

# Scalable Software Platform for Thermal Management in Fuel Cell Vehicles

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Eco-Mobility, 19<sup>th</sup> International A3PS Conference

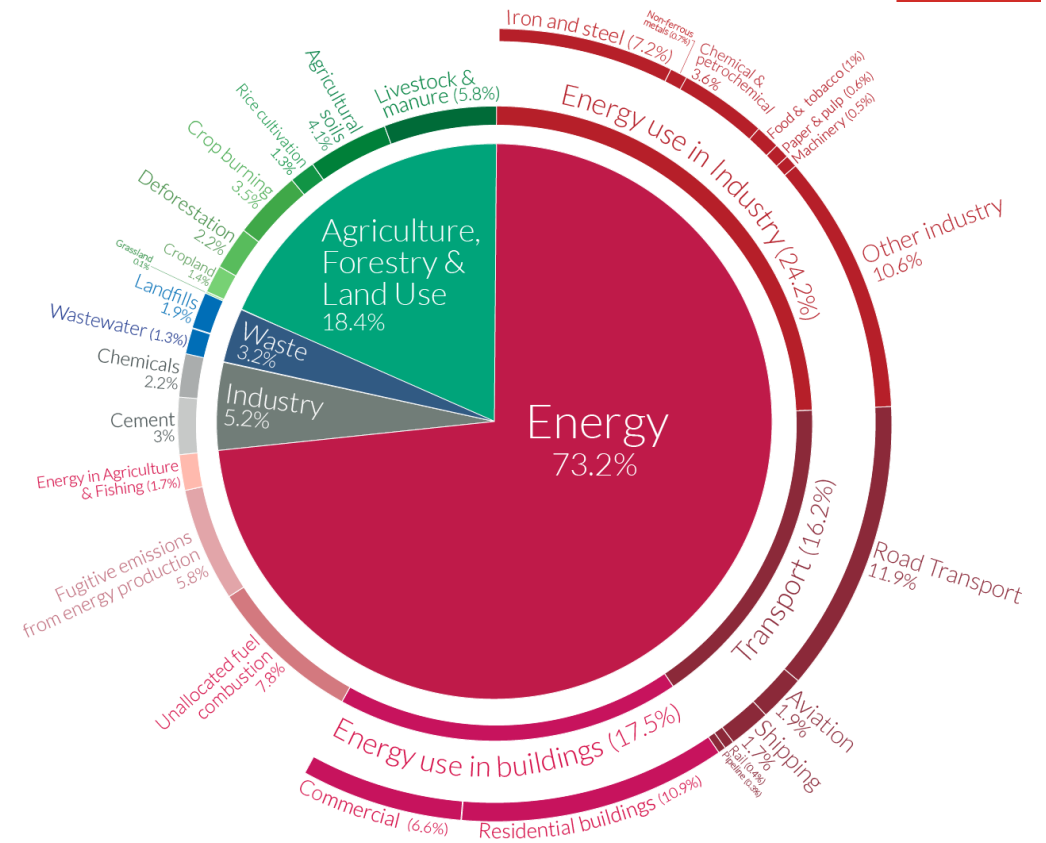
Vienna, 14-15 November, 2024

# Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO<sub>2</sub> eq.

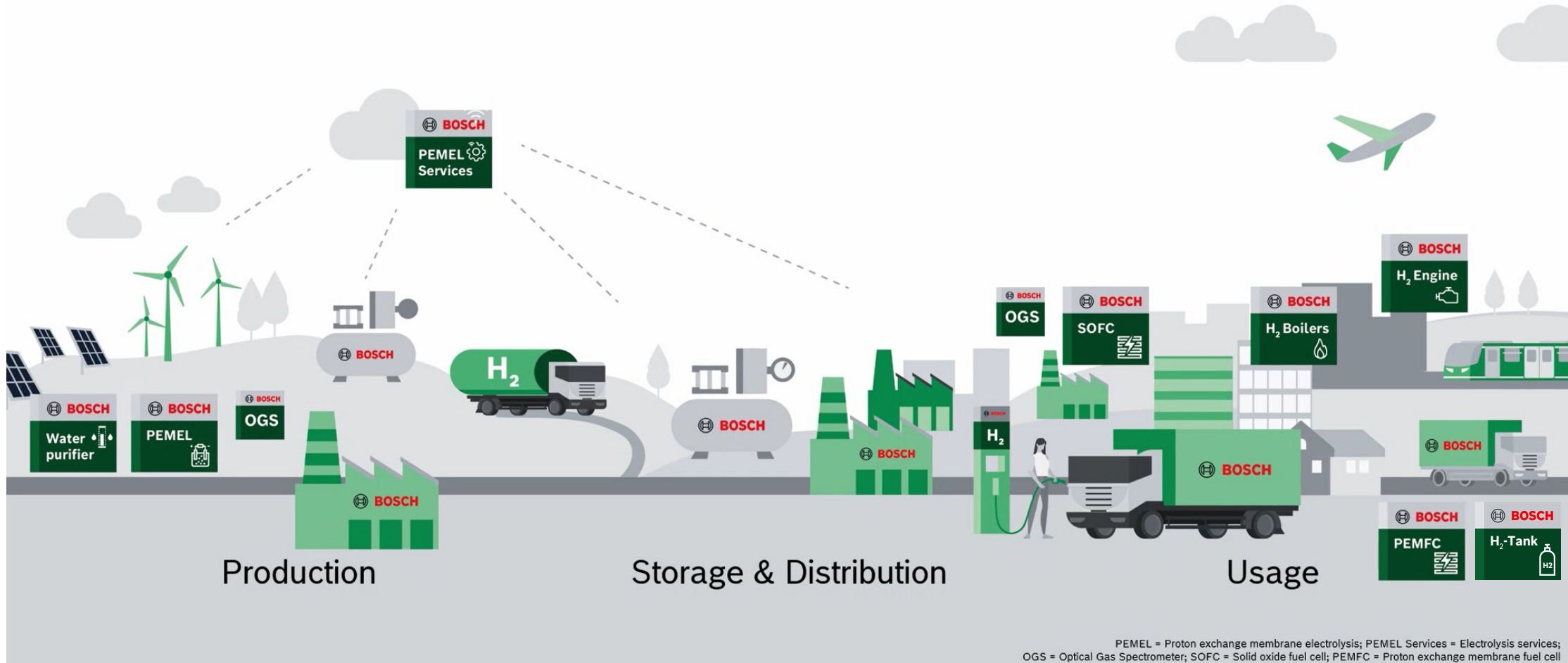
Our World  
in Data

The Bosch Group, with more than 400 sites worldwide, is carbon-neutral overall (Scope 1 and 2)\*.



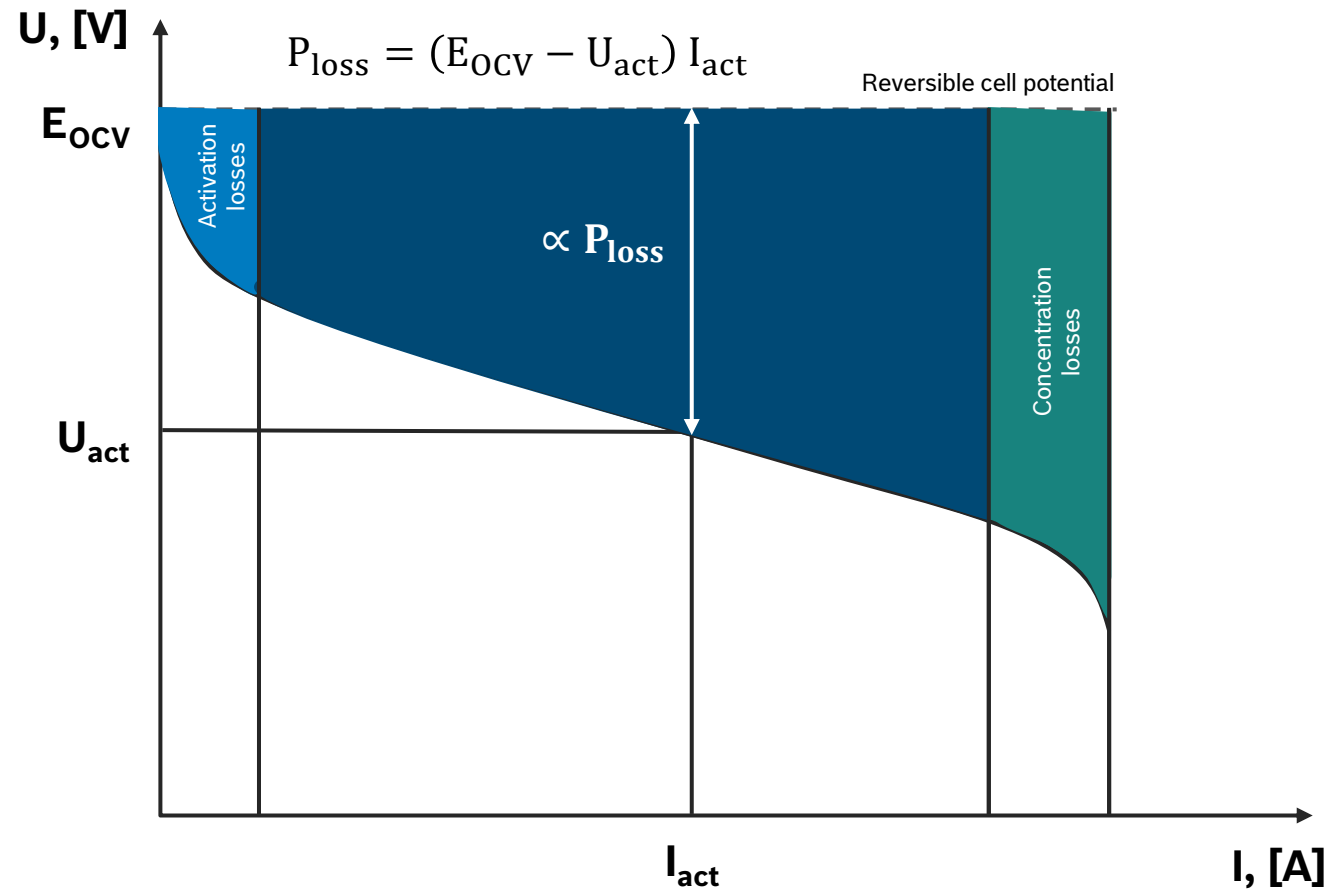
\* Scope 1, 2 according to [Greenhouse Gas Protocol Corporate Accounting and Reporting Standard](#). We have taken into account the effects of CO<sub>2</sub> and of other greenhouse gases, as well as climate-relevant substances, to the extent that these are of relevance for the analysis. For ease of reading, we use the terms CO<sub>2</sub> and CO<sub>2</sub> equivalents synonymously

# Bosch and the hydrogen economy



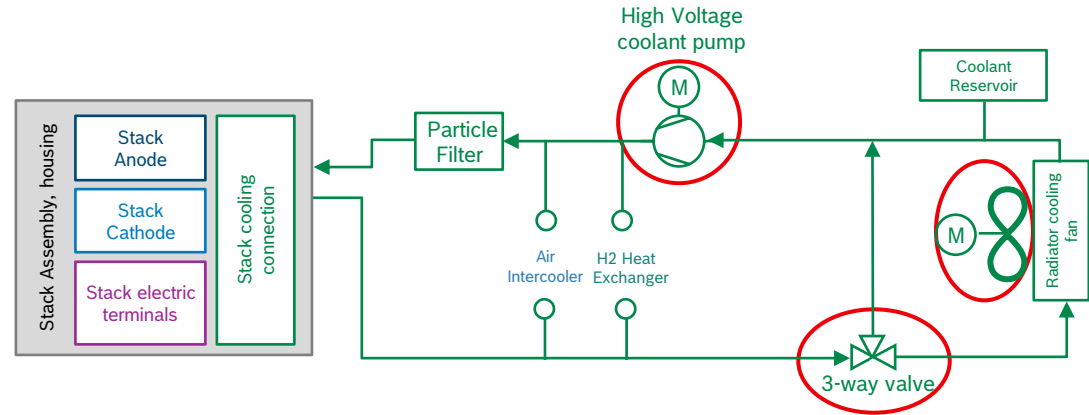
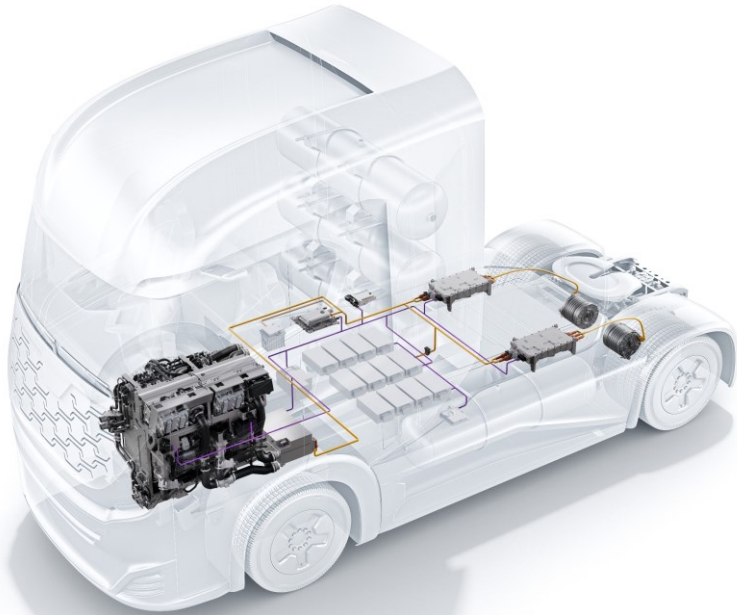
# Fuel Cell Mobility

## Polarization curve



# Thermal Management of Fuel Cells

## The Challenges



### High voltage coolant pump

Control the stack temperature difference

### 3-way valve

Control the stack inlet temperature

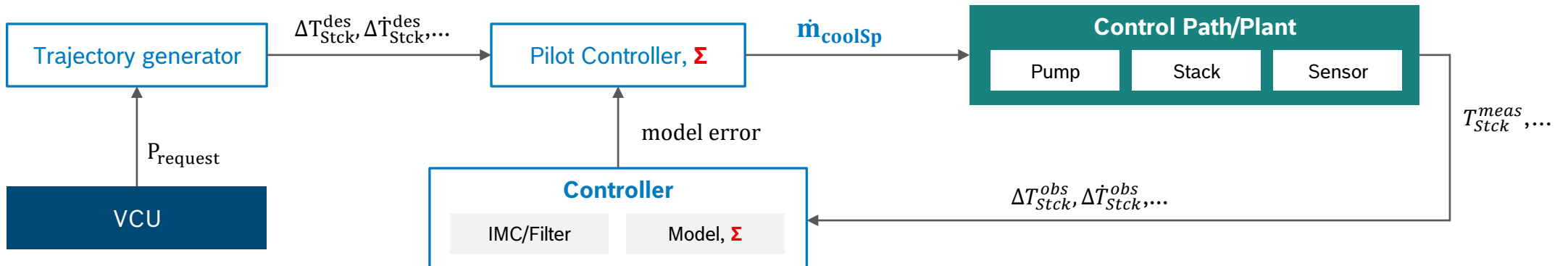
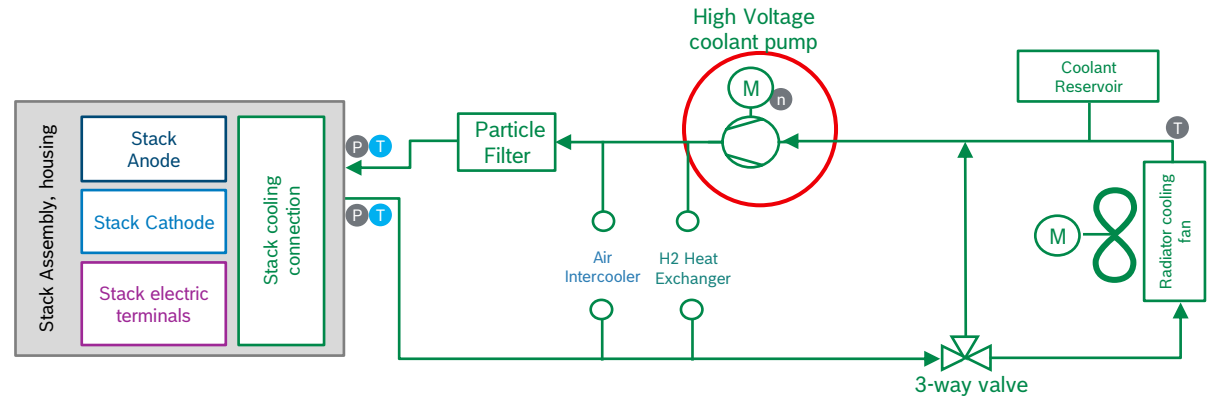
### Radiator fan

Control the radiator outlet temperature

# Model Based Control Strategy

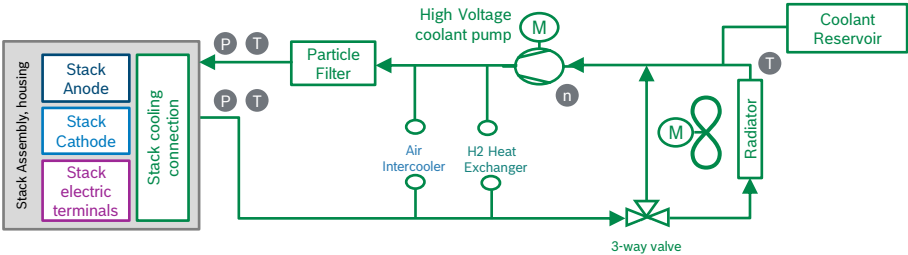
## Control of stack temperature difference $\Delta T_{Stck}$

- Model based control strategy
- Mass flow  $\dot{m}_{coolSp}$  as control variable
- Closed loop control loop – feedback via model error

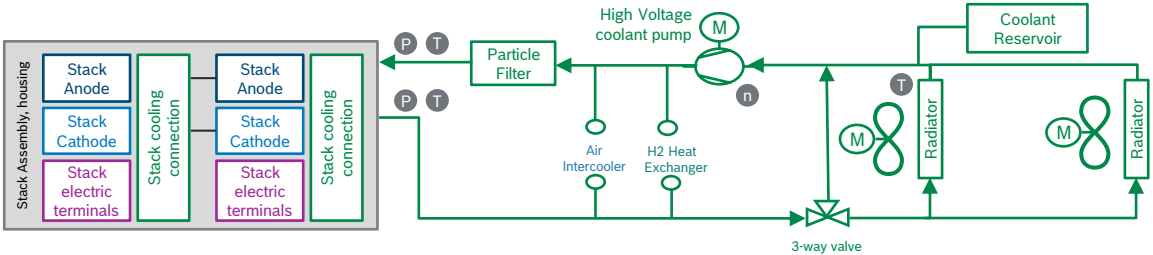


# Scalable Platform Solution

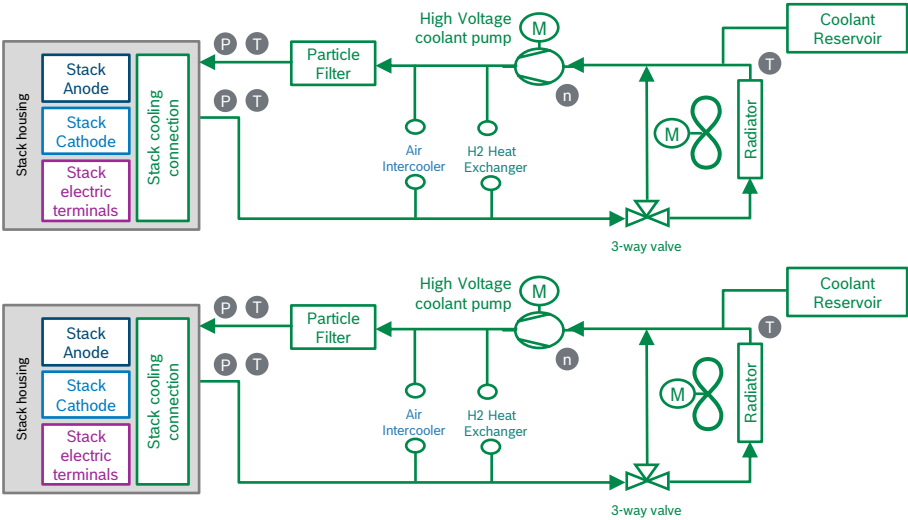
Single-Box 70 - 132 kW



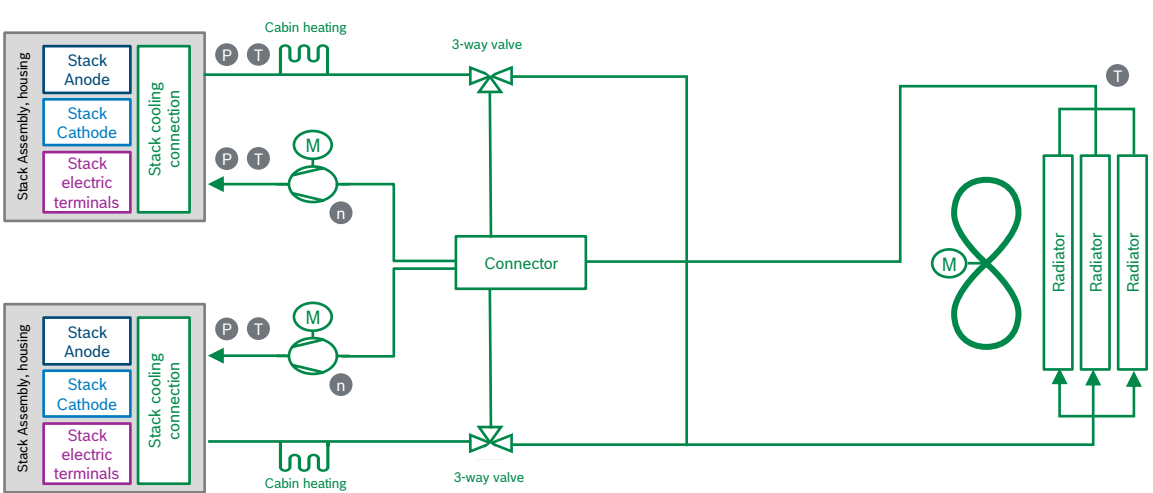
Twin-Box "One-Box" 190 kW



Twin-Box 200 kW

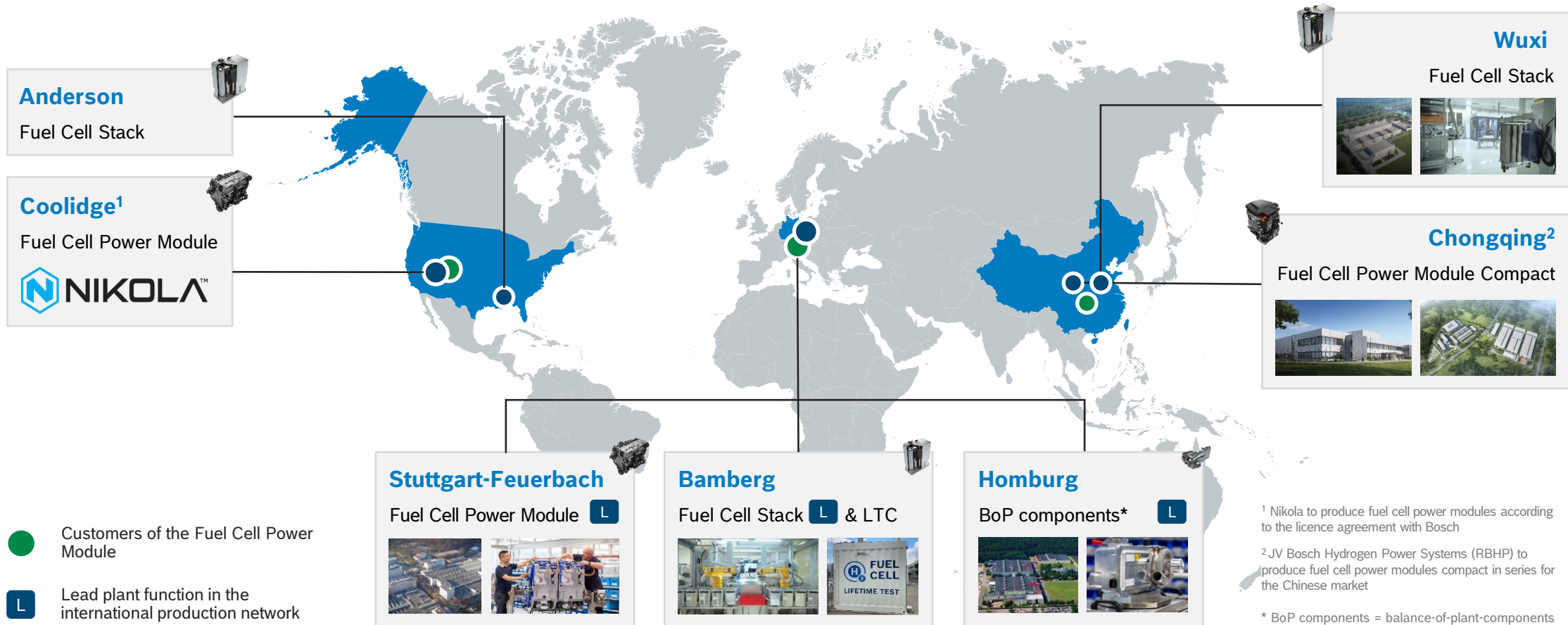


Twin-Box coupled 250 - 300 kW



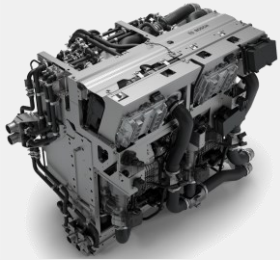
# Fuel Cell Mobility

## Local present at customer site: development & manufacturing

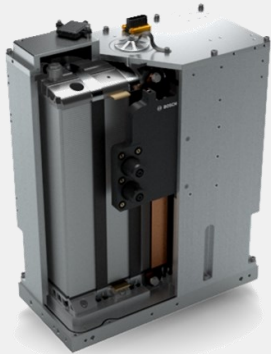




## Fuel Cell system



Fuel Cell power module twin box



Fuel Cell stack

## Trucks are already on the roads



## Our competencies

### Manufacturing excellence

Thin metal forming  
High-speed laser welding  
Precise assembling  
Tightness under all operating conditions  
Large-scale production

**216/ 300 kW**  
Twin box max power BoL



**Up to 30t**  
payload\*



**800 km**  
driving range\*



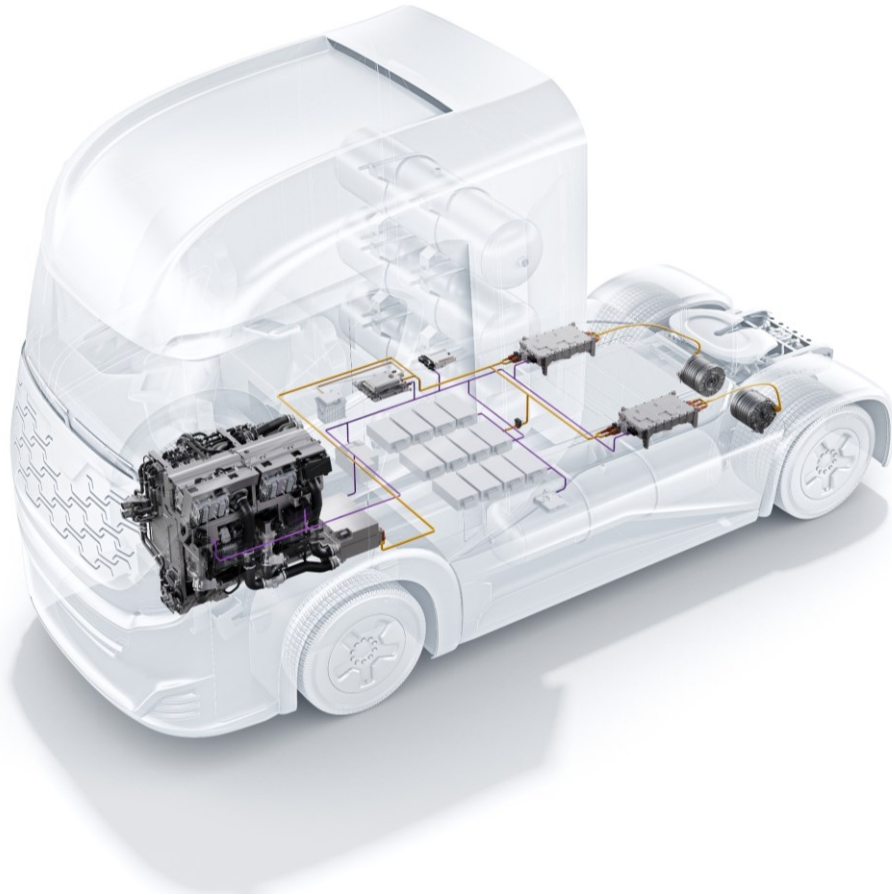
**<20 min**  
refueling time\*



**20.000/ 25.000 h**  
lifetime



Gen1 SOP2023 / Gen2  
BoL-Beginning of Life, \*reference Nikola Tre Gen1



**Thanks for your attention!**

**Scalable Software Platform for  
Thermal Management  
in Fuel Cell Vehicles**

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**Discover the fuel cell power module**

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