



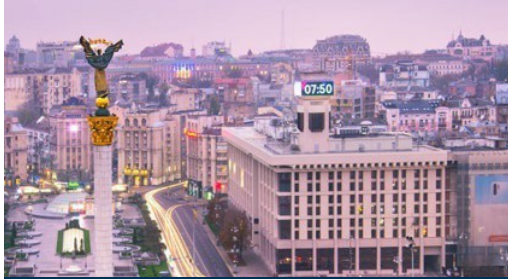
GIZ Electrolyser & Hydrogen Fuel cell
event – Johannesburg, 7th of June 2023

Mobility for today and tomorrow – meeting climate targets and exciting customers

Jean-Philippe Marillet

Head of Mobility Solutions, Original
Equipment – Region Africa
Robert Bosch (Pty) Ltd

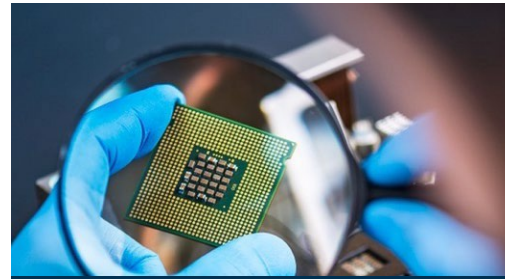
A turbulent time
...but technology gives us courage



Political crises



Energy supply



Raw material and
chip shortage



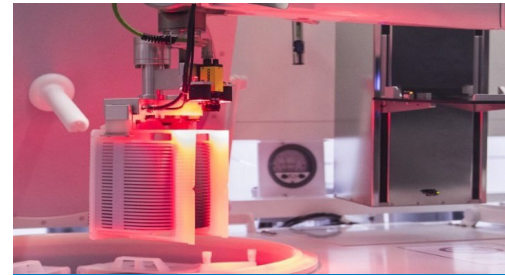
Covid-19
pandemic



Battery-electric
mobility



Heat pumps



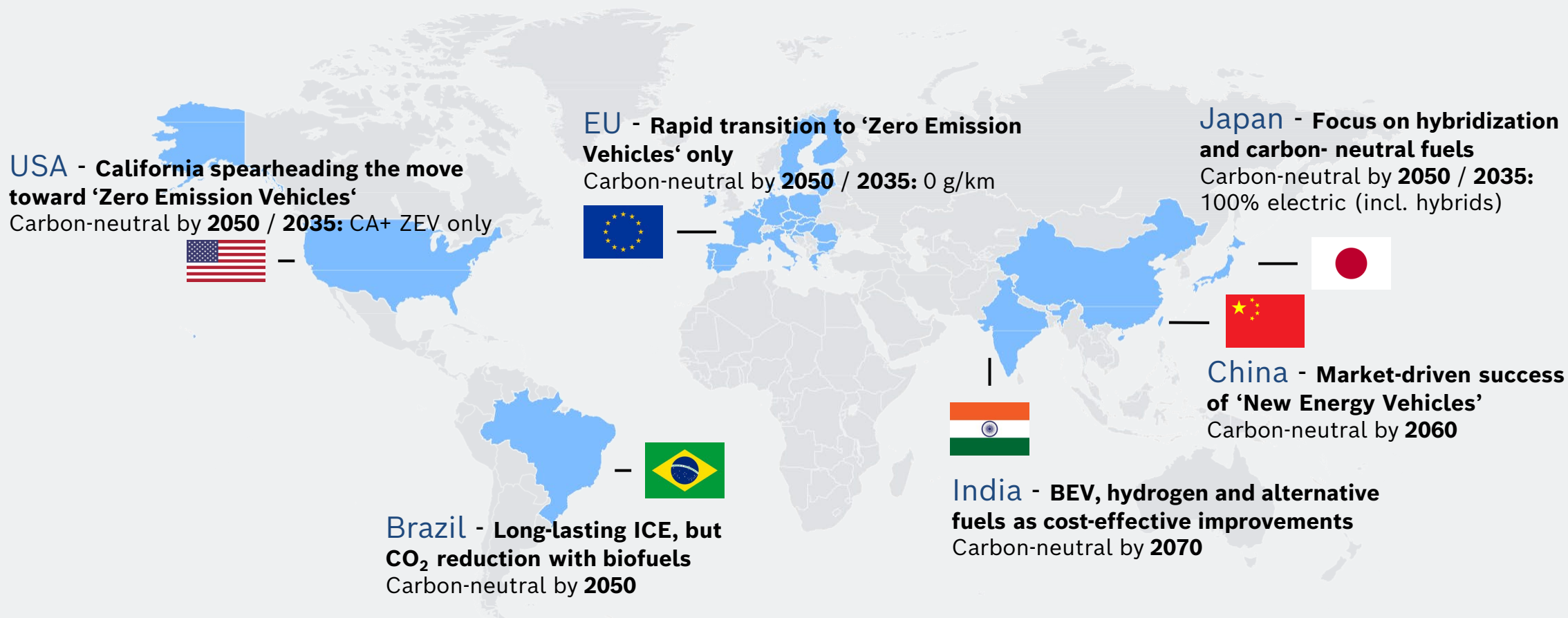
Semiconductor
industries



Mobile fuel cells

Legislation and future powertrain mix

Different paths to carbon neutrality and emission reduction... What would be the one chosen by South Africa and Africa ?



Renewable fuels

The challenge is to fuel all powertrains with renewables



Europe

Focus on **EV** and **H₂**.
Commitment to ICEs w/
carbon-neutral fuels



USA

Massive **H₂ production**
and infrastructure
spending



Brazil

CO₂ reduction **with**
renewable fuels as
mainstream



Japan

Hydrogen and
renewable fuels in the
government's roadmap



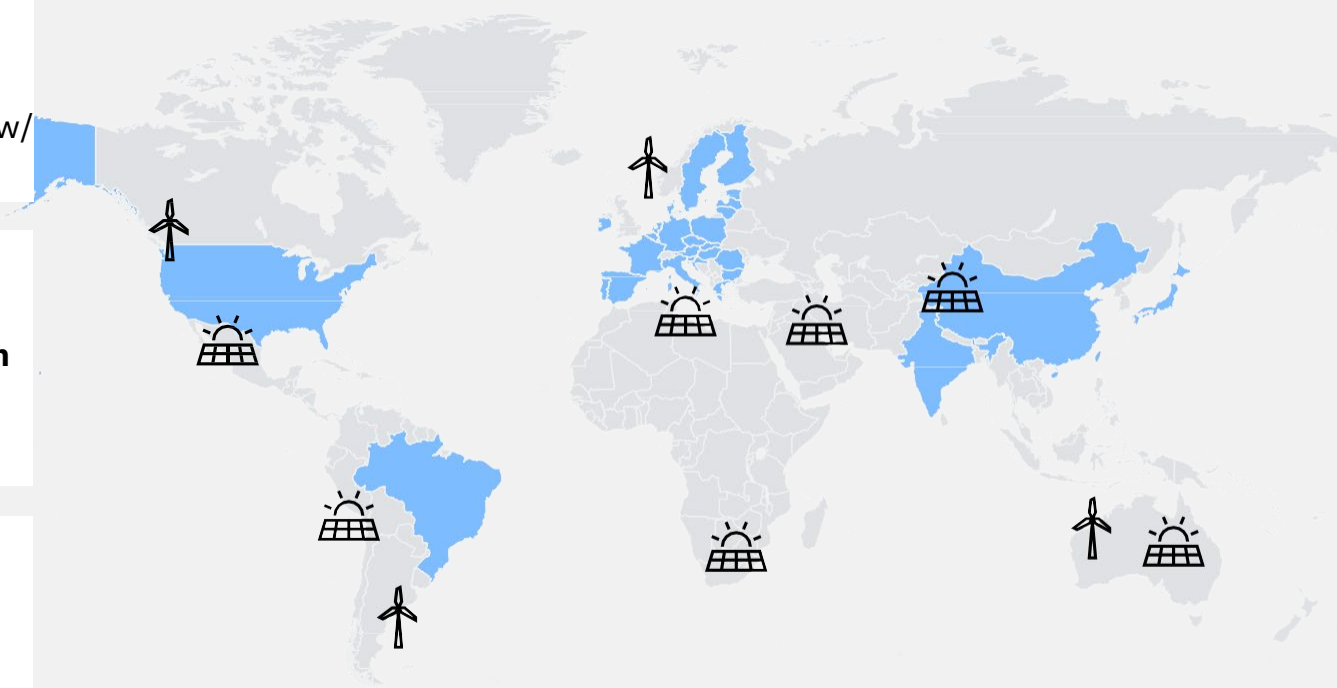
China

Focus on **new**
energy vehicles
and **infrastructure**



India

Alternative fuels and
National Hydrogen
Mission. First
hydrogen engine
vehicles to be on
the road



Schematic representation



Area with high
solar power potential



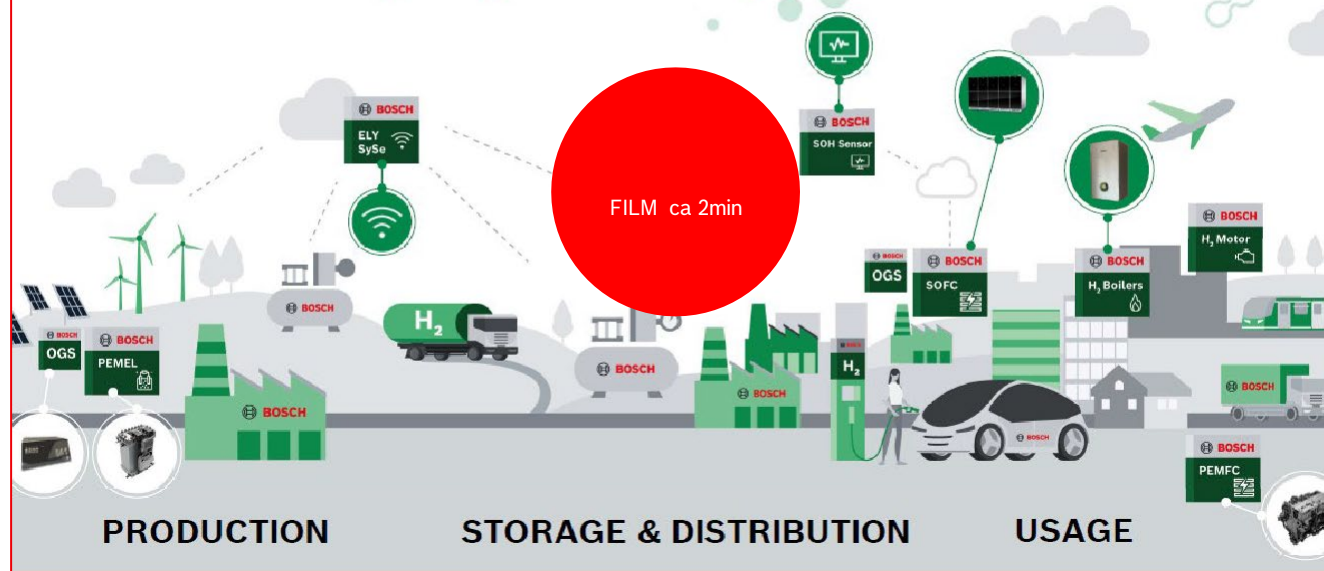
Area with high
wind power potential

Liquid **energy carriers** make **renewable energy usable** worldwide



BOSCH

Bosch and the hydrogen economy



H₂ production

Bosch provides the heart of the electrolyzer – the Stack



Control unit



Power electronics



Sensors



Digital service
portfolio for
electrolysis
system



1.25 MW maximum power input*



~50 kWh/kg H₂ maximum efficiency* **



23 kg/h H₂ output at full load



>30 bar H₂ output pressure

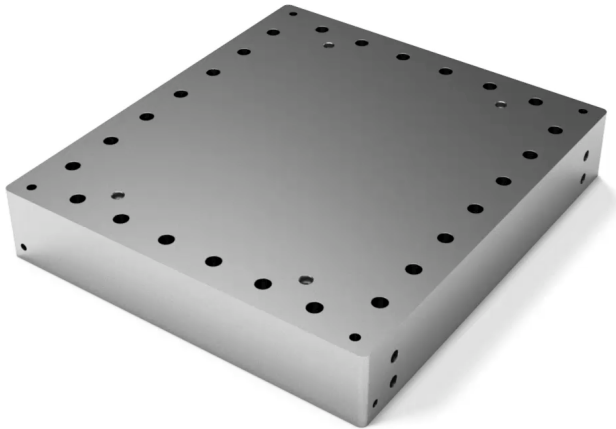
All values are subject to development activities and provided on a non-reliance basis.

* Beginning of life

**At partial load

H₂ production

The Bosch stack provides a wide range of benefits



Automotive
engineering and
manufacturing
capabilities



Synchronized
design for easy
integration and
commissioning



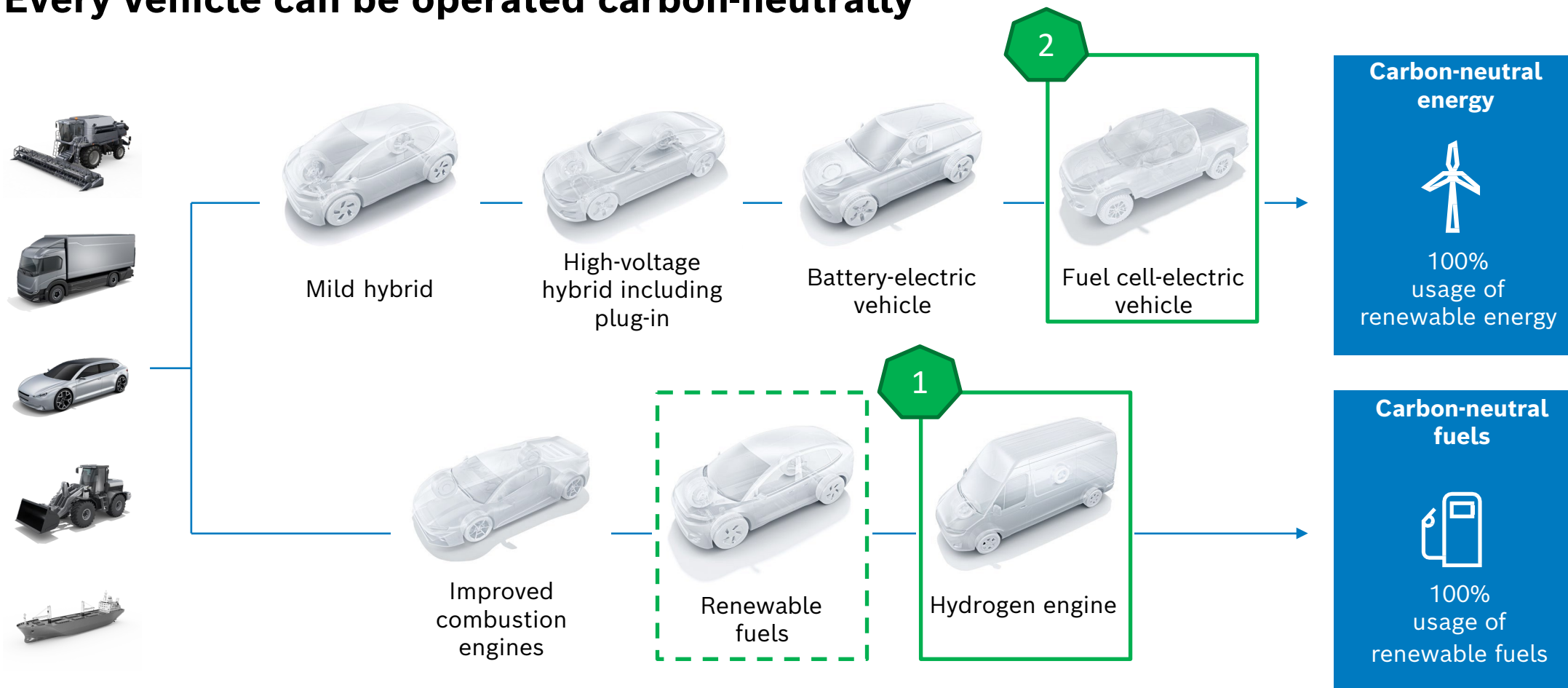
Scalable and
modular solution



High quality and
performance

All values are subject to development activities and provided on a non-reliant basis.
* Beginning of life; **At partial load.

Every vehicle can be operated carbon-neutrally



H₂ for mobility

Infrastructure ramp-up is a must



¹ Fuel Cell & Hydrogen Energy Association (FCHEA), based on PC fleet

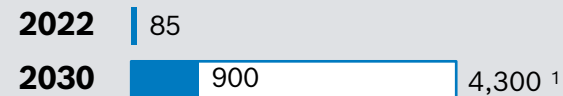
² ACEA based on CV fleet, Clean H2 JU scenario based on PC

³ Plan according to China Technology Roadmap 2.0, mainly based on CV fleet



Hydrogen refueling stations

USA:



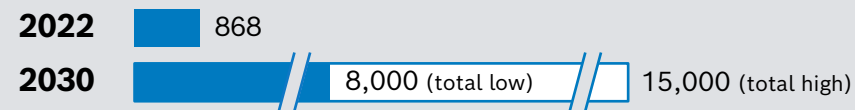
Europe:



China:



Worldwide:



2022: actual, 2030:  in planning  optimistic planning

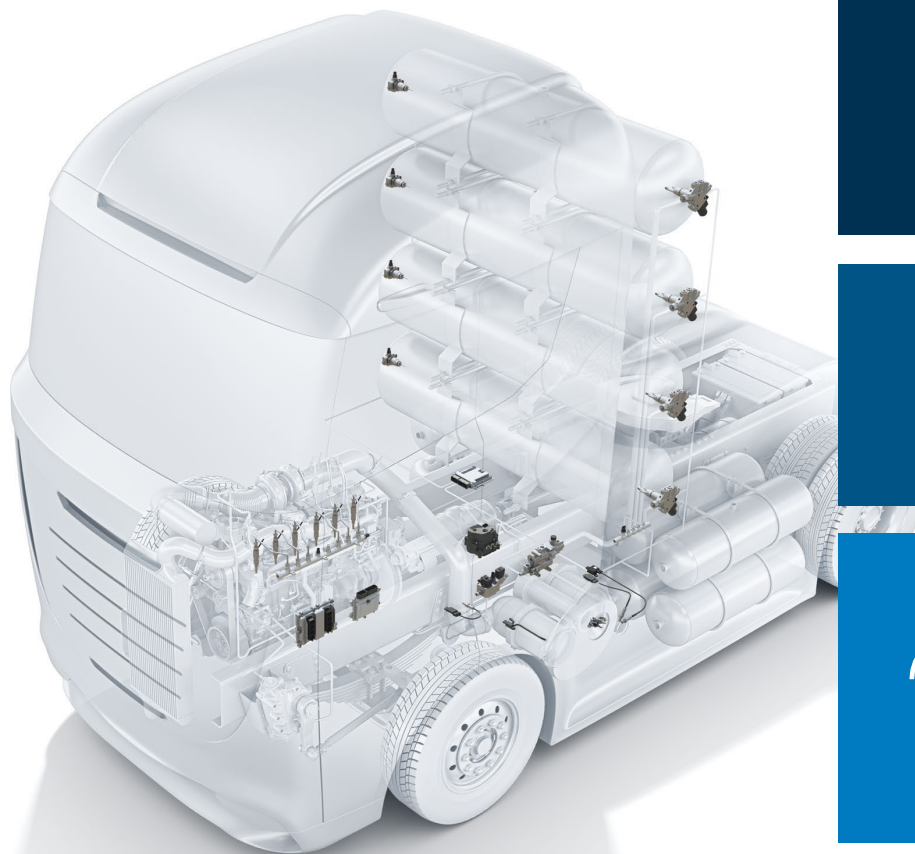


BOSCH

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H₂ engine

A complementary, robust, and sustainable technology option



Green energy and infrastructure

- Hydrogen production based on green energy
- Hydrogen refueling stations and services



Vehicle efficiency

- Improved combustion with direct hydrogen injection
- Additional powertrain and vehicle measures



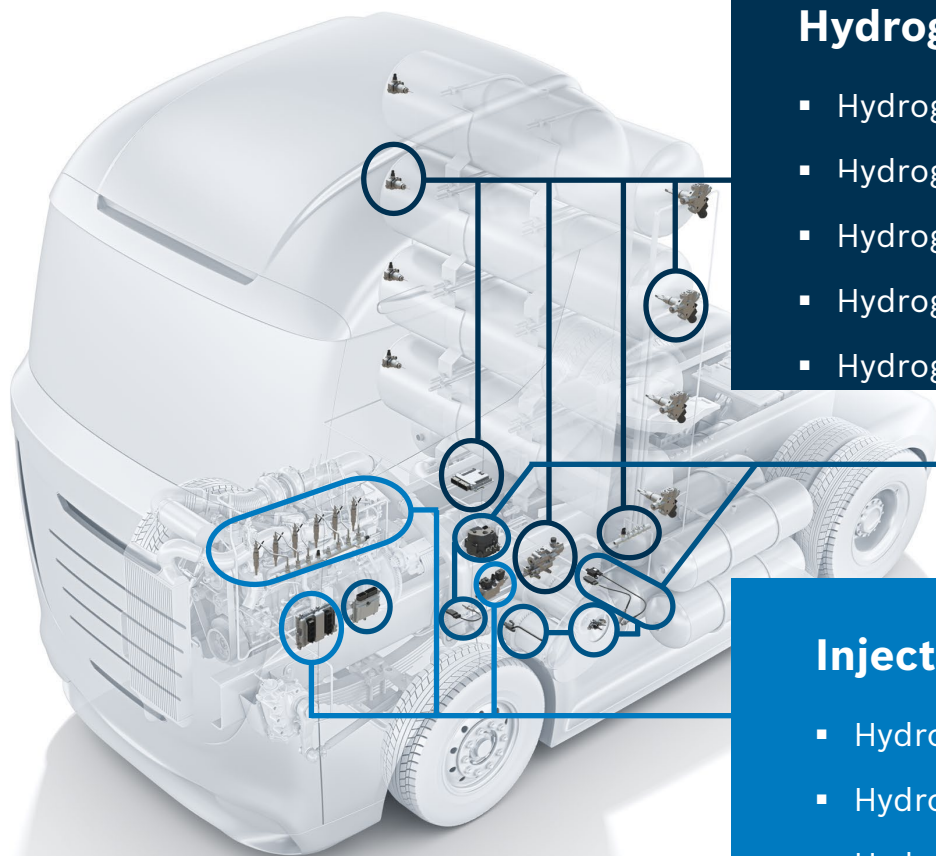
Sustainability

- Rapid availability, robust and cost-efficient
- Resilient against raw material and supply chain issues, use of established recycling processes
- No relevant impact on air quality

1

H₂ engine

Bosch provides components for hydrogen system solutions



Hydrogen storage system

- Hydrogen tank valve
- Hydrogen tank plug
- Hydrogen pressure regulator
- Hydrogen tank manifold
- Hydrogen storage control unit

Injection system

- Hydrogen direct injection
- Hydrogen injection rail
- Hydrogen injection pressure regulator
- Engine control unit

Exhaust gas treatment and sensors

- DNOX system
- NOx sensor
- Particulate matter sensor
- Differential pressure sensor
- Hydrogen exhaust sensor

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H₂ engine

Wide range of customer benefits...

for heavy commercial & light commercial use,



Extended driving range
and short refueling time



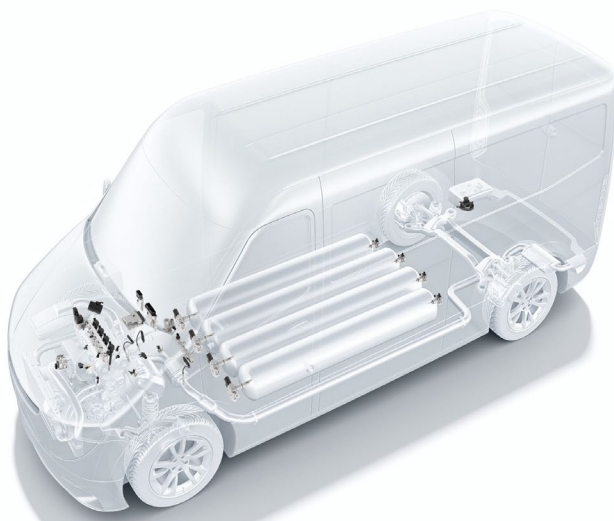
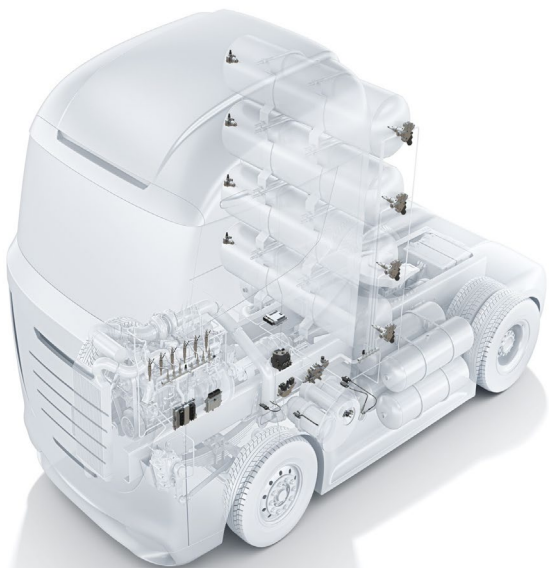
Robust, tried-and-tested
technologies, low H₂ quality
requirements



Use cases with high power
demand or highway driving



High payload



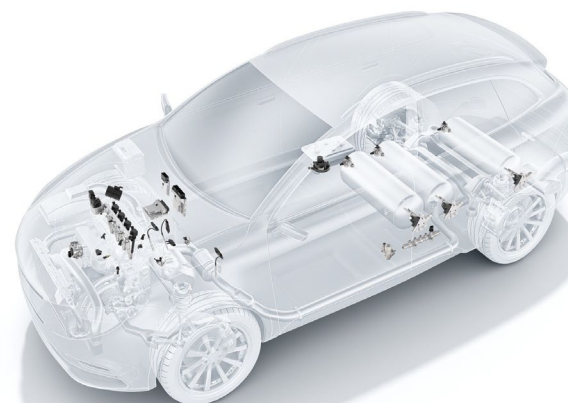
Scalable solution



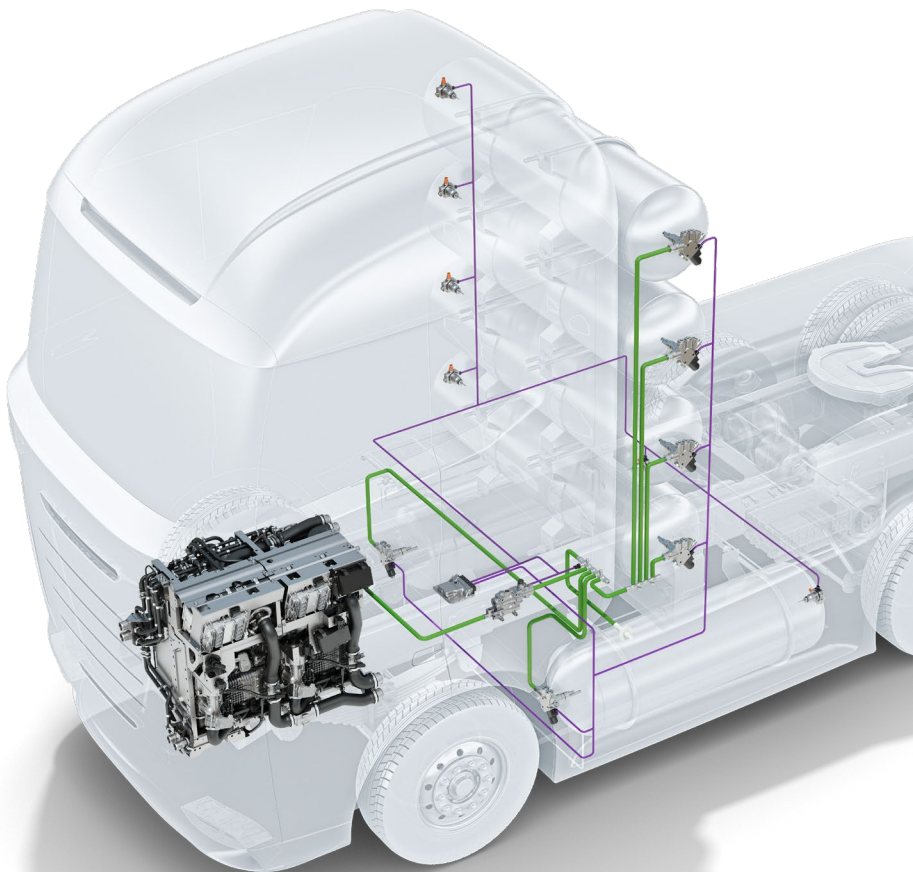
- Benefits not limited to commercial vehicles
- Focus on “one-fits-all” technologies
- Significant R&D activities for light commercial vehicle and passenger car applications

increasing development activities for passenger cars

“Hydrogen Engine for a Passenger Car Hybrid Powertrain: Attractive Solution for Sustainable Mobility”

**BOSCH**

Bosch provides fuel cell system solutions



Green energy and infrastructure

- Hydrogen production based on green energy
- Hydrogen refueling stations and services



Vehicle efficiency

- High technological maturity: volume production started
- High power density: long distance, high payload
- Short refueling time

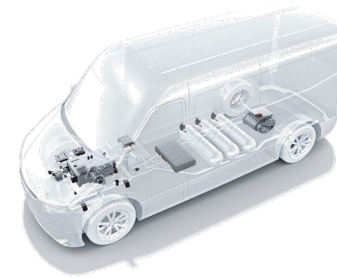
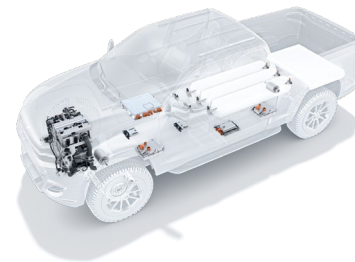
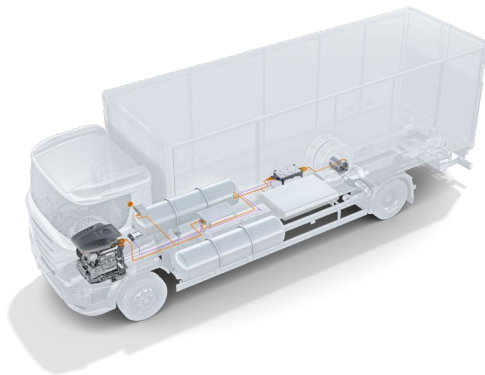
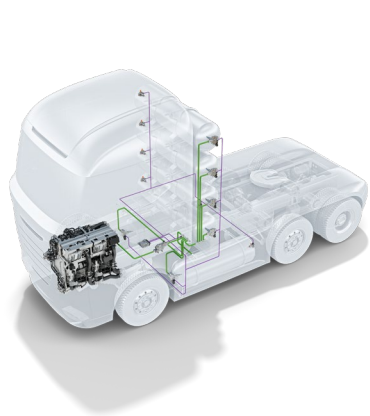


Sustainability

- “Circular economy” for raw materials
- Use of established recycling processes
- Zero-carbon operation

Wide range of customer benefits

Light and heavy
commercial vehicles



Benefits



Comprehensive
portfolio and
system expertise



Modular portfolio
tailored to
customer needs



Zero-carbon
operation



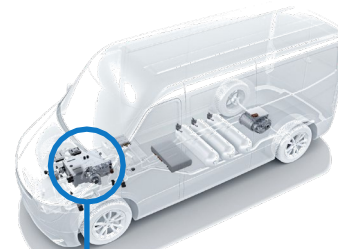
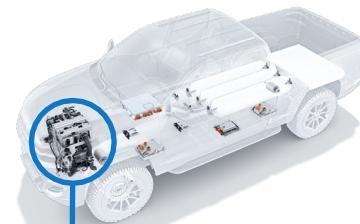
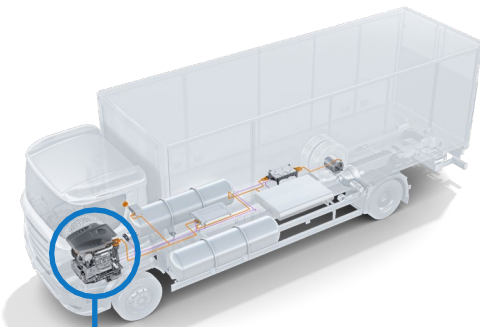
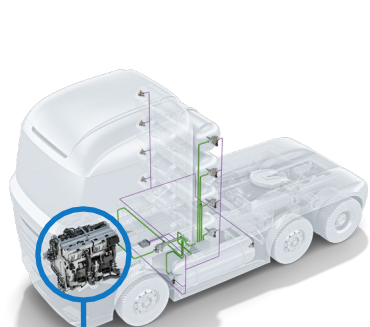
Fast refueling
time



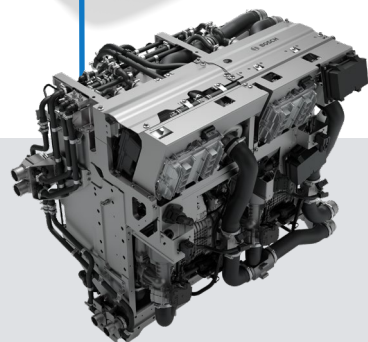
Extended driving
range with high
payload

Bosch system solutions ready for various vehicle segments

Light and heavy
commercial vehicles



Fuel Cell system
solutions



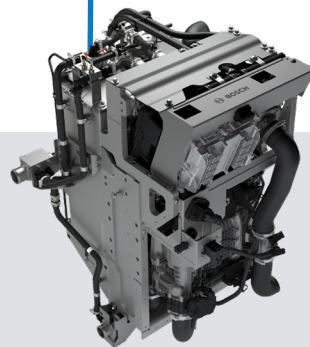
FCPM TwinBox

216/300 kW



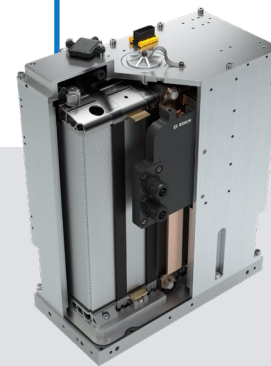
FCPM-C OneBox

132/190 kW



FCPM Gen 1.1 OneBox

150 kW



Stack

Scalable ~70 kW