
- Footprint: 3,500 sq. ft.

# Lessons Learned



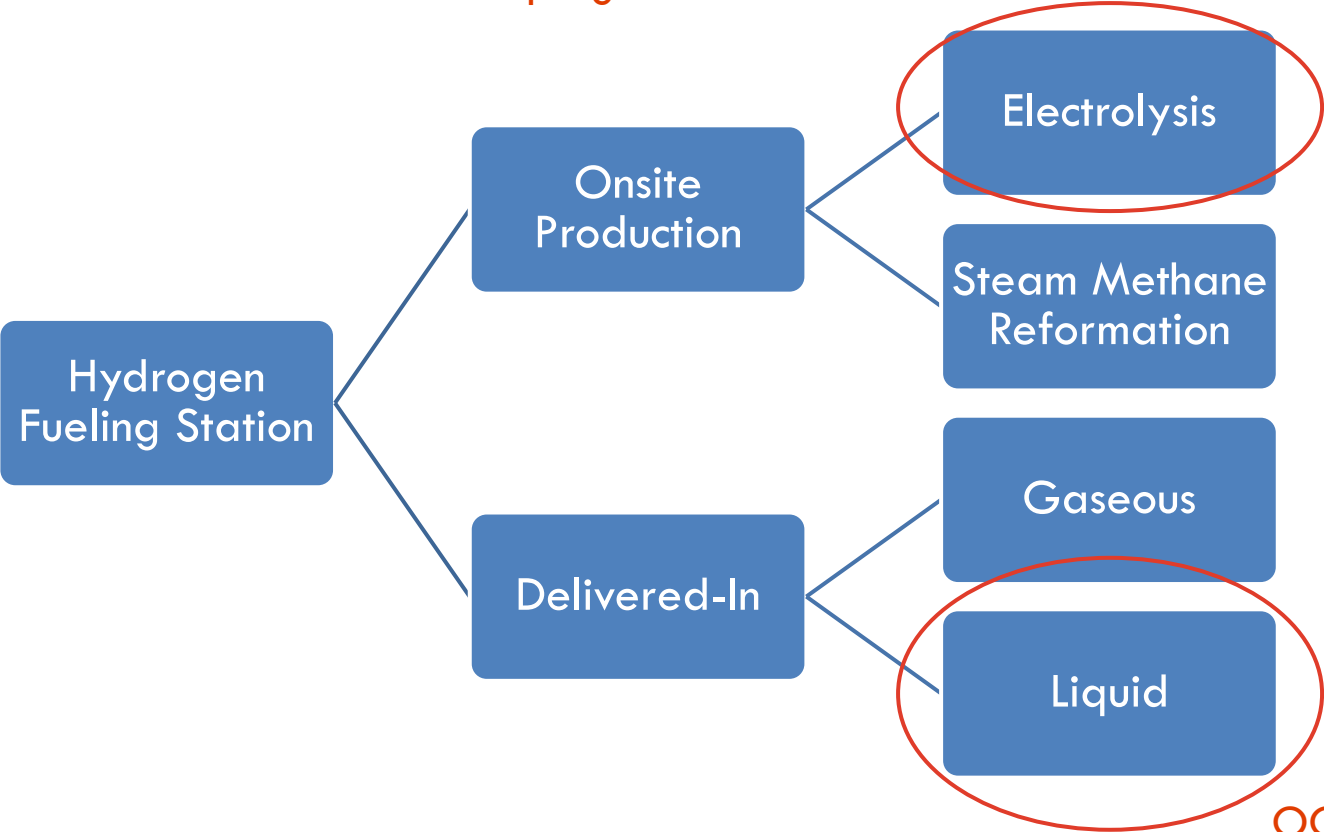
- Alarm and shutdown scheme between CNG and H2
- Chiller size and location
- Taxes
- Contracting
- Access

We learned a lot TOGETHER.

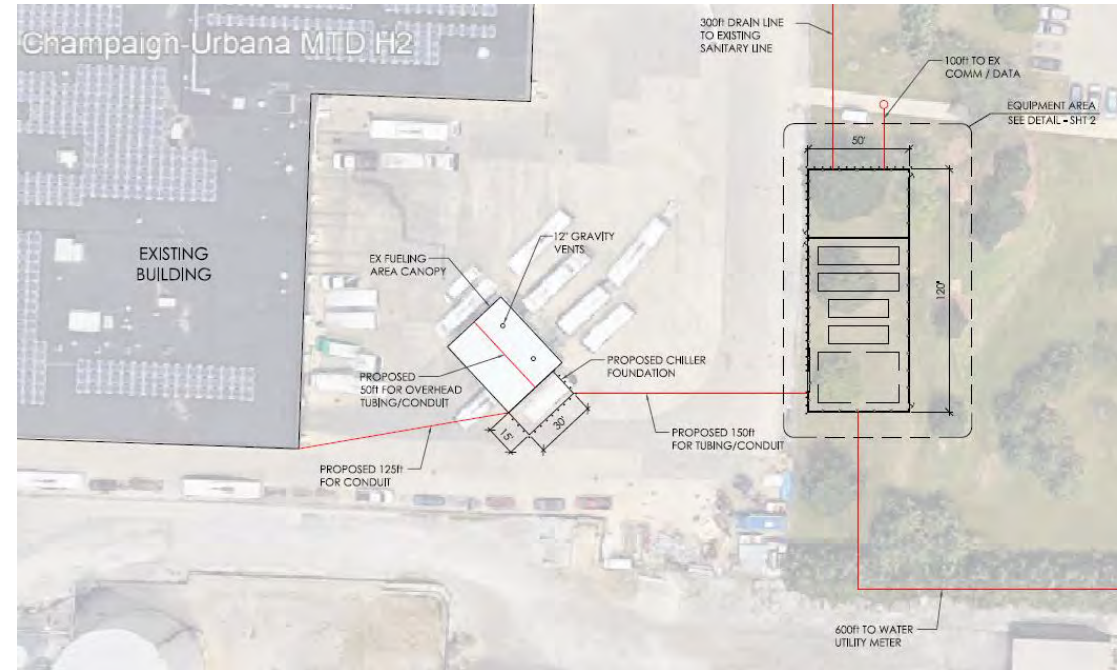
# Hydrogen Fueling Station Options



Champaign Urbana MTD



# Champaign Urbana MTD – Onsite H2 Production



- Produces 450 kg per day via Electrolysis
- 1 MW electrolysis system
- Flowrate : 3.6 kg / min
- Power: 2.2 kw/kg , 500 kwh/kg
- Water Usage : 3 gallons per kg
- Footprint: 6,000 sq. ft.

# Funding Options



Hydrogen fueling facilities are cost intensive. Fleets should consider external funding in order to assist with the transition. Funding options include:

**Grants**

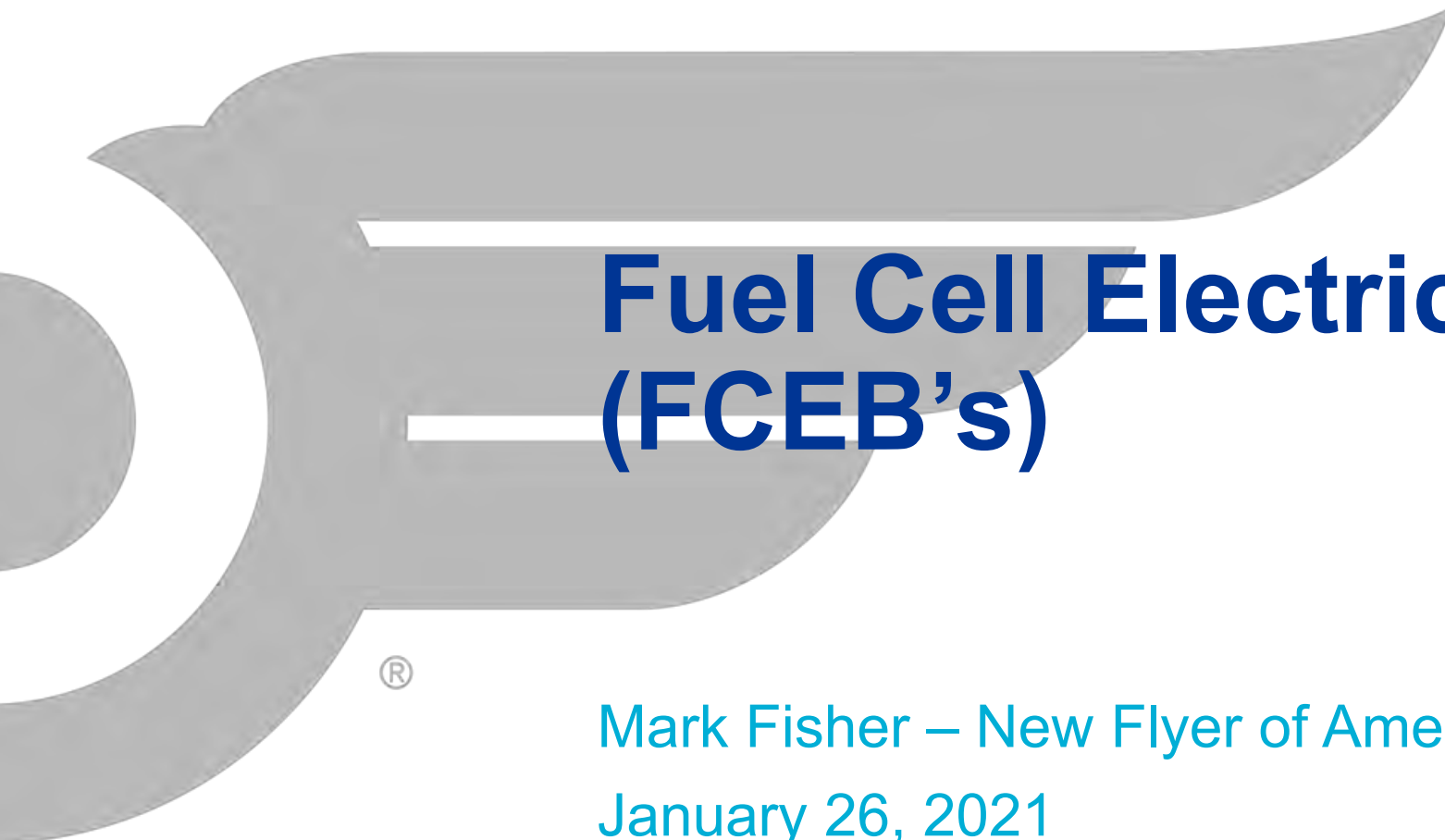
**Utility Assistance**

**Public-Private Partnerships**





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# Fuel Cell Electric Buses (FCEB's)

Mark Fisher – New Flyer of America  
January 26, 2021

**NEW FLYER®**

# New Flyer Electric Bus Experience

- Over 50 years of experience manufacturing zero-emission buses
- New Flyer actively supports over 41,000 heavy-duty transit buses currently in service, of which 7,300 are powered by electric motors and battery propulsion and 1,600 are zero-emissions
- New Flyer offers all 4 types of electric, and all 3 types of zero-emission propulsion systems:
  - Diesel-electric hybrid (low-emission)
  - Battery Electric (zero-emission)
  - Trolley-electric (zero-emission)
  - Fuel cell-electric (zero-emission)

# Whistler BC Fuel Cell Electric Bus Project 2009-2014



- BC Transit initiated a project with California Air Resources Board (CARB) & the US National Renewable Energy Laboratory (NREL) to test FCEBs in urban transit operation.

# New Flyer Integrator to Innovator

- Knowledge gained through experience
  - New Flyer needs to take ownership of systems controls
  - Serviceable components need to be located in accessible areas
  - Ownership of fuel cell balance of plant needs to be with the manufacturer
- Development of Electrical Accessories
  - Component selection needs to align with vehicle performance expectations
  - Select technology with proven performance & reliability
  - Improve energy consumption



# Fuel Cell Electric Bus Control Strategy

## THEN (2009):

- Fuel cell-dominant hybrid
- Large fuel cell / small battery pack
  - Ballard FCveloCity HD6-150 fuel cell (150 kW)
  - Single battery string ESS
    - Ability to take advantage of frequent regen events

## NOW (2020):

- Battery-dominant hybrid
- Small fuel cell / large battery pack
  - Ballard FCveloCity HD85 fuel cell (85 kW)
    - Sized to meet average Net Power of 30-45 kW
  - Two or Three String ESS (100-150 kWh)
    - Ability to take advantage of frequent regenerative braking events
    - Up to 235 kW peak power for acceleration, high-speed operation and hill climbs
    - Extends range when bus is out of fuel

# xcelstor **CHARGE H2**™

## Readiness Level

|                          | Bus Model                     | Fuel Cell               | Readiness             |
|--------------------------|-------------------------------|-------------------------|-----------------------|
| <b>Development</b>       | Xcelstor Charge H2<br>40-foot | Hydrogenics Celerity(+) | Evaluation            |
|                          |                               |                         |                       |
| <b>Production Builds</b> | Xcelstor Charge H2<br>60-foot | Ballard HD85            | Commercial Production |
|                          | Xcelstor Charge H2<br>40-foot | Ballard HD85            | Commercial Production |



# FCEB Deployment Status (Dec 2020)

- (10) XHE40 FCEBs Delivered to AC Transit (Oakland)
- (1) XHE60 FCEBs Delivered to AC Transit (Oakland)
- (10) XHE40 FCEBs Delivered to OCTA (Orange County)
- (6) XHE40 FCEBs Delivered to SunLine (Thousand Palms)

*Funding and Sponsorship  
Provided by Grants Through*



**NEW FLYER®**

# Zero-Emission Options



## **XCELSIOR CHARGE™**

- Battery Electric Bus (BEB)
- Eco Friendly
- Robust Design
- Up to 200 mile Range\*
- Curb Weight Heavier than FCEB
- 4 Hour typical overnight Charge
- One charger per 2-3 buses



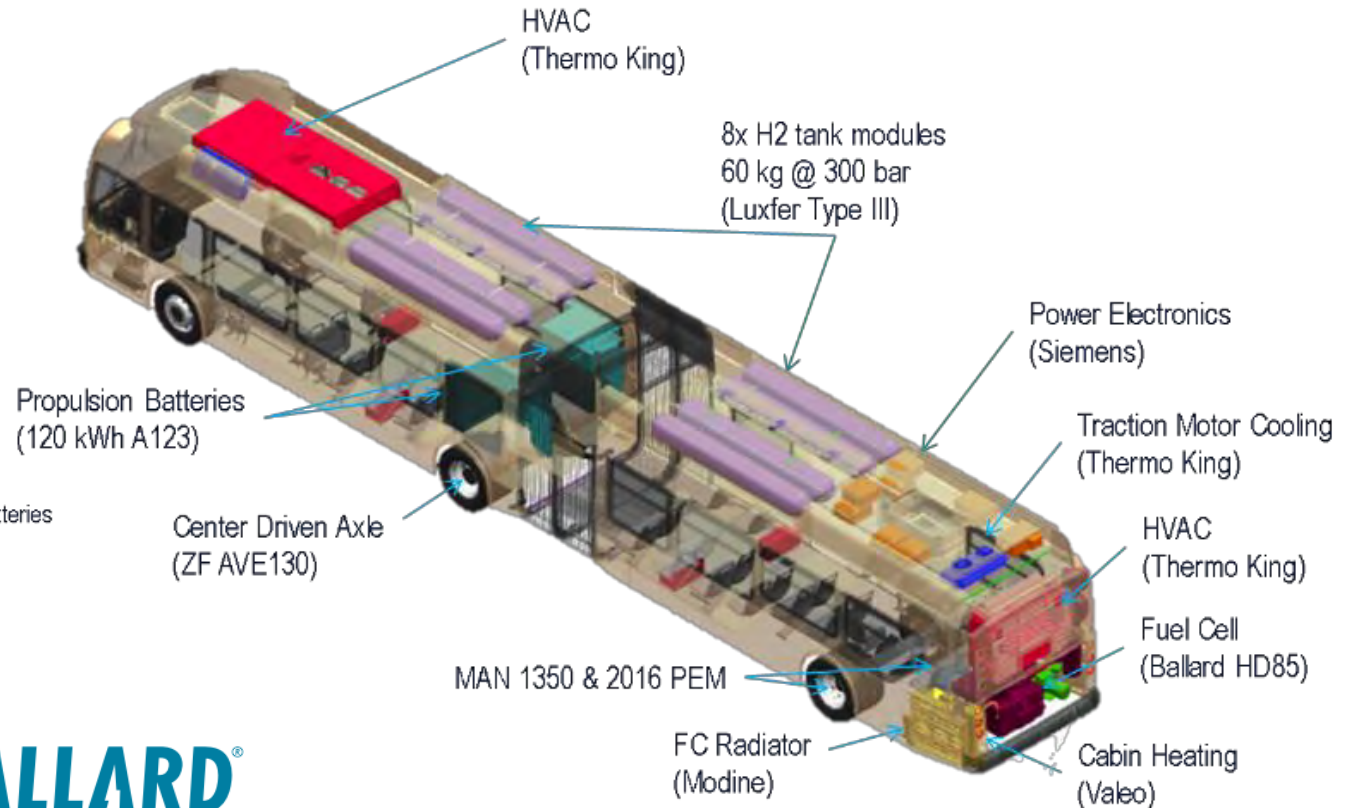
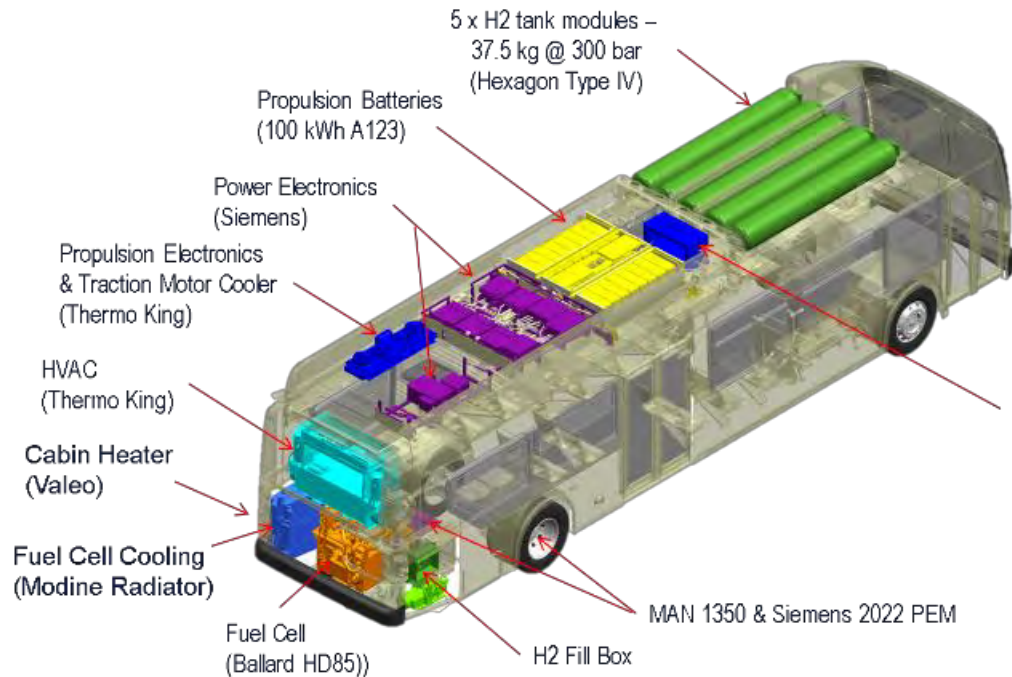
## **xcelSior CHARGE H2™**

- Fuel Cell Electric Bus (FCEB)
- Eco Friendly
- Robust Design
- 300+ Range\*
- Curb Weight Lighter than a long range BEB
- 6-20 minutes fill time
- Fill station scalable by fleet size
- No secondary Aux heater required for cold climates

\*40-foot on APTA BAC transit duty cycle

# xcelstor **CHARGE H2**™

## 60-foot & 40-foot Layouts



**NEW FLYER**®



# xcelcior **CHARGE** H2<sup>TM</sup>40-foot

## Altoona Range @ Seated Load Weight

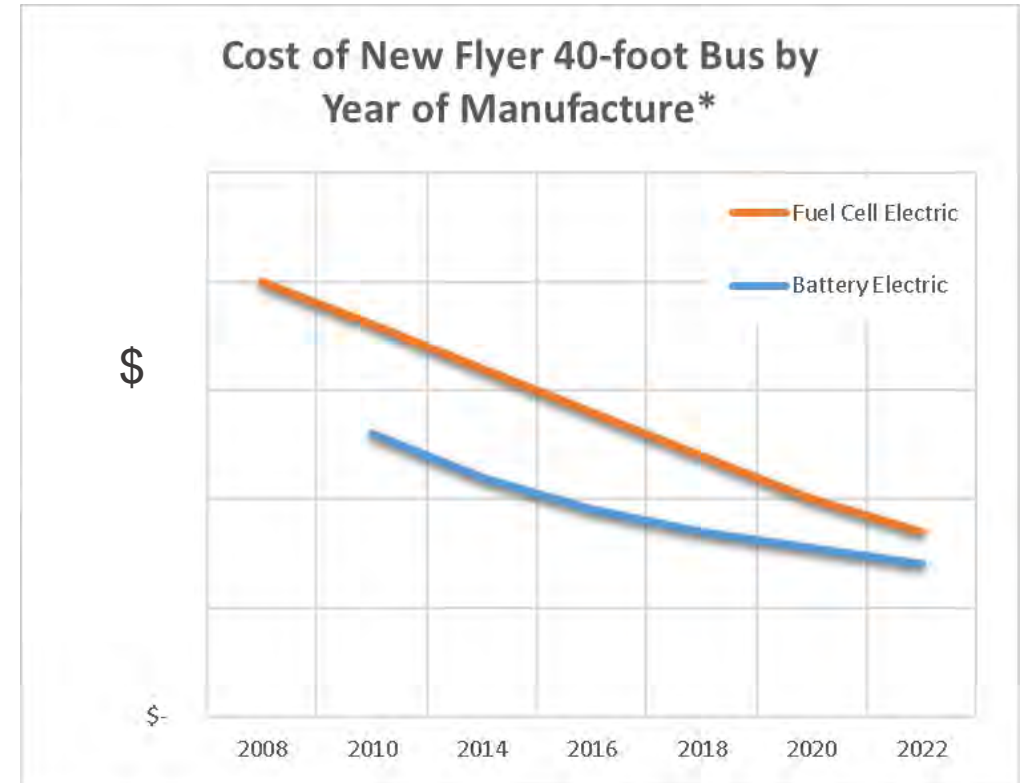
|                             | Manhattan  | OCBC       | UDDS       | Average    |
|-----------------------------|------------|------------|------------|------------|
| Power Consumption[kWh/mile] | 8.57       | 1.83       | 0.94       | 3.78       |
| Fuel Consumption [miles/kg] | 5.32       | 6.91       | 8.33       | 6.86       |
| Fuel Cell Range [miles]     | 192        | 249        | 300        | 247        |
| Battery Range [miles]       | 7          | 33         | 64         | 16         |
| <b>Total Range [miles]</b>  | <b>199</b> | <b>282</b> | <b>364</b> | <b>263</b> |

## Real Life Results

- **350 miles (560 km)** on a single fill validated during testing
  - 9.16 miles/kg (14.66 km/kg)
  - 330 miles (480 km) fuel only
  - 20 miles (32 km) extended battery range

# Fuel Cell Electric Bus Price Trends

- Decrease in Fuel Cell Cost
- Decrease in Battery Cost
- Improved Design for Manufacture and Assembly
  - Mass production optimization
  - Standardization between FC Electric and Battery Electric
  - Reduced complexity and highly repeatable assembly
- Expanded Supply Chain with Increased Competition
- Manufacturing Volume will reduce cost



\*Note: Actual bus price will vary based on battery capacity and customer options



**NEW FLYER®**



# Questions?

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# Thank you for attending!

The recording and slides will be posted to SCAG's  
Toolbox Tuesday site.

<https://scag.ca.gov/toolbox-tuesday>

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