Zero-Emission Bus Program Update

OCTA

Background

December 2018, the California Air Resources Board passed the Innovative Clean Transit (ICT) rule

- Requires transitioning to zero-emission bus (ZEB) fleet by 2040; Purchasing requirements began in 2023

June 2020, the Board approved the OCTA ZEB Rollout Plan

- Includes a mix of zero-emission technologies

February 2020, OCTA initiated the Fuel-Cell Electric Bus (FCEB) Pilot

- Ten 40-foot FCEBs, a hydrogen fueling station, maintenance shop upgrades
- Grant funded $13.2M - California Air Resources Board and South Coast Air Quality Management District

July 2022, OCTA initiated the Battery-Electric Bus (BEB) Pilot

- Started with two BEBs, eight more arrived in December 2022.
- Grant Funded $10.3M - California Transportation Commission Solutions for Congested Corridors Program (SCCP), SB 1 (Chapter 5, Statutes of 2017) State of Good Repair (SGR), and the Low Carbon Transit Operations Program (LCTOP)

June 2024, Battery Electric Paratransit Bus Pilot

- Board approved the purchase of ten battery-electric paratransit buses and infrastructure.
- Grant Funded $2.5M - Federal Transportation Administration's Low and No Emission Vehicle program and Transit and Intercity Rail Capital Program (TIRCP)

November 2024

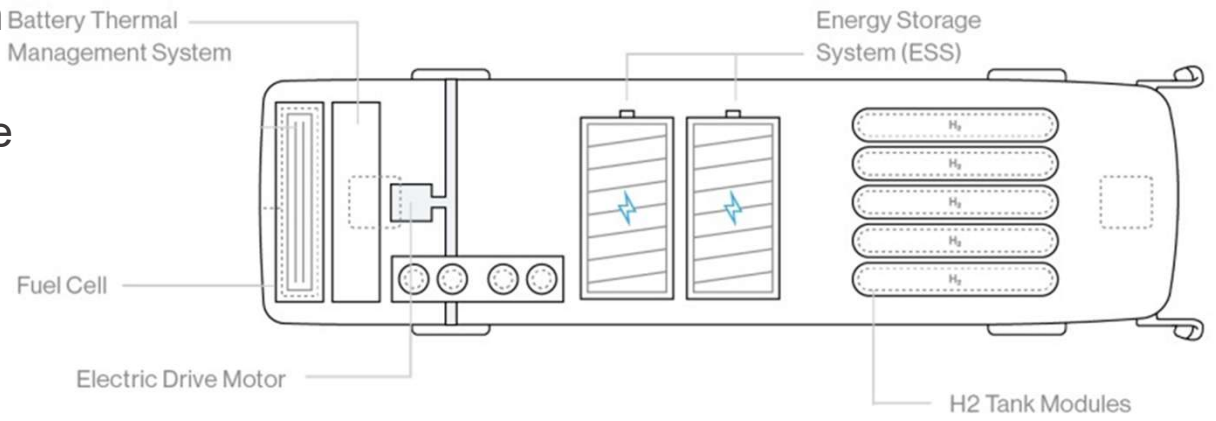
- Board approved the purchase of 40 additional FCEB and ten additional BEB
- Grant funded through the following sources: TIRCP, LCTOP, Congestion Mitigation and Air Quality (CMAQ), Carbon Reduction Program, and SB 125 Zero Emission Clean Transit Program (Chapter 54, Statutes of 2023)

ZEB Pilot Buses

Vehicle Information	CNG Bus	FCEB	BEB
Number of Buses	10	10	10
Manufacturer/Model	New Flyer Xcelsior	New Flyer Xcelsior	New Flyer Xcelsior
Model Year	2016	2018	2020
Bus Purchase Price	$580,000	$1.3M	$1.1M
Length	40 foot	40 foot	40 foot
Curb Weight	30,000 pounds	33,560 pounds	33,500 pounds
Propulsion System	CNG Engine 280 hp (209 kW)	Electric Motor 210 kW	Electric Motor 210 kW
	Transmission	Fuel Cell 85 kW	
Energy Storage	Six Composite Fuel Cylinders	Five Composite Fuel Cylinders	
		Lithium-ion Batteries 100 kW	Lithium-ion Batteries 440kW
Total Operating Range	400 miles	300 miles	200 miles
Usable Operating Range	350 miles	250 miles	150 miles

Fuel-Cell Electric Buses

- Ten pilot buses were deployed in February 2020
- Same standard equipment as the OCTA CNG Bus
- Fuel cell acts as an onboard battery charger
- Life-to-date miles: 1,461,260
- Operates on 80% of OCTA routes
- Refuel in six to ten minutes, similar to CNG
- Usable operating range 250 miles



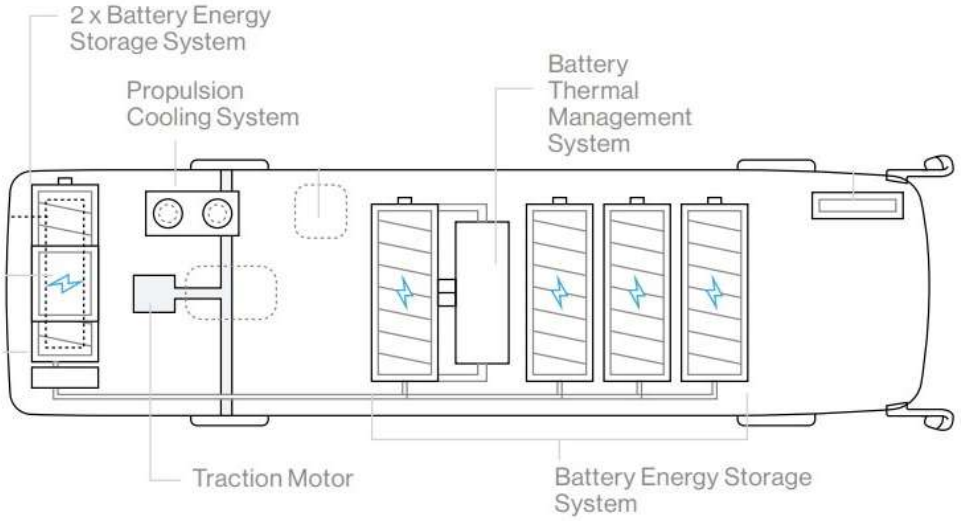
Fuel-Cell Electric Buses

Challenges

- Battery failures – 49 of 160 batteries replaced in six years
- Long lead times on parts
- Fuel-cell performance degrading sooner than expected
  - Overhauls in progress
  - Six-year warranty ended
- Hydrogen fuel
  - OCTA fueling station temporarily decommissioned
  - Limited fueling resources
  - Buses only operated 14,000 miles in 2025; 270,000 in 2024

Battery-Electric Buses

- Ten pilot buses were deployed in December 2022
- Same standard equipment as the OCTA CNG Bus
- 100% battery electric
- Life-to-date miles: 441,000
- Operate on 20% of OCTA routes
- Recharge in four hours
- Usable operating range 150 miles



Battery-Electric Buses

Challenges

- Battery Performance
  - 15 batteries replaced in three years, ten in 2025 alone
  - Six-year warranty
- Battery Recall
  - Thermal hazard if charged to 100%
  - Mitigated hazard by reducing charging to 75%
  - Monitoring battery temperature remotely
  - Plan to replace all batteries, currently testing

Key Performance Indicators

Bus Availability

- Percentage of days the buses are available compared to the total number of days that the buses are planned for revenue service

Miles Between Road Calls

- A road call is defined as a revenue vehicle mechanical or system failure that causes the bus to be replaced in route or causes a significant delay in the bus schedule

Fuel Economy

- Fuel economy is a measurement of how efficiently the fuel is being used by the propulsion system

Cost Per Mile

- OCTA calculates total CPM for each technology by tracking parts and labor cost and fuel cost.
- CPM is the lowest common denominator between the three technologies

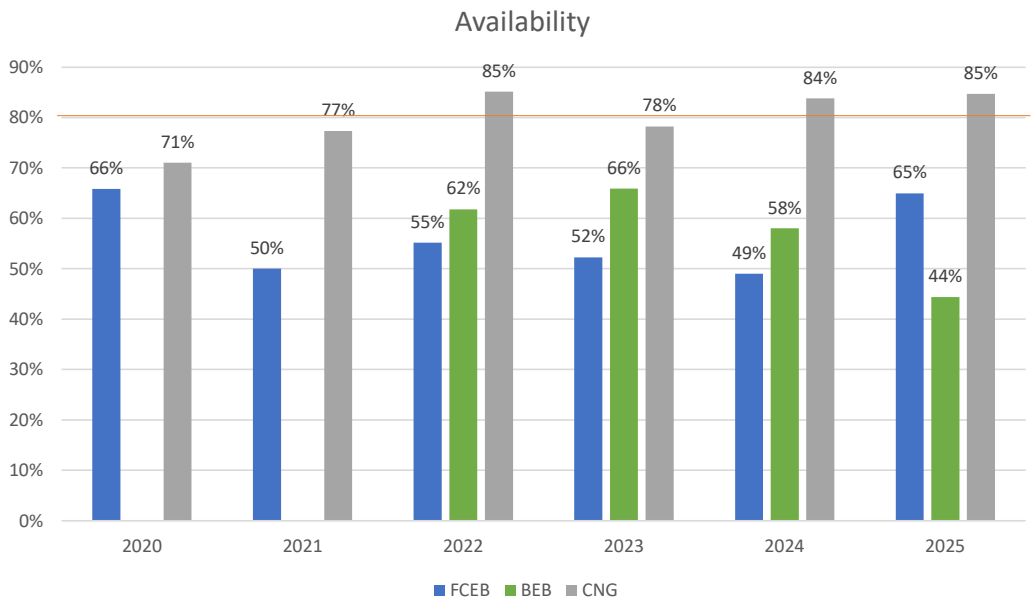
Bus Availability

FCEB

- Improving
- Warranty repairs
- Supply chain delays

BEB

- Declining
- Battery Recall
- Warranty repairs
- Supply chain delays



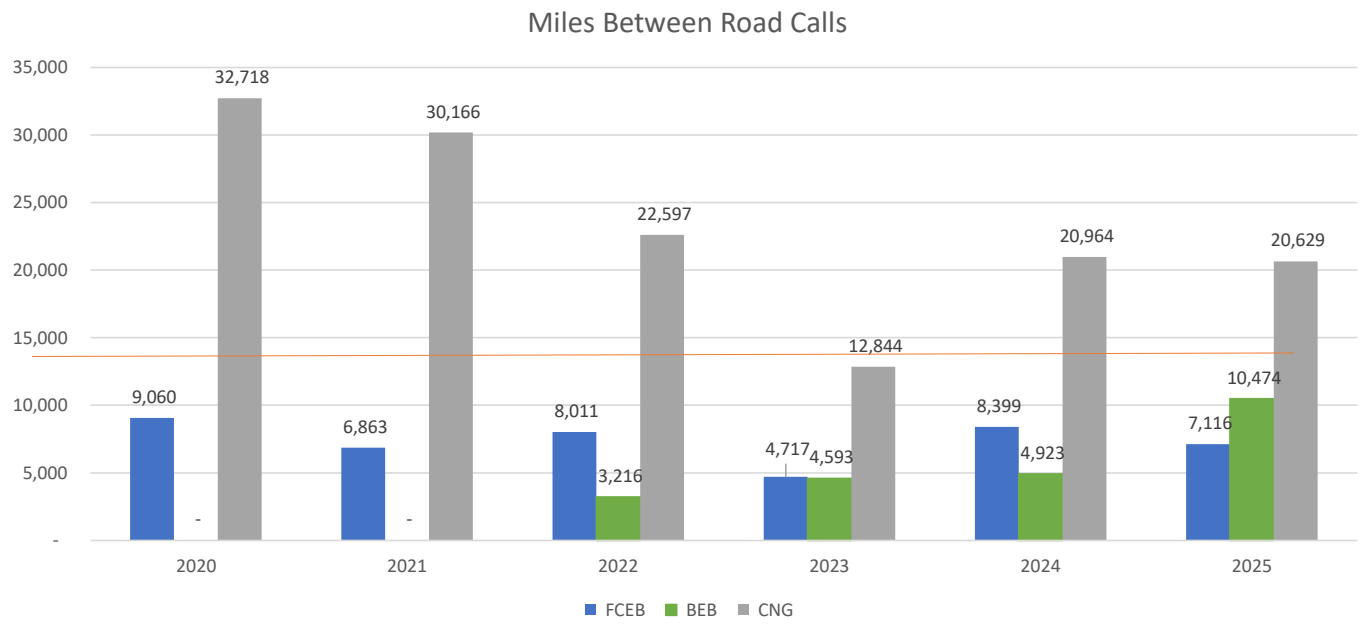
Miles Between Road Calls

FCEB

- Declining
- Battery failures
- Fuel cell degradation

BEB

- Improving
- Battery failures
- Warranty repairs

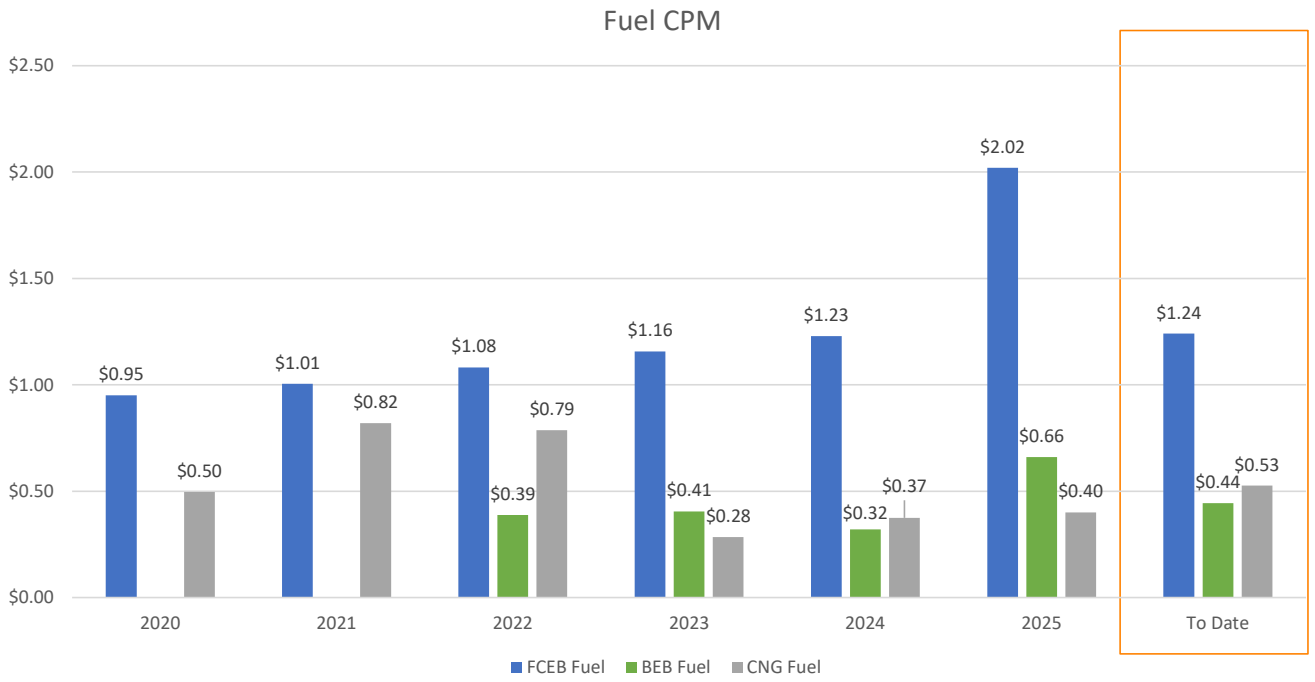


Fuel Economy

Measurement - Miles per diesel gallon equivalent			
Year	FCEB	BEB	CNG
2020	9.45		4.25
2021	9.93		4.17
2022	9.09	15.06	3.84
2023	8.93	16.62	3.91
2024	7.57	18.14	3.19
2025	6.81	16.87	3.74

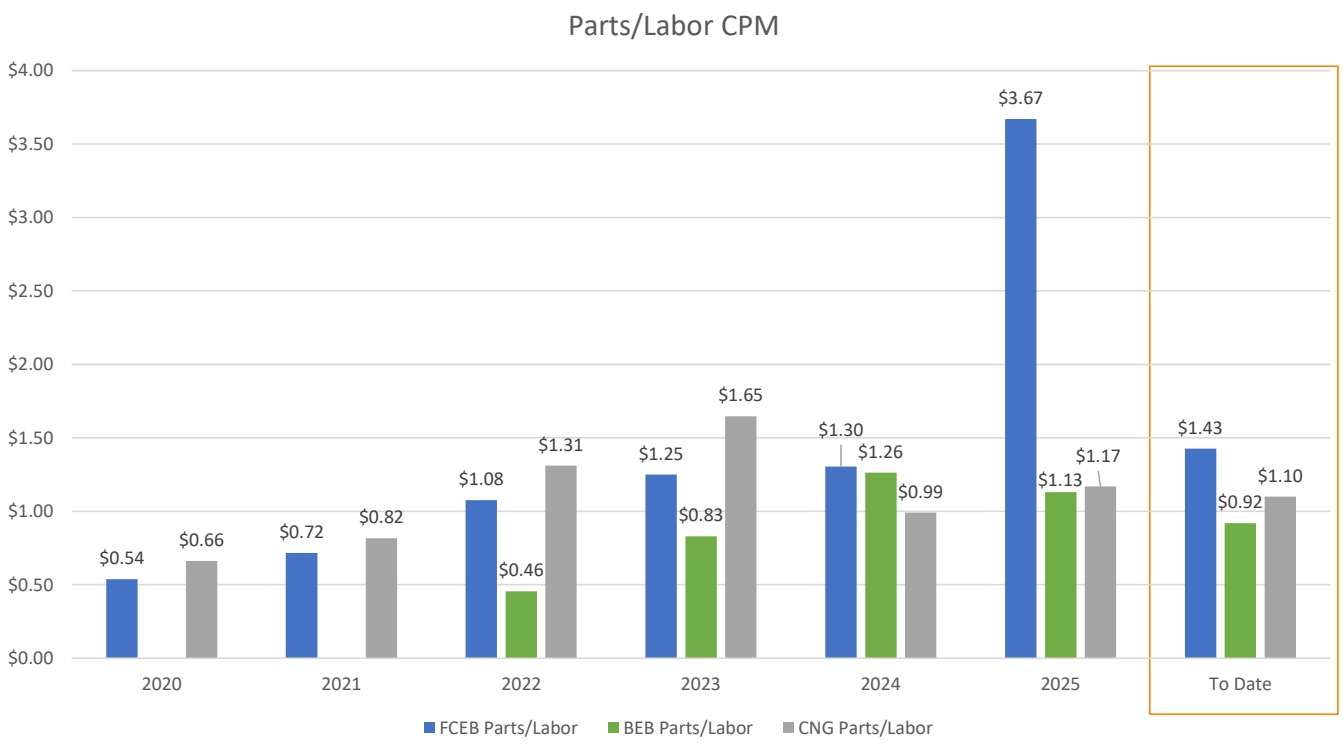
Cost Per Mile - Fuel

- FCEB fuel cost increased due to retail station fueling
- BEB electricity cost increased due to greater usage
- CNG fuel cost increased slightly due to rising fuel cost



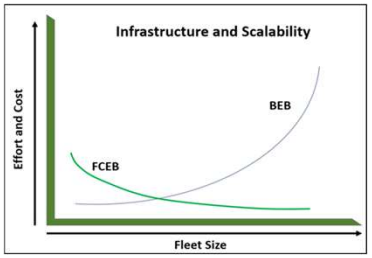
Cost Per Mile – Parts/Labor

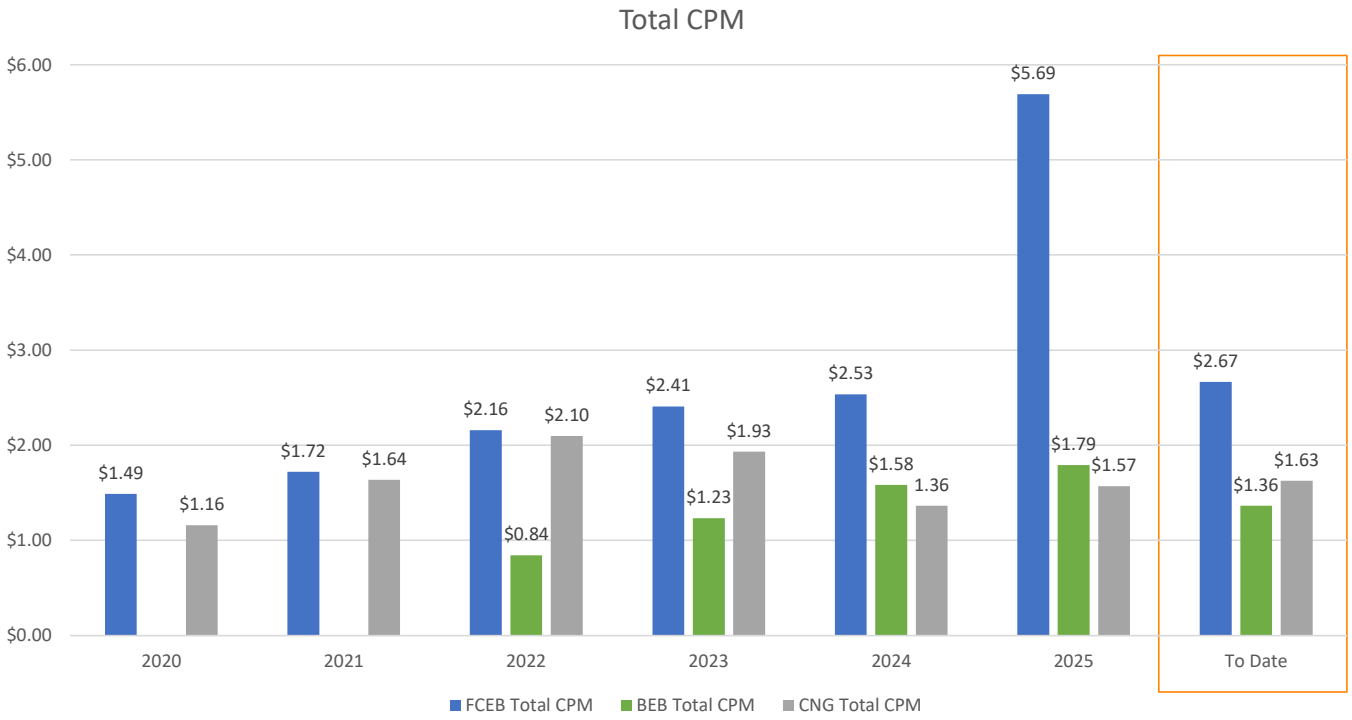
- FCEB increased due to low usage
- BEB decreased due to end of break-in period
- CNG increased due to expanded use of contingency buses



Cost Per Mile - Total

- Total CPM includes
  - Fuel, parts, and labor
- To Date
  - FCEB six-year average $2.67, 64% > CNG
  - BEB three-year average $1.36, 16% < CNG





Infrastructure - FCEB

Hydrogen Fueling Station Decommissioned by Air Products (AP)

- AP would not sell or continue to lease their equipment
- Feb 2025 - Board approved a sole source agreement with AP
- Oct 2025 – no agreement could be finalized with AP

Infrastructure - BEB

Battery Chargers Operational

- 80% availability
- No bus service lost due to unavailable infrastructure

Key Takeaways

- Higher Upfront Costs:
  - ZEBs currently cost 50–100% more than comparable CNG buses, but cost gap is narrowing.
- Reduced Operating Range:
  - ZEBs have 30–55% less operating range than CNG buses.
- Performance:
  - Performance consistent but remains below established operational standards. Availability remains a challenge, mainly due to supply chain issues.
- Maintenance:
  - ZEBs require more maintenance than anticipated, costs are comparable to CNG buses.
- Hydrogen Challenges:
  - Hydrogen fuel remains expensive, but supporting infrastructure is still evolving.
- Electricity Constraints:
  - Electrical capacity can be limited, and charging infrastructure deployment is often complex.

Other Zero-Emission Vehicles

50 Electric Operator Relief Vehicles

1 Electric Facilities Maintenance Truck

1 Electric Van for Facilities Maintenance

10 Electric Vans for Paratransit Service

3 Electric Vans for Electronic Technicians

ZERO EMISSION
FOR A HEALTHY
COMMUNITY

Next Steps

Receive

- 40 FCEBs – receive all in 2026
- Nine of ten BEBs – receive all in 2026

Install

- BEB charging stations at Santa Ana Bus Base - 2026
- Battery-Electric Paratransit Vans Charging Stations – 2026

Procure

- Equipment and Services for first hydrogen fueling station at Santa Ana Bus Base
- Second hydrogen fueling station at Garden Grove Bus Base – award April 2026
- Seven 60-ft FCEBs (On-Hold)