



Fuel Cell - MDEC

Oct. 4<sup>th</sup>, 2023

Ryan Sookhoo

# Near Zero to Net Zero

## Cummins' Commitment to Destination Zero



Lower emissions today



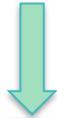
Reduce well-to-wheels emissions



Drive wide-scale customer adoption



Achieve zero emissions by 2050



### Accelera by Cummins

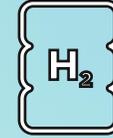
Zero Emission Technologies

Accelera's fuel cells, battery electric, electrolyzer and ePowertrain solutions are ready to transition the rail industry to zero emissions - today.

## ENERGY SOURCES



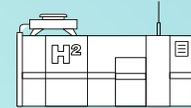
LOW CARBON FUELS



GREEN HYDROGEN ECONOMY



DECARBONIZED GRID



STORAGE

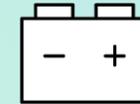
## POWER SOLUTIONS



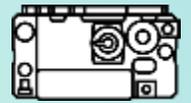
ADVANCED ENGINES



HYBRID



BATTERY ELECTRIC



FUEL CELL ELECTRIC

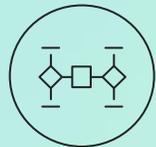


## Our Purpose

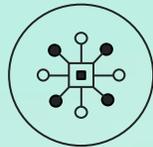
# We're here to accelerate the worldwide adoption of **zero-emissions** solutions.



A century  
of powertrain  
innovation



Powertrain  
of choice



Capabilities  
across  
applications



Ability to  
achieve  
scale



Security  
of supply



Global  
footprint  
for support

ACCELERA BY CUMMINS

# Experience + Agility

Accelera - a business segment of Cummins - is a global leader in zero-emission technologies for the world's most economically vital industries, empowering them to accelerate the shift to a sustainable future.

**2,000**

of the world's brightest minds  
focused on decarbonizing  
technologies

**70+**

years of hydrogen experience

**190+**

countries and territories in our  
distribution + support network

**2,500+**

vehicles in the field with Accelera  
electrified components

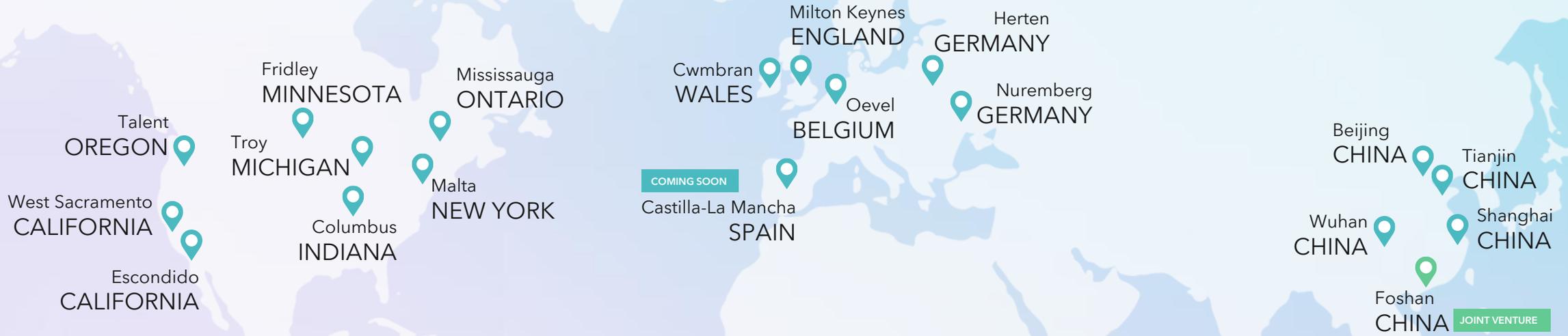
**600+**

electrolyzers deployed in the field

**3,000**

fuel cells deployed in the field

# Accelera Footprint



# Accelera's Core Technologies



## Electrolyzers

Creating solutions for industrial and commercial hydrogen generation and megawatt-scale energy storage

**Industrial processes and fueling stations:** PEM generator, alkaline hydrogen generator

Critical and uninterruptible power supply, power-to-gas technology



## Fuel Cell Systems

Creating and integrating fuel cells for mobility and stationary power applications

**Electric mobility:** heavy-duty truck, transit bus, rail

**Utility:** microgrids, megawatt-scale grid firming and renewable integration

**Commercial/Industrial:** manufacturing, data centers, water treatment facilities, hotels/resorts



## Electrified Components

Creating technologies and products for commercial battery electric vehicles and battery energy storage systems

**On-highway:** transit bus, school bus, medium-duty truck, walk-in van

**Off-highway:** construction equipment, terminal tractor, material handling, energy storage systems

**Components:** battery modules, battery packs, PCAs



## ePowertrain Systems

Creating technologies and delivering eAxles for electrified vehicles

**On-highway:** medium-duty truck, heavy-duty truck, walk-in van, transit bus, school bus

**Off-highway:** construction equipment, terminal tractor

**Components:** integrated eAxles



## Traction Systems

Creating technologies and delivering electric traction systems for electrified vehicles

**On-highway:** medium-duty truck, heavy-duty truck, walk-in van, transit bus, school bus

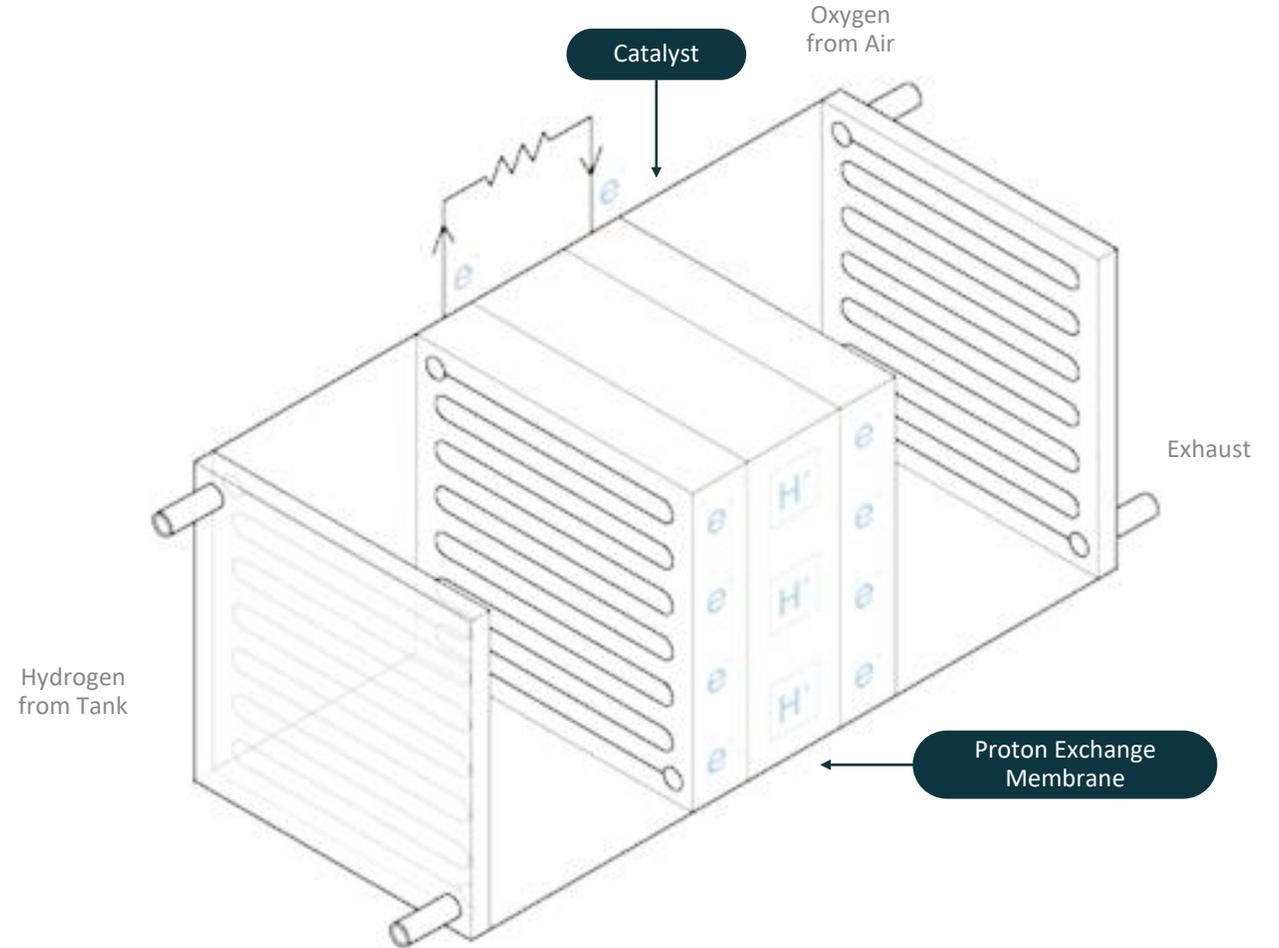
**Off-highway:** construction equipment, terminal tractor

**Components:** motors and inverters for remote mount and eAxle

# The Essentials of Fuel Cells

HOW IS H<sub>2</sub> USED AS FUEL ?

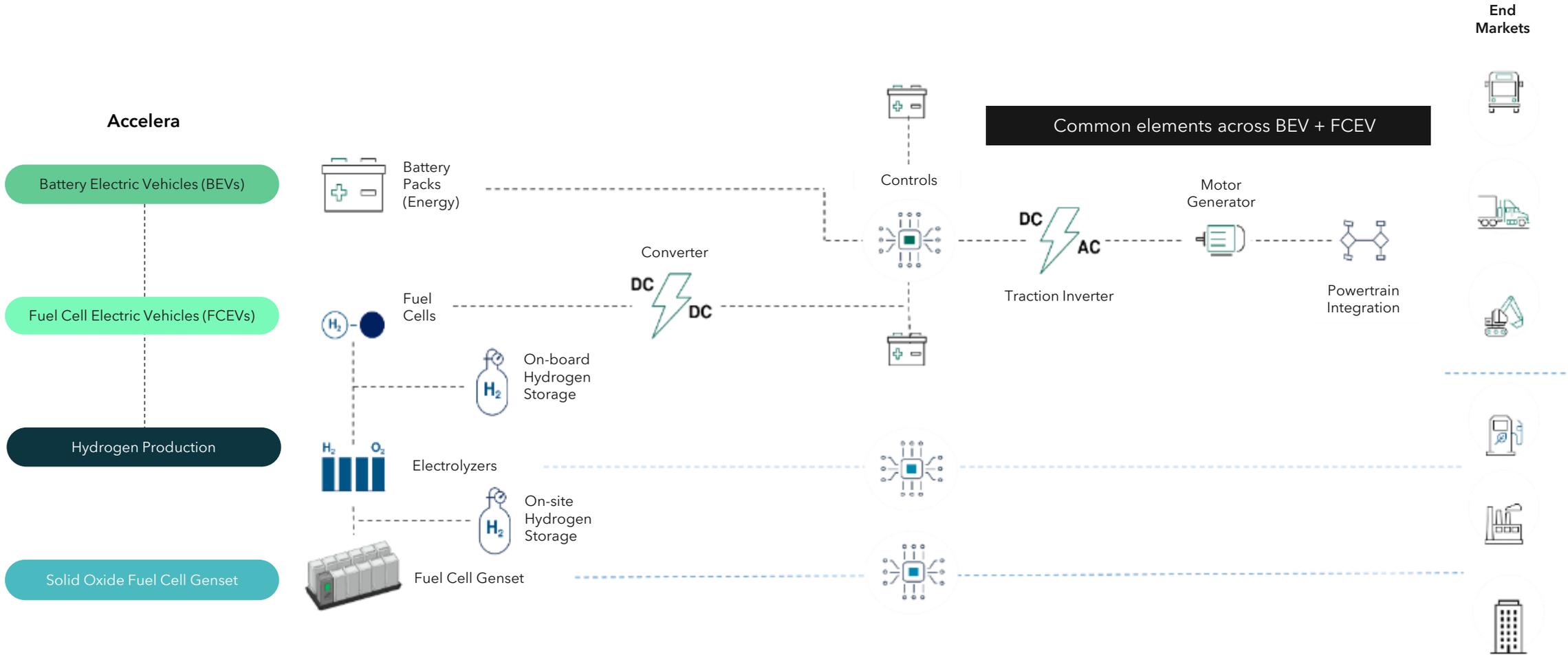
- 1** Oxygen (O<sub>2</sub>) and hydrogen (H<sub>2</sub>) migrate into the fuel cell.
- 2** The oxygen molecules migrate to the catalyst where the anode strips some of their electrons.
- 3** This allows them to move through the cathode and to react with the hydrogen molecules to produce water vapor.



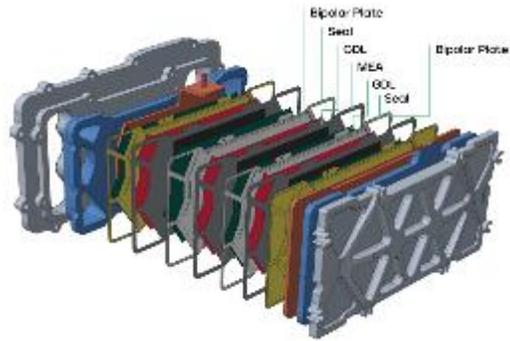
DELIVERING AND SCALING VALUE

# Complementary Technologies

SHARED KEY COMPONENTS AND CAPABILITY REQUIREMENTS



# Accelera innovates throughout the Fuel Cell value chain



## Fuel Cell Stack

- Developing proprietary technology at the core of a Fuel Cell
- Strong partnerships and proven capabilities in manufacturing allows Accelera to gain security of supply and provide differentiating technology

## Fuel Cell Module

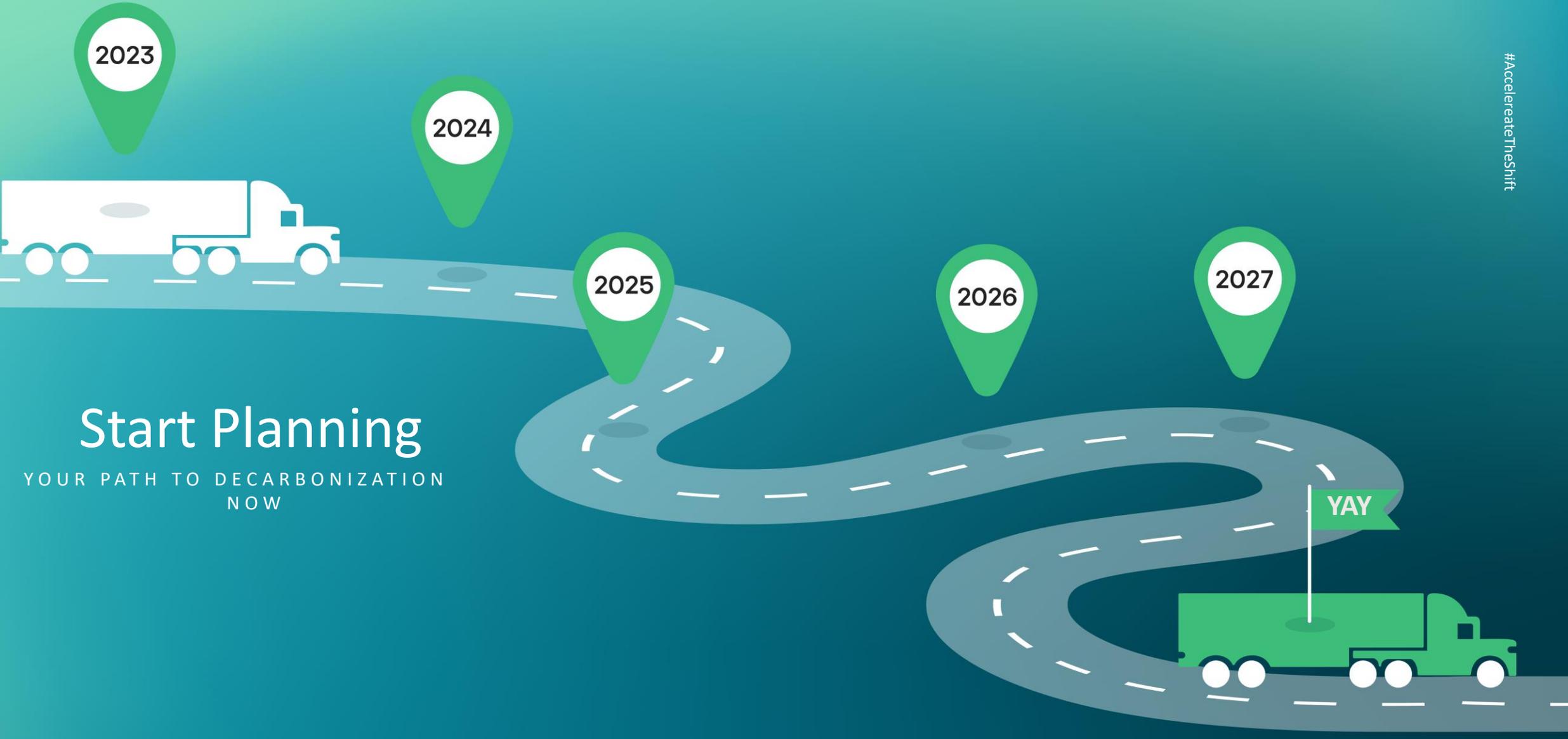
- Pulling forward Cummins advanced Balance of Plat components to enable best in class power densities
- Critical knowhow in Fuel Cell component sizing to ensure the best performance, efficiency and durability

## Fuel Cell Engine

- Increasing scope of supply to further improve performance, of Fuel Cell technology
- Using application and integration expertise to design solutions specifically for on road applications
- Packaging efficiencies provide best in class power density for Accelera Fuel Cell engines

## Powertrains

- eAxle's, Motors, Power Control & Accessory System (PCAS)
- Accelera's advanced application experience positions us to lead in Powertrain sizing and integration
- Diverse and industry leading product portfolio is a key part to our success and enables the development of differentiating and best in class systems



# Start Planning

YOUR PATH TO DECARBONIZATION  
NOW

Emissions Free

# Why Hydrogen?

POWERING THE FUTURE

## Performance

- Operates Quietly
- No compromise to:
  - Payload
  - Gradeability
  - Vehicle performance

## Passenger Comfort

- Uncompromised internal climate control

## High Autonomy

- Range of 300 miles or greater without recharging or refuelling
  - Tank volume dependent

## Fast refuelling

- Refuel in less than 15 minutes
- No extended charging queue or delay
- More time on road

## Technological Synergy

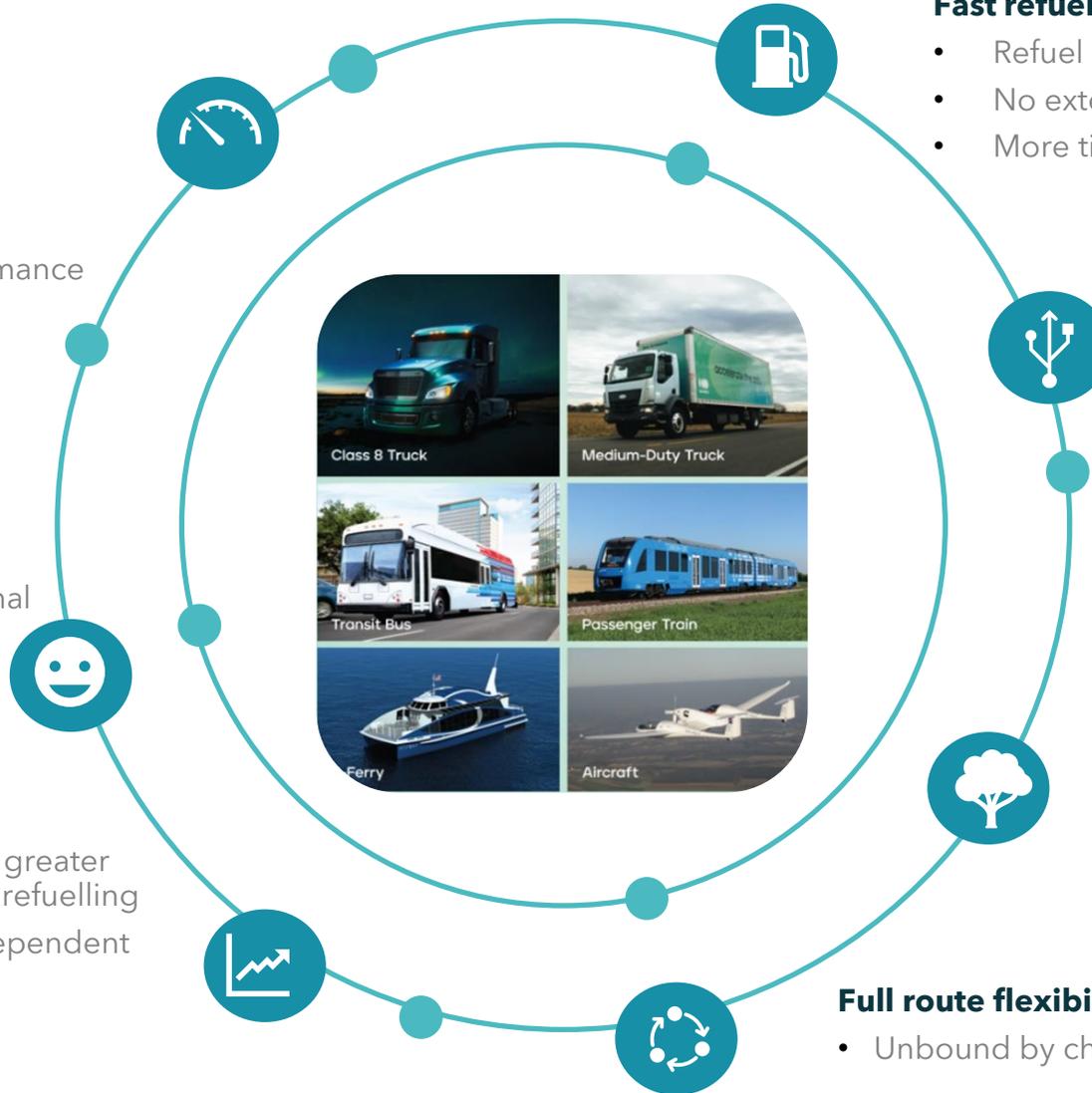
- Onboard battery is managed by the fuel cell for maximum performance and lifetime and vice versa

## Environmental

- Zero Emission at tailpipe
- Zero Emission well to wheel if hydrogen is generated from renewable energy sources

## Full route flexibility

- Unbound by charging schedule on the route



## Field Tests: On- and Off-Highway



- Class 8 fuel cell truck is on the road in California and deploying with a marquee fleet customers



- Fourth-generation fuel cell technology deployed with both Scania and Daimler Truck



- 91 Faun Trucks in operation in Europe on waste collection and sweeper vehicles



- Delivery trucks with European grocery retailer ASKO
- Dump trucks - newly-engineered trucks incorporate an advanced e-powertrain system - comprised of Accelera's 120kW hydrogen fuel cell engine
- Alstom trains operational in Germany, Canada, Saudi Arabia

# From Sea to Sky we're Powering the World with Clean Energy

## FUEL CELL



## ELECTROLYZER



# U.S. Electrolyzer Production

Fridley, Minnesota



*President Biden visits in April*



*Ribbon cutting event in May with DOE Secretary Granholm*

# Accelerating the Shift

Recent successes and news highlights from Accelera by Cummins



## Capabilities

Completed acquisition of **Meritor** and expanding electrification capabilities

Completed acquisition of **Siemens Commercial Vehicle** business, adding traction system technologies to the Accelera portfolio



## Capacity

**Spain:** Construction underway on electrolyzer production plant, opening in 2024

**United States:** Began electrolyzer production in Fridley, MN in April

**Belgium:** Expanded electrolyzer production capacity to 1 gigawatt



## Customers + Partners

**Blue Bird:** 1,000 electric school buses across North America

**Tata:** Pursuing zero-emission technologies in India

**Battery:** Announced a JV with Daimler Truck and PACCAR for battery cell production in U.S.



**Thanks!**