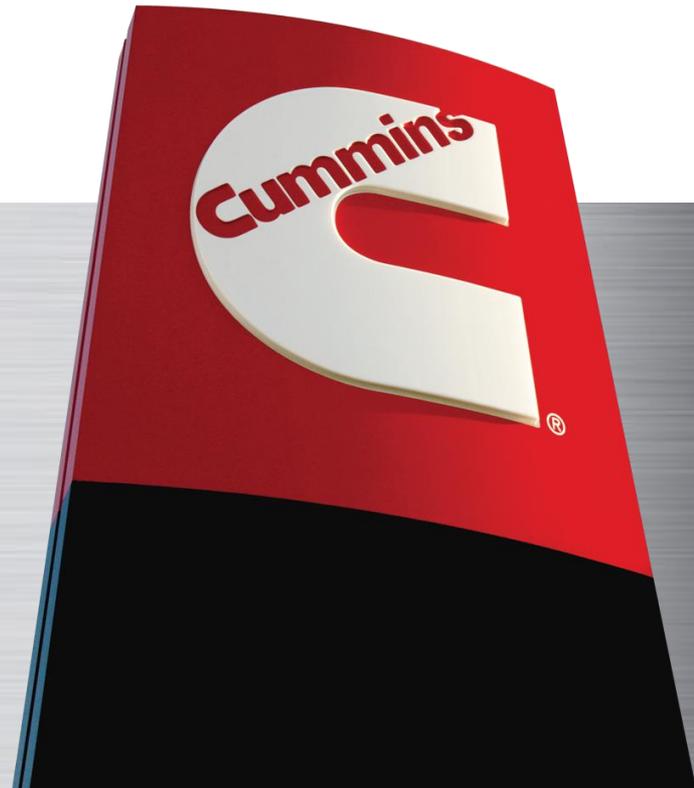


# Cummins - Natural Gas & Electric Powertrains

**David Sturdy**

June 1, 2018





# Overview

- Cummins History
- Cummins Westport Natural Gas
- Why Electrification
- Cummins Value Proposition
- Electrification Strategy
- Where We are Now
- Future Success





THE  
**POWER**  
OF CUMMINS





**190+**

Countries and territories



**55,000+**

Employees worldwide

# Global Presence



**6**

Continents where we develop,  
design and manufacture products



**1.1M+**

Engines produced in 2016

Cummins Westport  
The Natural Choice



## 2018 Engines

David Sturdy, Manager East Region Rail  
and Transit



# Introducing CWI 2018 North American Products

- 80,000 NG Engines in NA. Run on CNG, LNG and RNG
- Fuel savings – 60% less costly than diesel
- EPA/ARB Ultra Low emissions certification. Near Zero L9N, ISX12N (.02 g/hp-hour)
- Lowest Emission MR and HD engines in North America. 13 – 21% less than diesel
- On-Board Diagnostics (OBD) applied for optimal emissions system performance



**ISX12N™**



**L9N™**



**B6.7N™**



2018 Changes	ISX12N™	L9N™	B6.7N™
Emission Certification	EPA/CARB Optional Near Zero 0.02 g NOx	EPA/CARB Optional Near Zero 0.02 g NOx	EPA/CARB Optional Low NOx 0.1 g NOx
NOx Reduction to 2017 EPA	90%	90%	50%
OBD	YES	YES	YES
CCV	YES	YES	YES
TWC	<ul style="list-style-type: none"> <li>• Increase in size (TBA)</li> <li>• One piece design</li> <li>• Mid bed O2/Temp Sensor</li> <li>• OEM Harness</li> </ul>	<ul style="list-style-type: none"> <li>• Same size as '17 ISL G NZ</li> <li>• One piece design</li> <li>• Mid bed O2/Temp Sensor</li> <li>• OEM Harness</li> </ul>	<ul style="list-style-type: none"> <li>• Same size as '17 ISB6.7 G</li> <li>• One piece design</li> <li>• Mid bed O2/Temp Sensor</li> <li>• OEM Harness</li> </ul>
Product Changes	<ul style="list-style-type: none"> <li>• New fuel system improves performance and reduces parts content</li> <li>• On-engine electric CCV filter with 2 CCP sensors</li> <li>• CM2380 ECM</li> <li>• 500 kbaud datalink</li> <li>• New wiring harness</li> <li>• New 2380 ICM</li> </ul>	<ul style="list-style-type: none"> <li>• Steel Pistons</li> <li>• New Liners</li> <li>• Improved Ring Pack</li> <li>• New Valve Seat Material</li> <li>• New Oil Cooler</li> <li>• Improved Piston Cooling</li> <li>• Additional crankcase pressure sensor</li> <li>• New CM2380 ECM</li> <li>• 500 kbaud datalink</li> <li>• New wiring harness</li> <li>• New Ignition Control Module</li> </ul>	<ul style="list-style-type: none"> <li>• Additional crankcase pressure sensor</li> <li>• New CM2380 ECM</li> <li>• 500 kbaud datalink</li> <li>• New wiring harness</li> <li>• New Ignition Control Module</li> </ul>



# Today's Disruptive Trends



ENERGY DIVERSITY

CONNECTIVITY

AUTOMATION

Understanding, embracing  
and enabling these trends  
are how we are shaping our  
strategy at Cummins.

The background of the slide is a dark, almost black, field filled with numerous jagged, glowing white and light blue lightning bolts. These bolts are scattered across the frame, creating a sense of dynamic energy and power. The central text is overlaid on this background.

CUMMINS WILL BE THE  
leading provider of electrified power.



## OUR ELECTRIFICATION VISION

We will be a leader in electrified power in all the markets we serve today.

- Similar to our current position in diesel.
- Recognized as an industry expert.
- Creating sustainable competencies.
- Supporting all market segments.

# PHASE 1

# PHASE 2

# PHASE 3

DRIVERS

Sociability Need  
Capable Current Technology  
Drive Cycle Suitable  
Subsidized

Improved Technology  
Wider Local Regulation Appears  
Still Subsidized

Viable Economics

REGIONS

High Density Urban Cities like London  
Emissions containment areas like LA ports  
Industrial policy driven: China, etc.

High Density Urban Cities in India,  
Eastern EU, etc.  
ULE Zones in US, Western EU

Leapfrogging Diesel Emissions  
(ex: Africa, South America)  
Traditional Commercial Vehicles

EXAMPLES

## MOVING NOW



## WITHIN 5-10 YRS



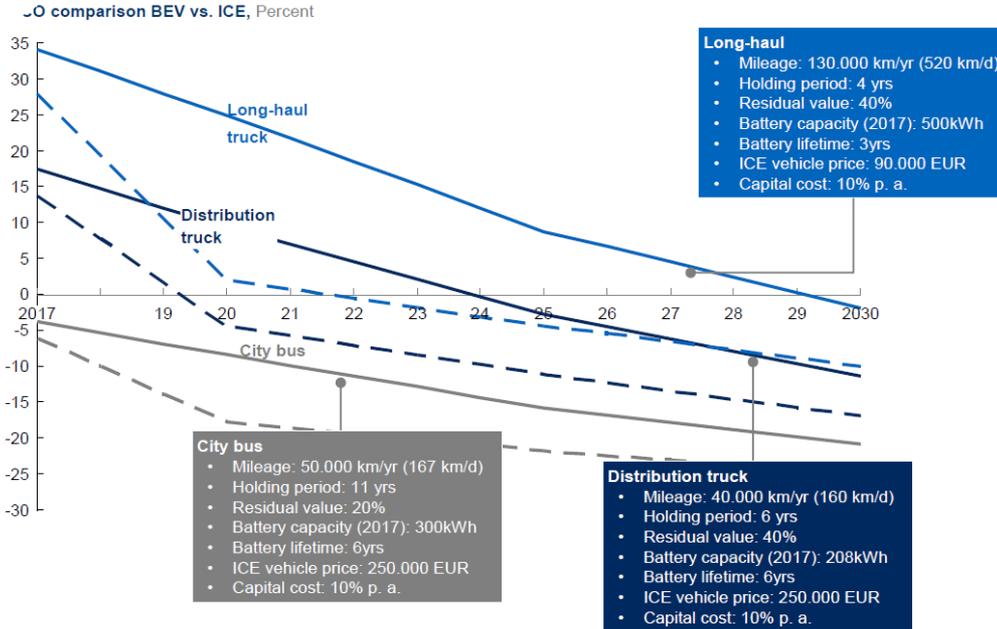
## 10-15 YRS



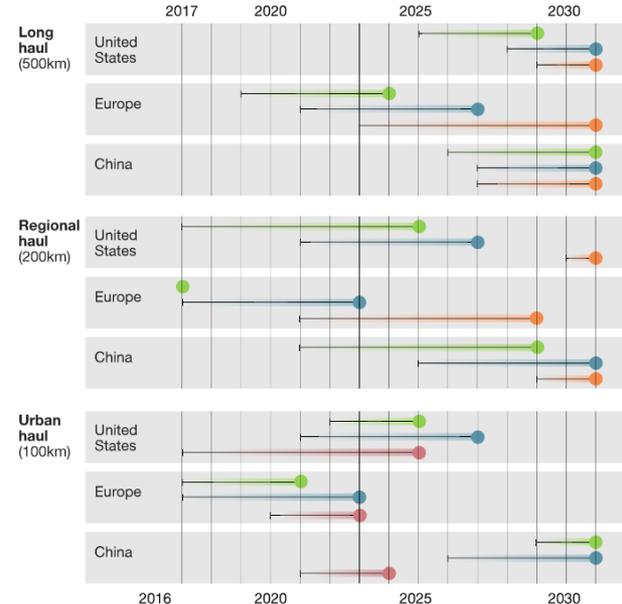
# Current market reports predict tipping point before 2030



Different applications and weight classes will see varying breakeven points for electric vehicle total cost of ownership



Timing of battery electric vehicle total cost of ownership parity with diesel vehicle, year achieved range



Source: McKinsey

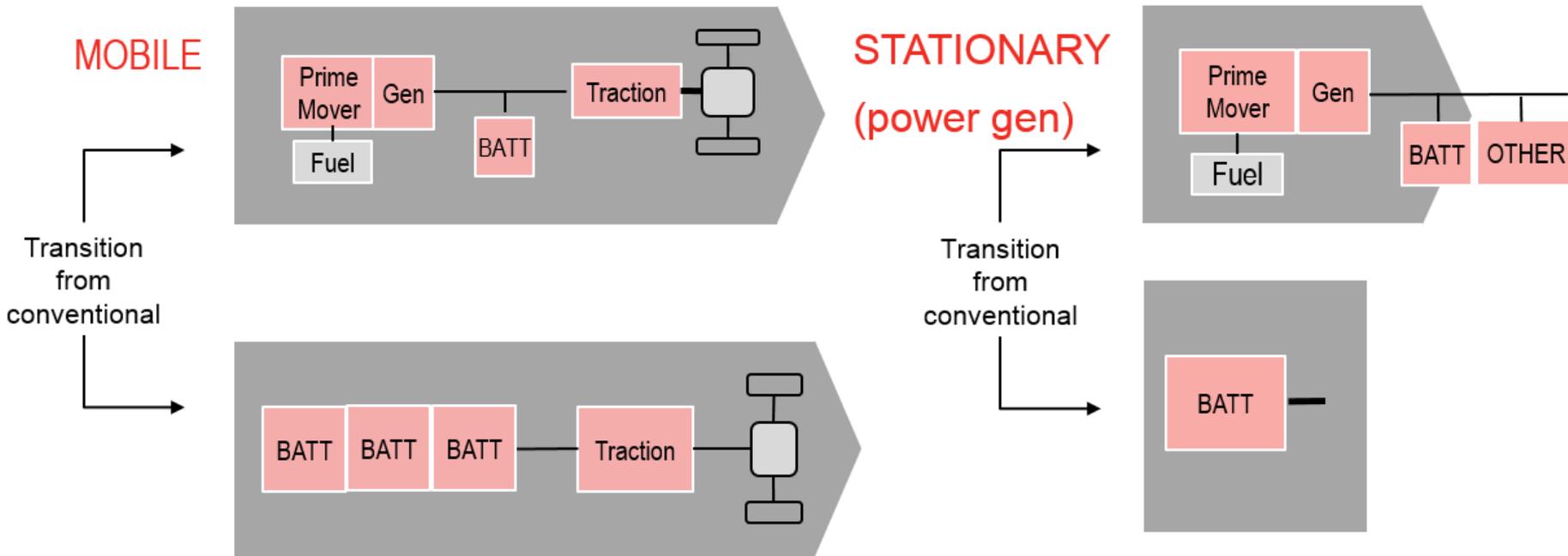
McKinsey&Company | Source: McKinsey Center for Future Mobility

Confidential



# Offering a Portfolio of Options

as segments transition to full electric power





# Current Programs

feeding the overall growth in capabilities



System Controls  
for Full EV



RE System Controls and ESS  
Integration in Urban Bus &  
Truck, Fast Charging



SI System  
Integration in  
Urban Truck



Low Voltage  
Power  
Electronics and  
Energy Storage



High Voltage  
Power  
Electronics  
Integration



Rack-able ESS  
Form and Fit



Electrical  
Machines  
for CV's

## Prepared us for our First Commercial Programs:

- Cummins REEV/BEV Powertrain for Bus
- Cummins Energy Storage System



# Cummins Commercial Programs

are underway

2017				2018				2019				2020			
Q1	Q2	Q3	Q4												



Demonstrators

*Multiple Vehicle Types*



Urban Bus  
Alpha Build



Urban Bus  
Beta Build

- Urban bus segments in US, Canada and EU.
- Range extender (REEV) and battery electric (BEV) powertrains



Urban Bus  
**BEV** Production



Urban Bus  
**REEV** Production



***POWERING* A MORE PROSPEROUS WORLD**