

MOBILITY

INDUSTRY

INSIDER

DEEP DIVE

48V Systems

H2 2019

FutureBridge

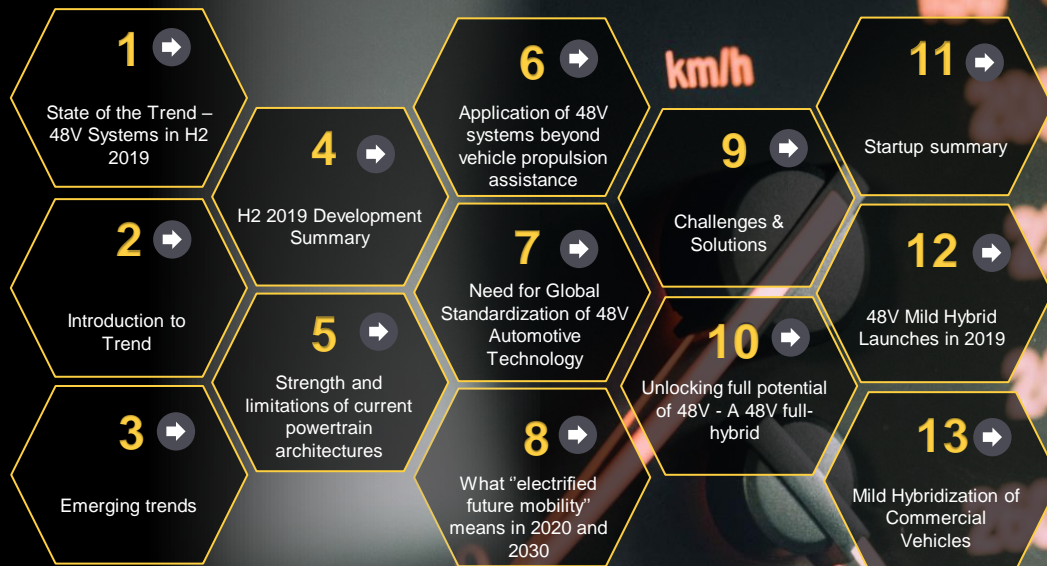


WHAT'S NEW?

H2 2019

EXECUTIVE LENS

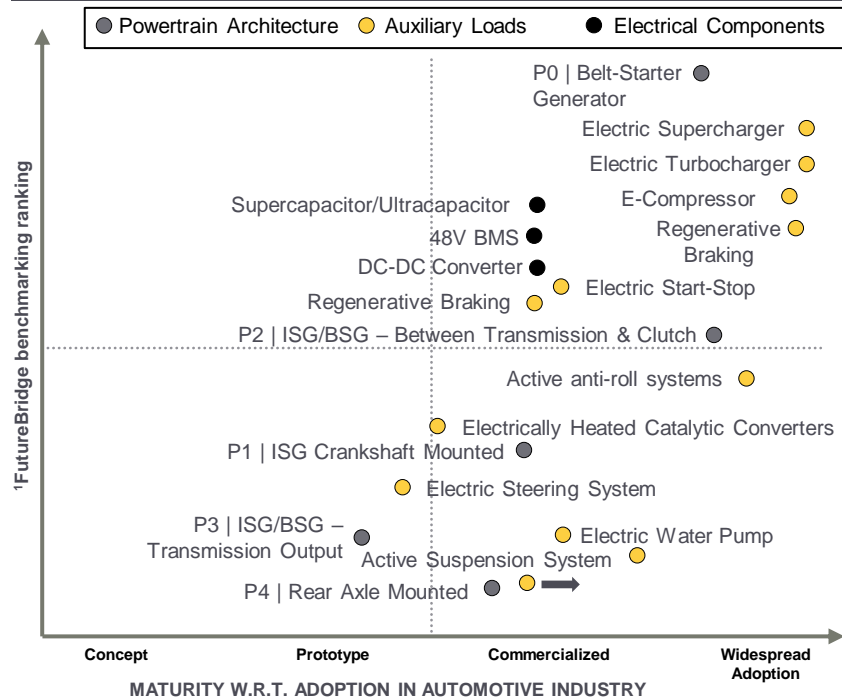
Summarized insights for 48V Systems w.r.t. trends in technology, market, and players



State of the Trend – 48V Systems in H2 2019

Innovation in 48V systems by suppliers continues to boost easy transition to electrification

Which tech/solution categories are on the move? What are the key developments in 48V?



- Audi remains the major OEM to implement 48V mild-hybridization with more than ten models currently in the market. Series production vehicle manufacturers are also following this trend
- H2 2019 witnessed wide spread adoption of 48V active anti-roll systems among luxury SUVs
- 48V full hybrid powertrains which could offer an all electric mode is under development by [Continental](#) and [Valeo](#)

P0 and P2 Powertrain architecture → Multiple vehicle launches and future product line of OEMs with 48V systems indicates momentum for P0 and P2 architecture

48V Battery → Many suppliers are developing 48V based batteries that are optimised for energy recovery and can easily be incorporated in the 48V mild hybrid architecture.

Key Developments in past 6 months

- July 19** Continental [showcases](#) 48V drive solution for full hybrid application
- Sep 19** Bosch and CATL collaborate on 48V battery cells >>>
- Oct 19** Volvo to launch its 3rd gen VEA SI engines with KERS - 48V mild hybrid technology >>>
- Nov 19** Mahle Powertrain unveils new 48V battery prototype optimized for use in mild-hybrid vehicles >>>
- Dec 19** Valeo collaborates with Gunma university on Japan's first 48V four-wheel drive electric light truck >>>

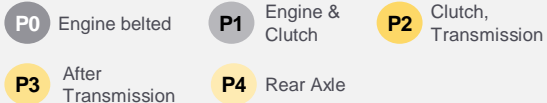
¹ Y-axis: FutureBridge Benchmarking Ranking – Outcome of benchmarking analysis performed based on weightage based model. For more details, please check 'Benchmarking section' >>>

Introduction to Trend

A vehicle power supply standard designed to tackle emission, efficiency and performance of IC engines

What are various technologies in 48V?

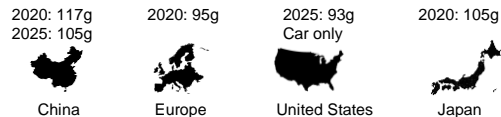
- 48V is a vehicle power supply standard, with power capacity between 10 to 20 kW.
- It utilizes a 48V battery independent/in-tandem with 12V battery with electric motor-generator/ electrical machines (EM).
- Based on the position of EM the architecture of 48 V can be classified as follows:



Why is there a need of 48V?

To meet the upcoming fuel economy and CO2 norms at lowest cost

CO2 limits in g/km →



- Need: Electrification of key components to meet requirements of power hungry systems (e.g. active suspensions)
- Benefits: Higher voltage allows efficient, powerful and light weight components and wire harness

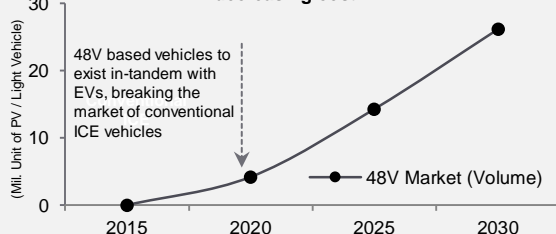
Who are the leading OEMs and suppliers in 48V?



- Key players adopting 48V systems and planning to roll out across vehicle models
- Key suppliers driving the 48V system
- Key startups active in 48V domain

When is 48V likely to achieve widespread adoption?

Increase adoption post 2020 driven by regulation, decreasing cost



Where is the major drive for 48V market?



Europe

Most 48V enabled vehicles launched so far are targeted at EU region



China

Expected to take the lead in future



United States

Will follow through

Things to watch in the next 6-18 months!

- Consumer reluctance towards EVs caused by ranged anxiety and poor infrastructure could force mass-market OEMs to convert their existing models to hybrids
- 48V full hybrids could be made possible by low voltage high power drive units under development by many suppliers and could be a viable option to tackle local zero emission requirements
- Optimized 48V batteries with enhanced energy recovery capacity could become a pivotal factor

Emerging Trends

Increased cost pressure on traditional components on the one hand, and high R&D expenditures to enter a highly competitive alternative powertrain market with initially low sales volumes on the other hand, force choices by automotive suppliers

Which are the upcoming trends in 48V?

Who's behind them?

What do we see happening?

European OEMs have been taking the mild hybrid route

48V systems in course of accelerated development in Q3'19



Volkswagen will use Mk8Golf to introduce 48V mild hybrid powertrain and a new range of micro-hybrids >>>



Mercedes reveals New GLE 53 with Coupe 48V EQ Boost hybrid system >>>



BMW updates its 5 series range with its first 48V mild-hybrid engine option >>>



Audi's new A8, SQ8 TDI SUV, Q3 Sportback features various 48V systems

- Mass adoption of 48V mild hybrids rather than low volume BEVs will have more impact on CO2 reduction and it will also help in meeting the 2030 emission targets

Read more in our Q3 pulse 2019 >>>

48V Systems being developed to be used for off-highway and commercial applications

Technology solution providers and automotive suppliers introduces new technologies to push mild hybridization in commercial vehicles



Avid Technology showcased a 48V MHEV delivery truck concept featuring a fully electrified ancillary system >>>



Ford Tourneo van to be offered in 48V mild hybrid variant with 3 per cent additional fuel efficiency improvement >>>



Eaton Contributes 48V components to Truck manufacturers participating in the U.S. Department of Energy's (DOE) SuperTruck II program >>>



SEG Automotive showcased its new 48V products at IAA 2019, including a 25kW e-machine that can be integrated flexibly in P2, P3 and P4 models >>>

- 48V systems are expected to begin an initial adoption in the commercial truck and agricultural equipment markets within five years or less since more players working on 48V products

48V based Battery technologies are becoming more advanced and matured

Suppliers have been developing battery technologies to support 48V mild hybridization



New 48V MHEV DC/DC converter developed by Texas instrument >>>



Akasol showcases 48V solution AKARack battery system >>>



Hella showcases 48V battery management systems >>>



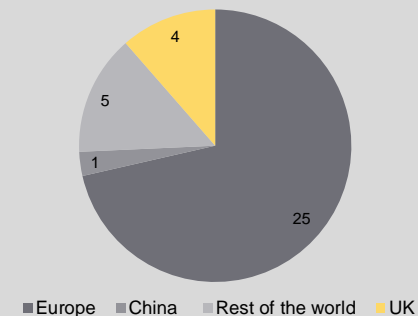
Mahle Powertrain division presents a new 48V battery prototype with improved charge and discharge rates >>>

- Major suppliers have been developing battery technologies based on 48V systems to support electrification strategies

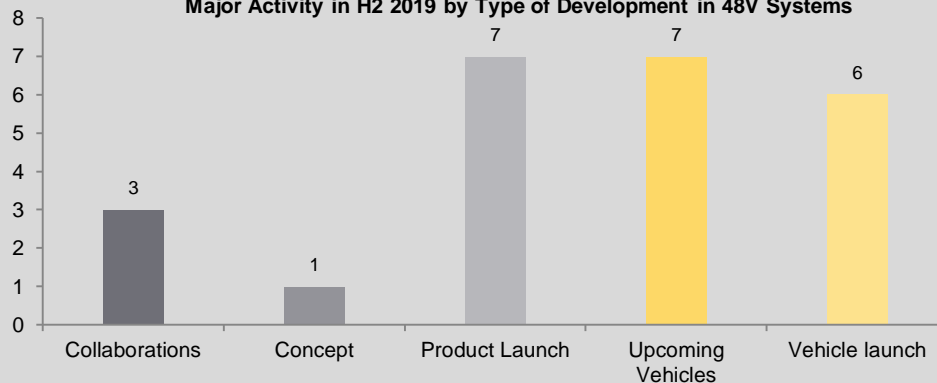
H2 2019 Development Summary

Volkswagen group was making major developments in H2 2019 with announcements of upcoming models and launches and major activities were concentrated around Europe.

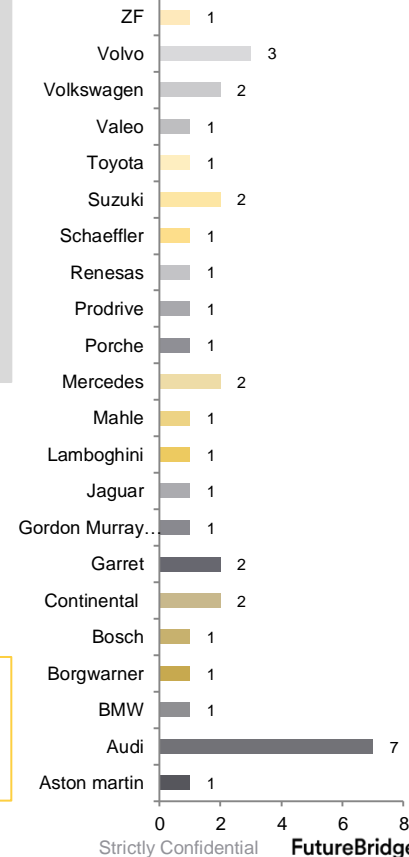
Major Activity in H2 2019 by Geography



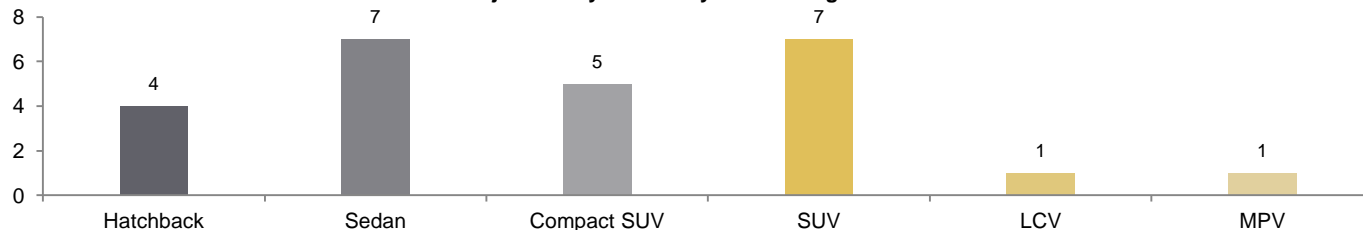
Major Activity in H2 2019 by Type of Development in 48V Systems



Major Activity in H2 2019 by Entity



Major Activity in 2019 by Vehicle Segment



- The number of vehicle models with 48V tech available in the market has considerably increased in 2019 with luxury sedans and SUVs being the major segments of 48V mild-hybridization
- Also, the technology for 48V mild hybrid has matured and hence major activity was seen in new 48V mild hybrid launches
- Volkswagen group has been the leading OEMs focused on 48V mild hybridization with major product launches



Strength and limitations of current powertrain architectures

The diversity and complexity of the powertrain value chain is creating a market disruption. A technology neutral assessment of existing powertrain architectures exhibits their strengths and limitations

		ICE Powertrain			E-Powertrain	
		ICE	MHEV	PHEV	BEV	Fuel-cell EV
Environment	T2W emissions	Challenged	Moderate	Good	Excellent	Excellent
	W2W emissions	Challenged	Challenged	Good	Good	Good
	Recycling	Good	Good	Moderate	Challenged	Moderate
Performance	Range	Excellent	Excellent	Excellent	Moderate	Good
	Refueling time	Excellent	Excellent	Moderate	Challenged	Good
	Acceleration	Good	Good	Excellent	Excellent	Excellent
	Top speed	Excellent	Excellent	Good	Moderate	Moderate
Economics	Current TCO	Excellent	Excellent	Good	Moderate	Challenged
	Price	Excellent	Good	Moderate	Challenged	Challenged
	Infrastructure costs	Excellent	Excellent	Good	Challenged	Moderate
Key performance parameters	ICE power, kilowatts (kW)	50-400	50-400	50-200		
	Electric power, kW		<25	<100	>100	>100
	Battery capacity (kWh)		<2	<30	>40	<10
	T2W CO2 savings, % CO2		10-20%	50-80%	100	100



Excellent



Good



Moderate



Challenged

Can MHEV bring out the better of two worlds?

Four key factors that could determine the speed of adoption of alternative powertrains are **Regulation, Infrastructure, Technology and Consumer preference**

- Regulations:** With tech developments like [Continental's full hybrid system](#) delivering 30kW paving way for 100% electric operation, the European regulation challenge of 95g/km by 2020 is an achievable target for MHEVs.
- Infrastructure:** 48V mild-hybrids doesn't demand major infrastructure changes which makes it more welcoming to existing market
- Technology:** With players like [Mahle](#) working on compact and cost effective batteries that is capable of high charge and discharge power levels relative to its storage capacity for 48V systems, there is still potential for technology breakthrough in mild-hybridization
- Consumer preference:** Consumer reluctance to make the switch from fossil fuels to electrons for automotive transport could be blamed on everything from patchy recharging infrastructure to relatively elevated EV prices to cheap oil. This could provide the right window for MHEVs to broaden its market footprint



Application of 48V systems beyond vehicle propulsion assistance

Cost effectiveness, simplicity and other advantages of 48V systems have helped OEMs to develop and deploy 48V solutions in other areas including vehicle dynamics

Infotainment

Instrumentation
Navigation
Displays
Communication
Audio Amplifier



Chassis and Safety

Suspension System
Parking Brake
Roll Stabilization
Active suspension system
Vacuum Pump
Electric Power Steering
ABS/ESP
IPB (intermediate power bus)
iBooster (Bosch)

Body Control

Access system
HVAC Control
Rear Window Heater
Wipers
Seat Heater
A/C compressor
Electric Heating
Exterior Light
Windscreen Heater
Auxiliary Heater
Low Beam Light
LED Daytime Light

■ : 12V Systems

■ : 48V Systems

Recent Developments



- Bentley introduced its dynamic ride technology in Bentayga where they fitted electric motors between the two halves of anti-roll bar and uses planetary gear sets to multiply torque, and can deliver up to 959 lbs-ft of torque to each anti-roll bar. >>



- The Audi SQ7 features a 48V system which controls the electromechanical roll stabilization system (EAWS), and also powers an Electric Powered Compressor (EPC) to eliminate turbo lag as the first turbo spools up >>

Recent Developments



- The Audi A8 comes with a predictive active suspension powered by 48V system which can lift up or force down each of the luxury sedan's wheels individually, to manage the body's ride height in every situation actively >>



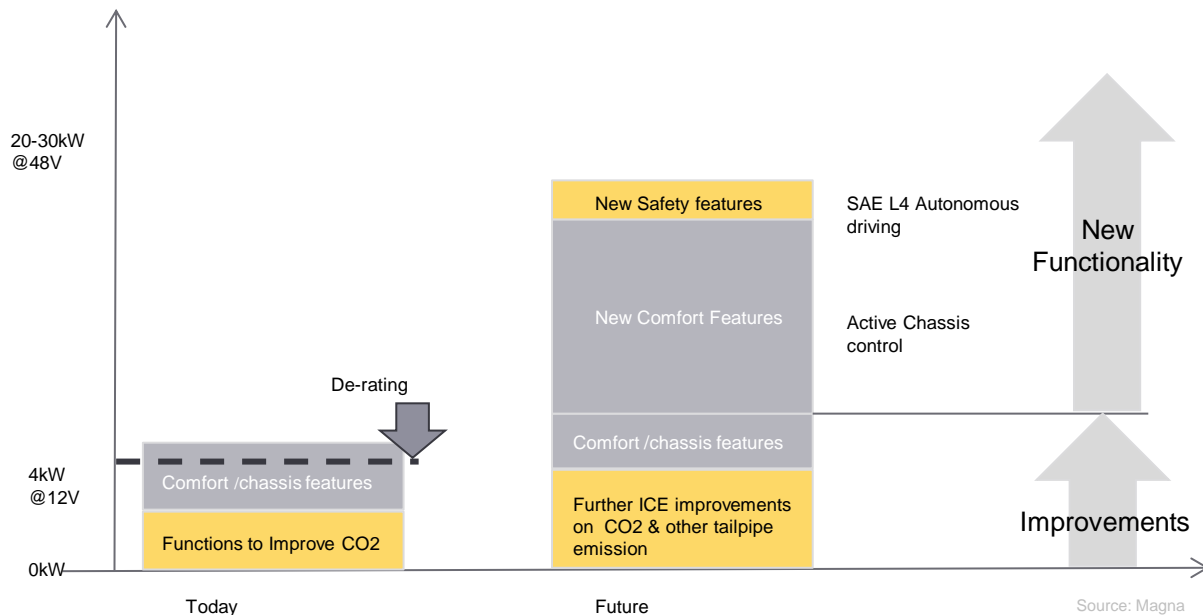
- Mercedes E-Active body control in which suspension damper is connected to an intelligent motor/pump unit in the 48V network by hydraulic lines >>

- 48V hybridization has become an attractive and viable option due to significant savings in weight, package space and cost compared to high voltage alternatives
- Safety considerations for vehicle maintenance are also a key factor in the adoption of 48V architectures



Need for Global Standardization of 48V Automotive Technology

Global market is observing expansion of 48V applications beyond MHEVs, energy recuperation and torque boost, which demands global standards for 48 volt systems



Standard Under development: ISO/DIS 21780

Road vehicles — Supply voltage of 48 V — Electrical requirements and tests –Under development

- suppliers of components and sub-systems will have a global unambiguous standard in order to save development time and costs, as well as guaranteeing a well-tested, defect free product. >>>
- ISO has tasked the ISO/TC 22/SC 32 Technical Committee with developing such a unique 48V specification. >>>

Overview

Existing standards are inadequate to directly address the 48V powernet

- ISO 7637 which specifies test methods and procedures to ensure the compatibility of the conducted electrical transients of equipment installed on passenger cars and commercial vehicles fitted with 12V or 24V electrical systems is generic and does not address specific issues regarding electrical requirements and testing applicable to 48V
- Current specifications for 48V exist in the form of V148/VDA32 Source >>>

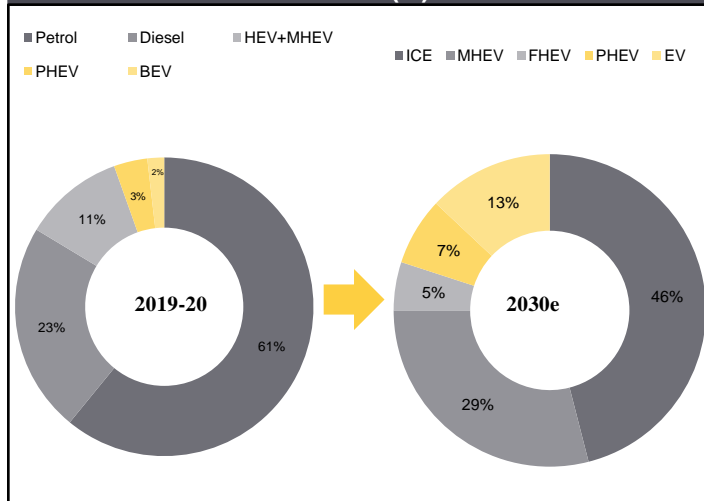
Benefits for suppliers

- Conformance to a single global standard builds customer confidence that products are safe and reliable
- Suppliers will be able to meet regulatory requirements, at a lower cost
- A global standard will cut costs for suppliers developing solutions for international markets
- A single standard makes it easier for suppliers to access global markets
- Component level and System level testing time and costs will be reduced

What "electrified future mobility" means in 2020 and 2030

MHEVs are expected to reach their market peak in the next decade with the arrival of more and more cost optimized high power 48V tech solutions

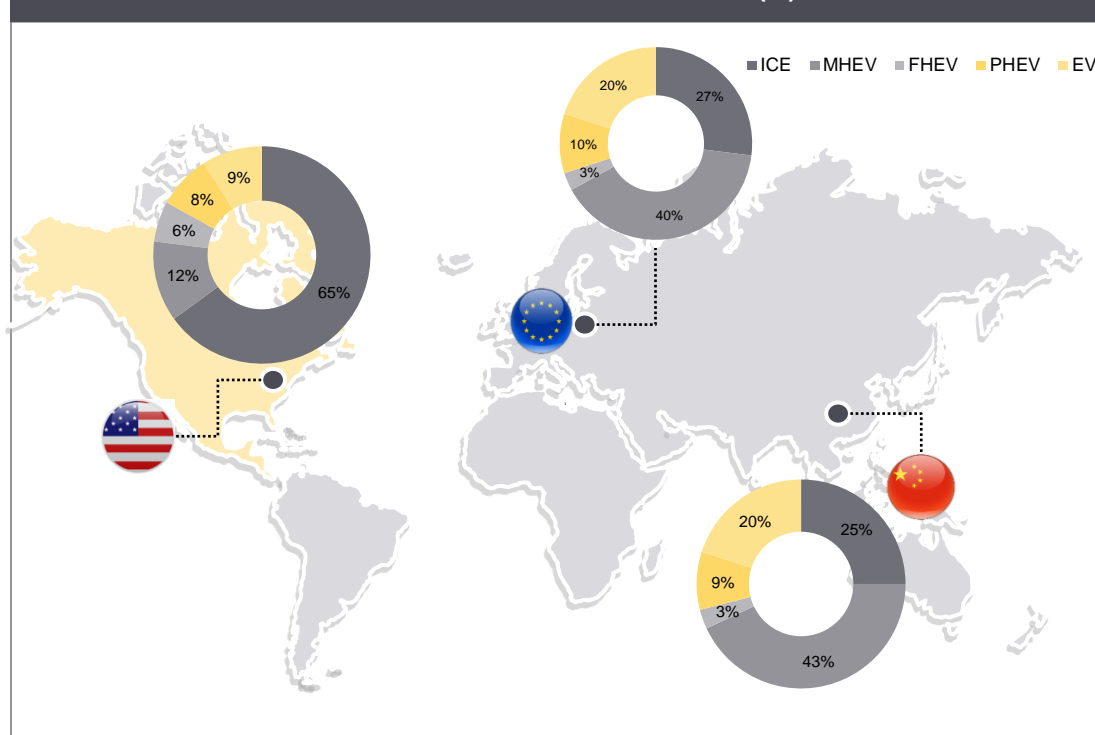
Global car sales forecast by powertrain:
2020-30 (%)



Source: IEA, FutureBridge

- For both North America and Europe, hybrids and BEVs are set to lead over the next decade as plug-in hybrids are not proving very popular in either region
- China is expected to lead the EV market in the next decade as well

Powertrain share forecast 2020-30 (%)



Source: IEA, FutureBridge

Challenges & Solutions

New 48V solutions from OEMs and suppliers to help in smooth transition of commercial and passenger vehicle to electrification

NEW

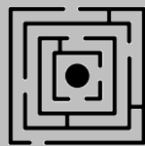
- Market requirement of a battery with high charging and discharging rates compared to its capacity for use in energy recuperation systems



- To restrict vehicle body roll for SUVs and provide active safety



- Provide better ride comfort, handling characteristics and agility



CHALLENGES



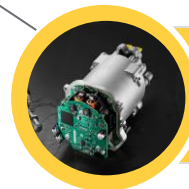
48V SOLUTIONS



- Mahle Powertrain division presents a new 48V battery prototype with improved charge and discharge rates \geq



- OEMs such as Daimler, Audi, Aston Martin has developed active anti-roll bar systems using 48V tech \geq



- Mercedes E-Active body control in which suspension damper is connected to an intelligent motor/pump unit in the 48 V network by hydraulic lines \geq

NEW

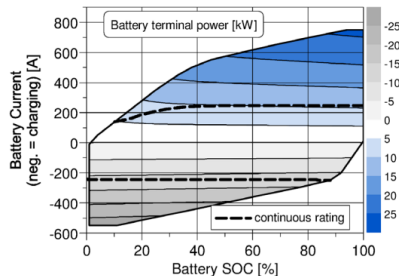
Challenges & Solutions

New 48V battery solution performance optimized for use in MHEV energy recuperation systems from MAHLE

Industry Requirement

- During deceleration and coasting, the 48V systems in mild-hybrid vehicles need to recover energy efficiently and at a relatively high power.
- This application which comprises of recharge and discharge cycles involving high currents does not require a high storage capacity battery rather it requires a compact and cost effective battery that is capable of high charge and discharge power levels relative to its storage capacity.

MAHLE



Charging and discharging power map targets >>>



Development

Mahle Powertrain division presents a new 48V battery prototype with improved charge and discharge rates



Innovation

Lithium Titanium-Oxide (LTO) chemistry in the prototype battery cells allows continuous charge / discharge rates of 10 kW and peak rates for short periods up to 20 kW from a battery pack that has only a 0.5 kWh storage capacity



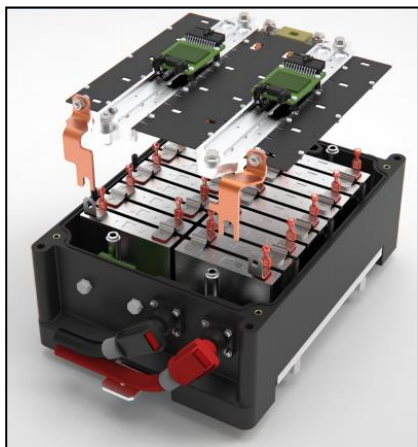
Battery Cooling

Optimized the battery cooling system to maximize the recuperated energy which could have a potential fuel savings up to 12 to 15 percent



Next Step

The battery prototype is under testing to verify the performance targets and will be soon installed in MAHLE Powertrain's 48V eSupercharged extreme downsizing demonstrator vehicle for on-board testing



MAHLE 48V Battery >>>



48V eSupercharged extreme downsizing >>>

Technical specifications

- Power: 260bhp
- Torque: 315 Nm@1500
- BMEP: 33 bar
- CO₂ output NDEC: 25% reduction compared to baseline engine

Unlocking full potential of 48V - A 48V full-hybrid

Recent developments and introduction of breakthrough technologies related with 48V systems points to the advent of a 48V full-hybrid vehicle. A fact check and investigation of positives



Overview

- Faster than previously anticipated by some in the industry, 48V full hybrid versions for cars, buses and trucks are being prepared that are a fraction of the cost of the high voltage versions currently offered.
- Today's full hybrids are now under severe pressure from two directions. Engine-dominant parallel and series-parallel hybrids will lose to the quieter, lower cost 48V full hybrids.
- Battery-dominant series hybrids like the LEVC London taxi and the BMW i3 range extender version will hand over to rapidly-improving pure electric options

Investigation of positives

- Potential advantages includes
 - Pure electric drive mode
 - Engine off - leaving
 - Active coasting
 - Silent parking
 - Achieve local zero emission targets

Recent Developments

- **Valeo** collaborates with Gunma university on Japan's first 48V four-wheel drive electric light truck >>

Powertrain: Valeo's proprietary eDrive motors on front and rear axles enabling 4x4

Capacity: 15kW

Range: 100kms (under testing)

Future: Testing continues to achieve 100kms with 100km/h top speed



Valeo 48V four-wheel drive electric light truck

- **Continental** showcased technologies for the safe, clean and connected mobility of the future at IAA 2019
- Continental Powertrain presented its 48V full hybrid system which delivers up to 30kW which can be integrated with both SI and CI engines >>
- Continentals full hybrid system is in its infant stage and is undergoing various testing



48-volt high-power electric motor

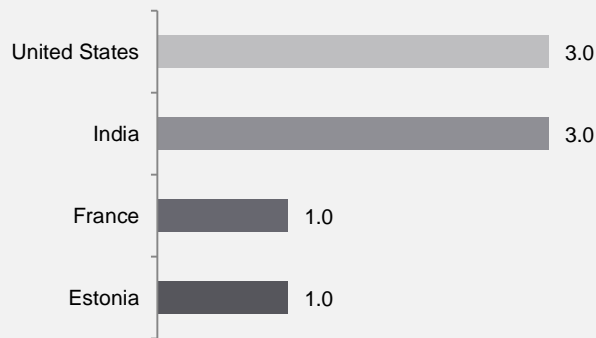
- A 48V full hybrid was not feasible up until recently. Faster than previously anticipated by some in the industry, 48V full hybrid versions for cars, buses and trucks are being prepared that are a fraction of the cost of the high voltage versions currently offered. The 48V mild-hybrid technology, which greatly improves the ICE efficiency at relatively low cost, is a sensible compromise in terms of cost and emissions

Startup summary

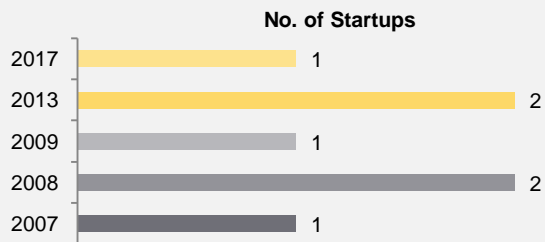
Though majorly dominated by automotive suppliers, startups are now finding relevancy in 48V battery and Ultracapacitor Technologies

Startups by geography

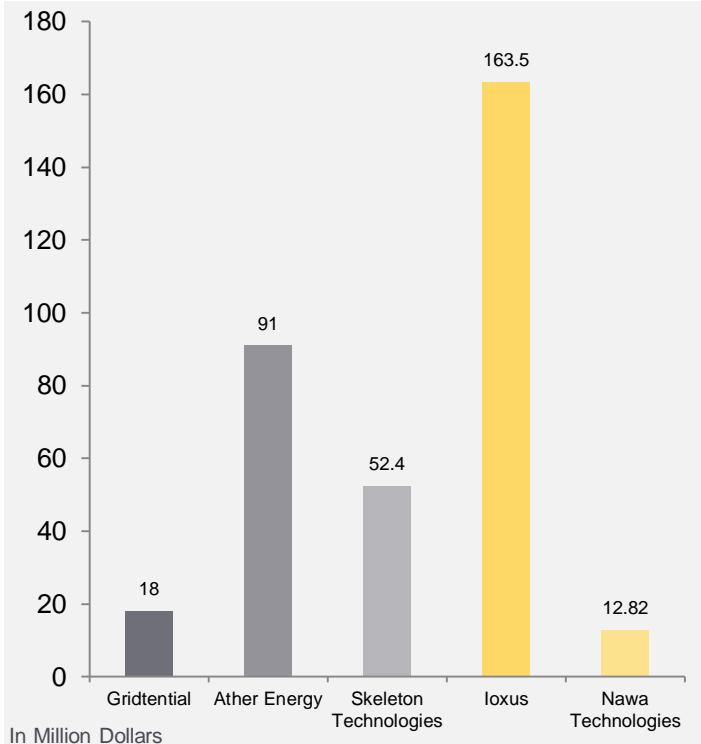
Number of Startups by Originating Country



Number of Startups by Year



Startup funding distribution (H2 2019)



Ultracapacitor for automotive application



Novel silicon based battery technology



Aftermarket 48V solution

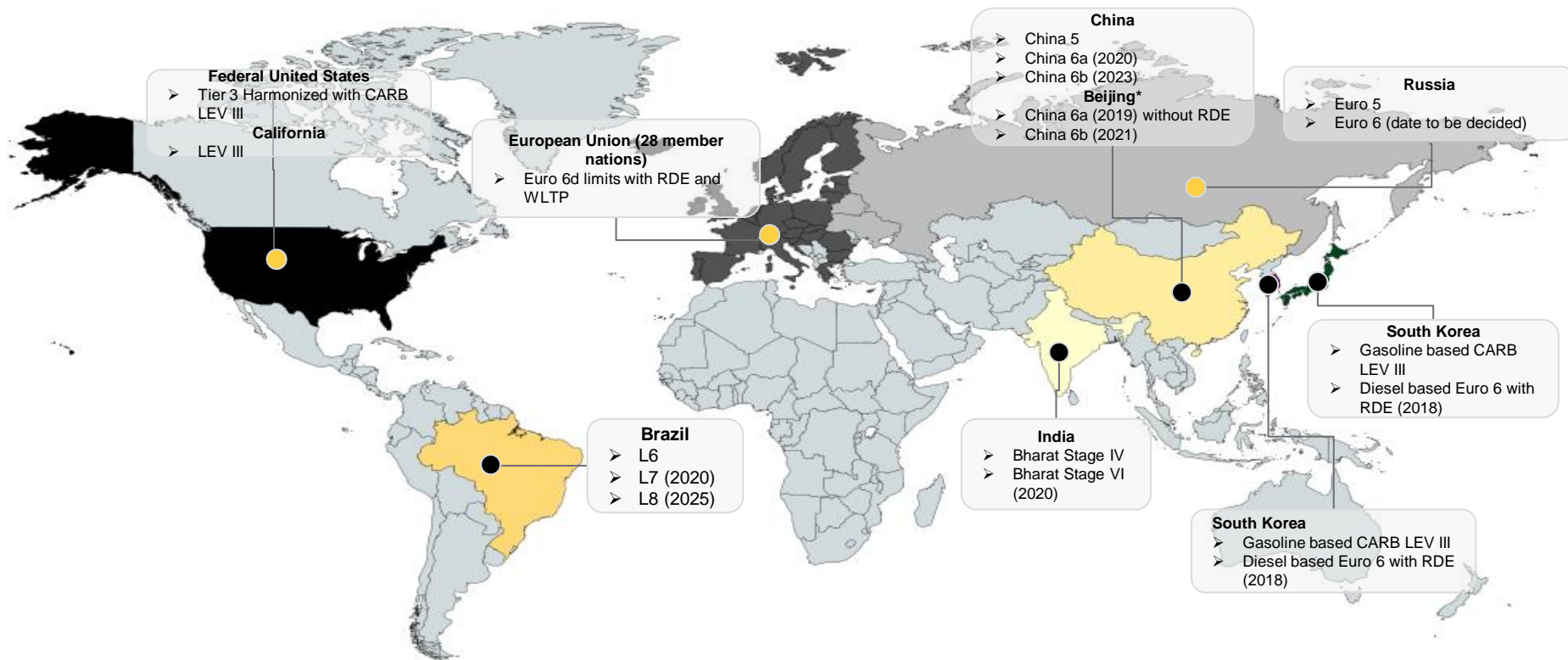


Investment by

Delphi Technologies

Global Regulation Lens: Passenger Vehicle

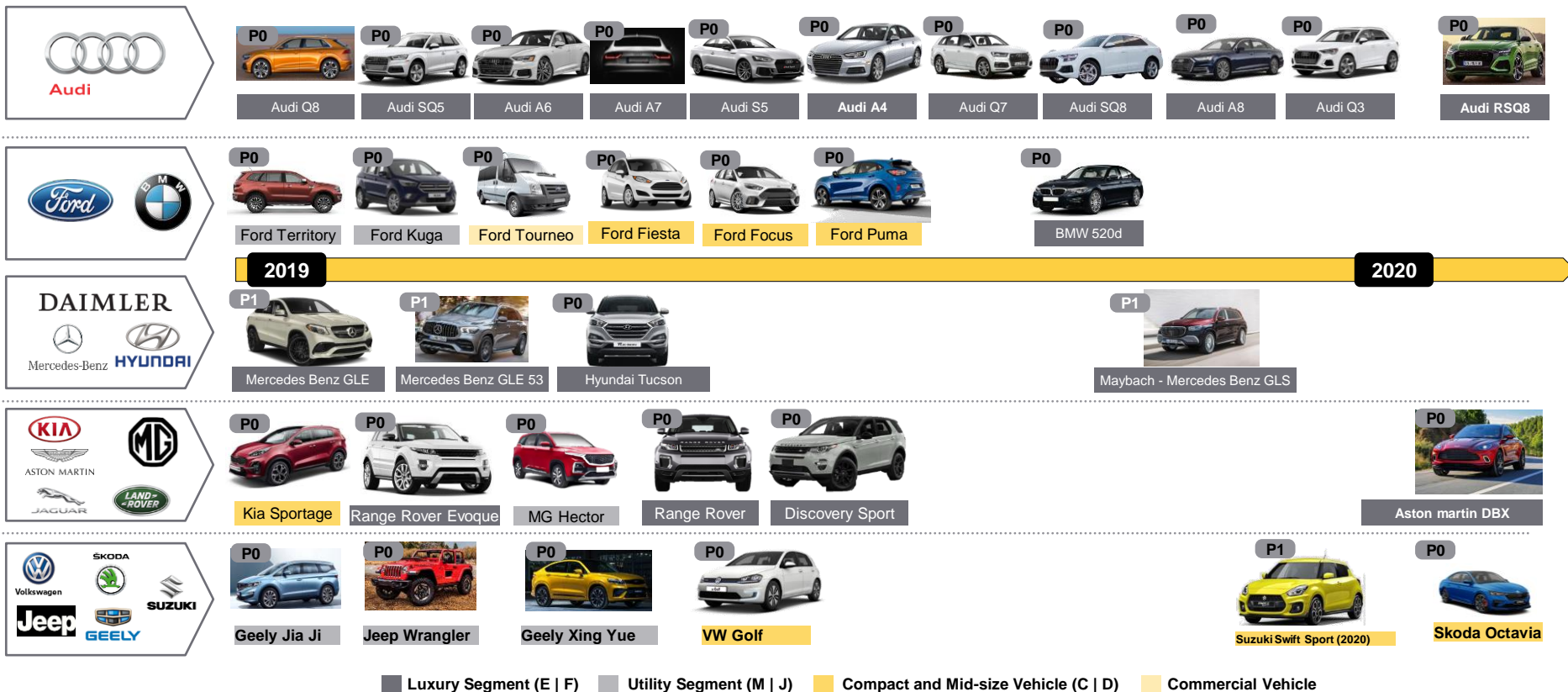
Passenger vehicle emission regulations are becoming more stringent forcing OEMs to innovate new ways to control the exhaust gas emissions and 48V systems stands as a viable option for achieving this in a cost effective way.



Source: Continental

48V Mild Hybrid Launches in 2019

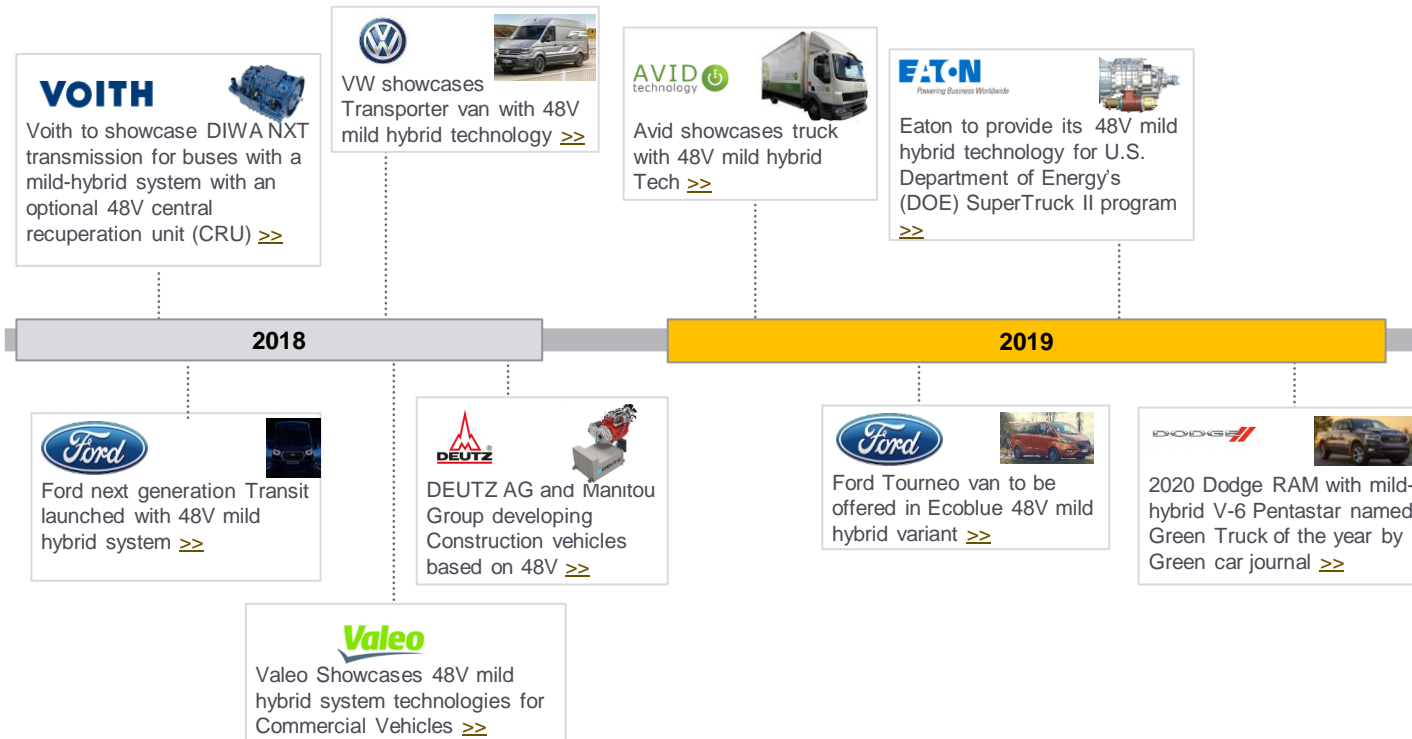
Timeline for 48V mild hybrid launches in 2019



Mild Hybridization of Commercial Vehicles

Major OEMs and Suppliers are adopting 48V mild hybrid technologies and developing it for Commercial Vehicles

How players are working towards capturing market opportunity in Commercial Vehicle Mild hybridization?



- The 48V Mild hybrid technology is being developed and implemented for commercial vehicles by many OEMs and Suppliers like Ford has already launched two vans with 48V mild hybrid Tech.
- Also, It is also being considered for Industrial vehicle applications like Duetz applying it in construction vehicles

North America

55 Madison Ave, Suite 400
Morristown, NJ 07960
USA
T: +1 212 835 1590

Europe

328-334 Graadt van Roggenweg
4th Floor, Utrecht, 3531 AH
Netherlands
T: +31 30 298 2108

United Kingdom

5 Chancery Lane
London EC4A 1BL
United Kingdom
T: +44 207 406 7548

Asia Pacific

Millennium Business Park
Sector 3, Building # 4, Mahape
Navi Mumbai 400 710
India
T: +91 22 6772 5700