FC4HD – Heavy-duty fuel cell road demonstrator

Public

Fuel cell driven heavy duty vehicles
Challenges

- High Range – daily milage up to **800 km**
- High share of **highways**
- **High average speed** – Low inclinations
- Mostly point to point transport
- Almost **no stops** for loading/unloading
- Overnight in parking lots along the highway
- Legal breaks of **45min**

(Picture: MAN)


(Picture: euroluftbild.de / Hans Blossey

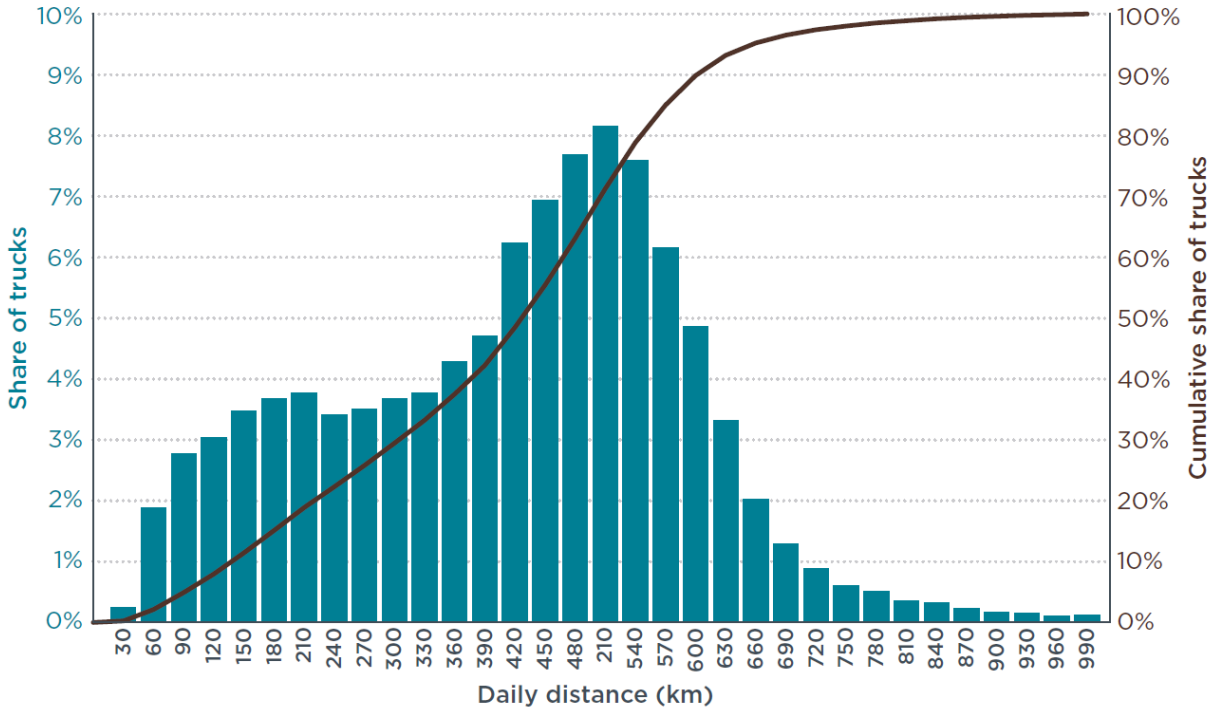
Fuel cell driven heavy duty vehicles
Challenge - Daily milage

Customer expectation:

- milages **>1000 km**
- relistically only **640 -800 km**

Driver has to pause for 45min after 4,5h of driving.

- Enough energy **stored**
- **Refueling** has to fit



(Source: ICCT White Paper TCO-BET v4, November 2021

Fuel cell driven heavy duty vehicles
Challenge - Truck Body

- Typical EU Long Haul Trucks (Class 5LH) have rather short wheelbases **(<4000 mm**) while having a sleeper cabin, increasing the length of the cabin.

- Building "**hydrogen towers**" behind the cabin with short wheelbases means **incompatibility** with certain trailers (16.5 m max length)

- **Increasing the wheelbase** also leads to problems with the allowed maximum length.

- **Changed heat rejection split** compared to ICE-based vehicles

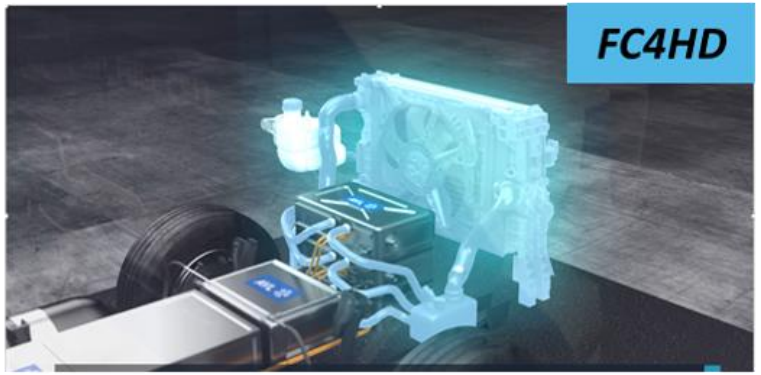
AVL's Fuel Cell World
Demonstrator Vehicles

Fuel Cell Demo Truck		KEYTECH4EV
DAF XF	**Donor vehicle**	VW Passat GTE
9800 kg	**Vehicle curb weight**	1746 kg
70 kWh	**Battery size**	9.9 kWh
~310 kW	**Fuel cell system power**	~55 kW
540 kW	**e-drive power**	100 kW
30 kg	**Hydrogen tank capacity**	3.8 kg
2	**Number of tanks**	3
approx. 13 min	**Hydrogen refilling time**	approx. 3 min
7.9 kg / 100 km	**Hydrogen consumption**	0.8 kg /100 km
>350 km	**Driving range**	>500 km

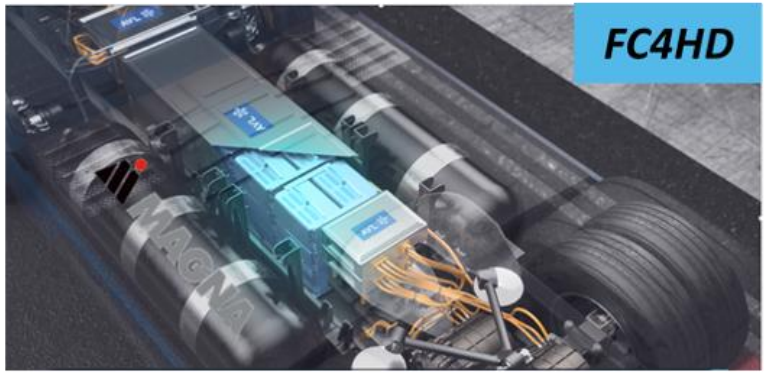
AVL develops and integrates Fuel Cell Powertrains from passenger vehicles up to various commercial applications

Fuel cell driven heavy duty vehicles
Solutions

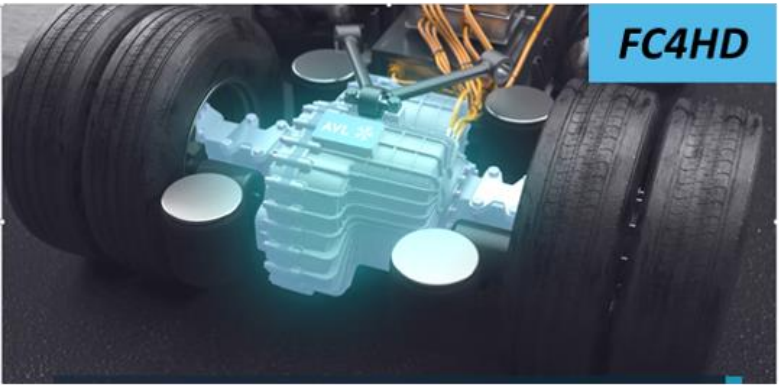
310kW Fuel Cell System



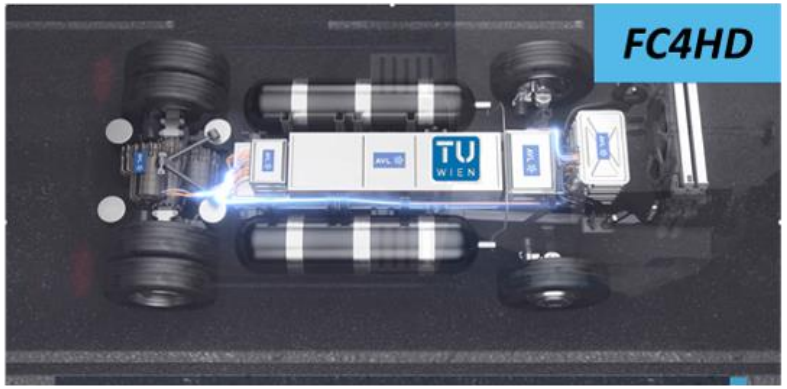
Advanced Vehicle Cooling



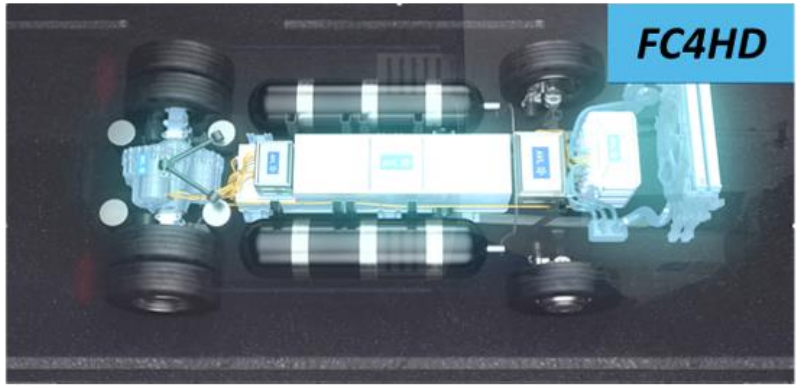
700bar H2 Storage System



Integrated e-Axle



Predictive Energy Management

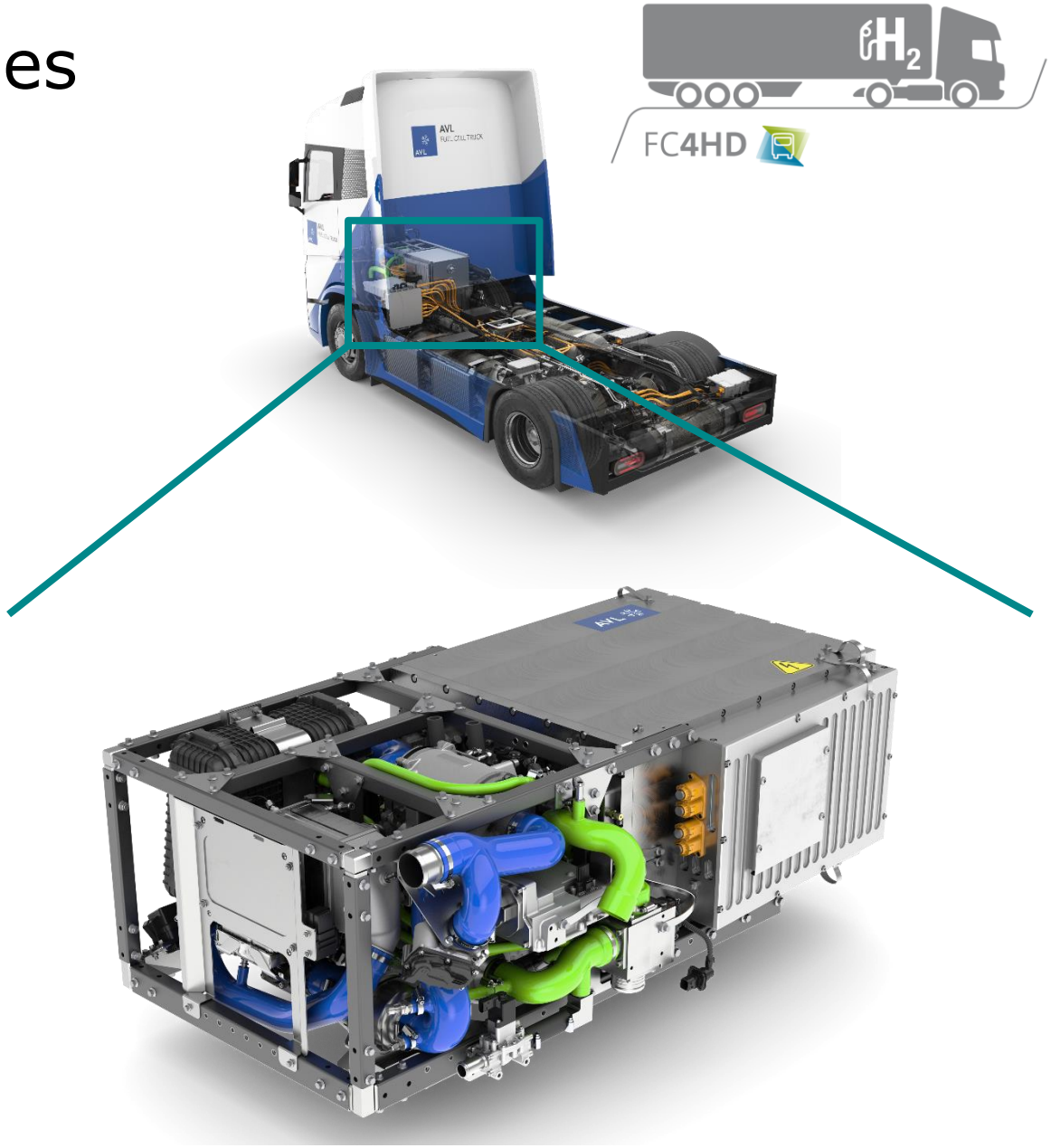


Smart System Integration

Fuel cell driven heavy duty vehicles
Solutions – Fuel Cell system

AVL Fuel Cell System

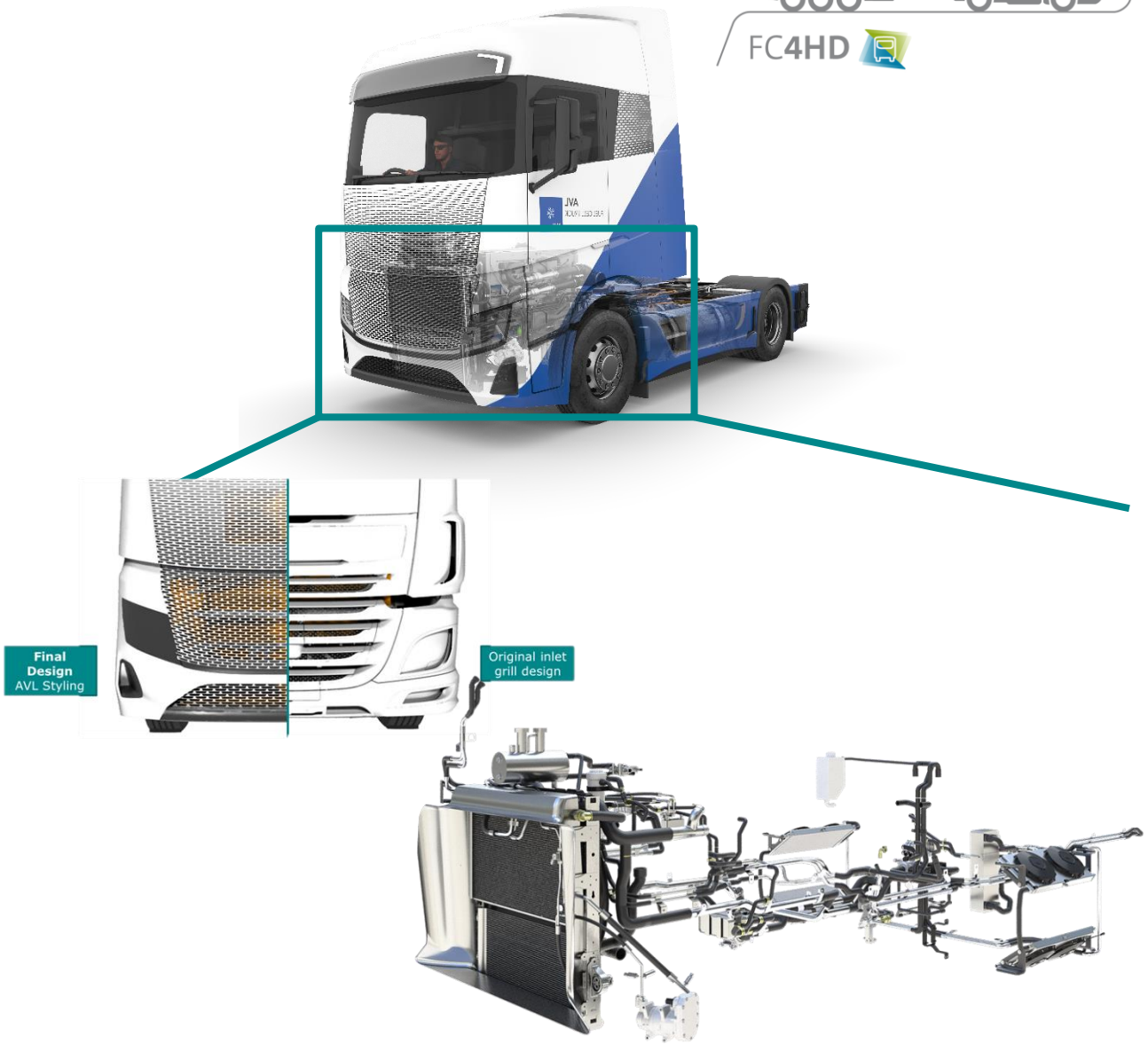
- FCS net rated power (BOL/EOL)
  2 x 154 kW / 136 kW
- Max. FCS **efficiency** (BOL): **~55 %**
- **Stack** development by AVL
- Fuel cell **system integration** by AVL
- **Highest** fuel cell **power density**



Fuel cell driven heavy duty vehicles
Solutions – Thermal system

AVL Thermal System

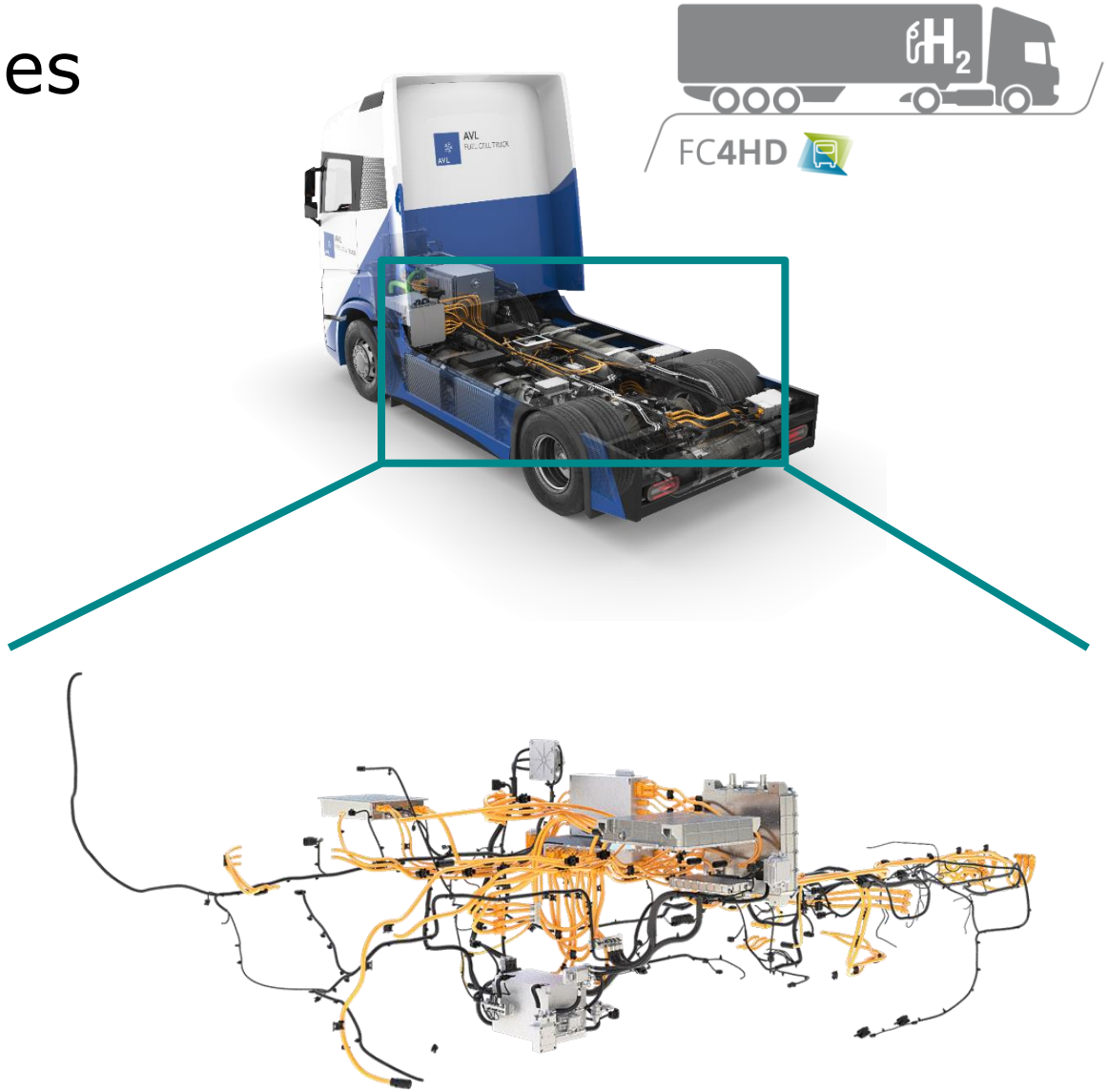
- **All thermal circuits** are interconnected via valves or heat exchangers
- **Load split between circuits** depending on boundary conditions
- **Airflow management** around and over cabin to improve airflow to radiators on vehicle side
- **High performance HV-fan** for FCS cooling



Fuel cell driven heavy duty vehicles
Solutions – E/E-System

E/E-System

- **HV Components** are dispersed throughout the vehicle. Also a lot of Truck specific components like an air compressor are packaged.
- **Bespoke PDU (Power Distribution Unit)** Additional HV Functionalities include Isolation Monitoring, switching additional Relais and fuses for component protection in case of failure
- 6 additional **CAN busses** for new vehicle Systems, VCU also acts as Gateway to original vehicle CANs
- **LV System with 12V and 24V,** Supplied by common DC/DC, only 24V Batteries

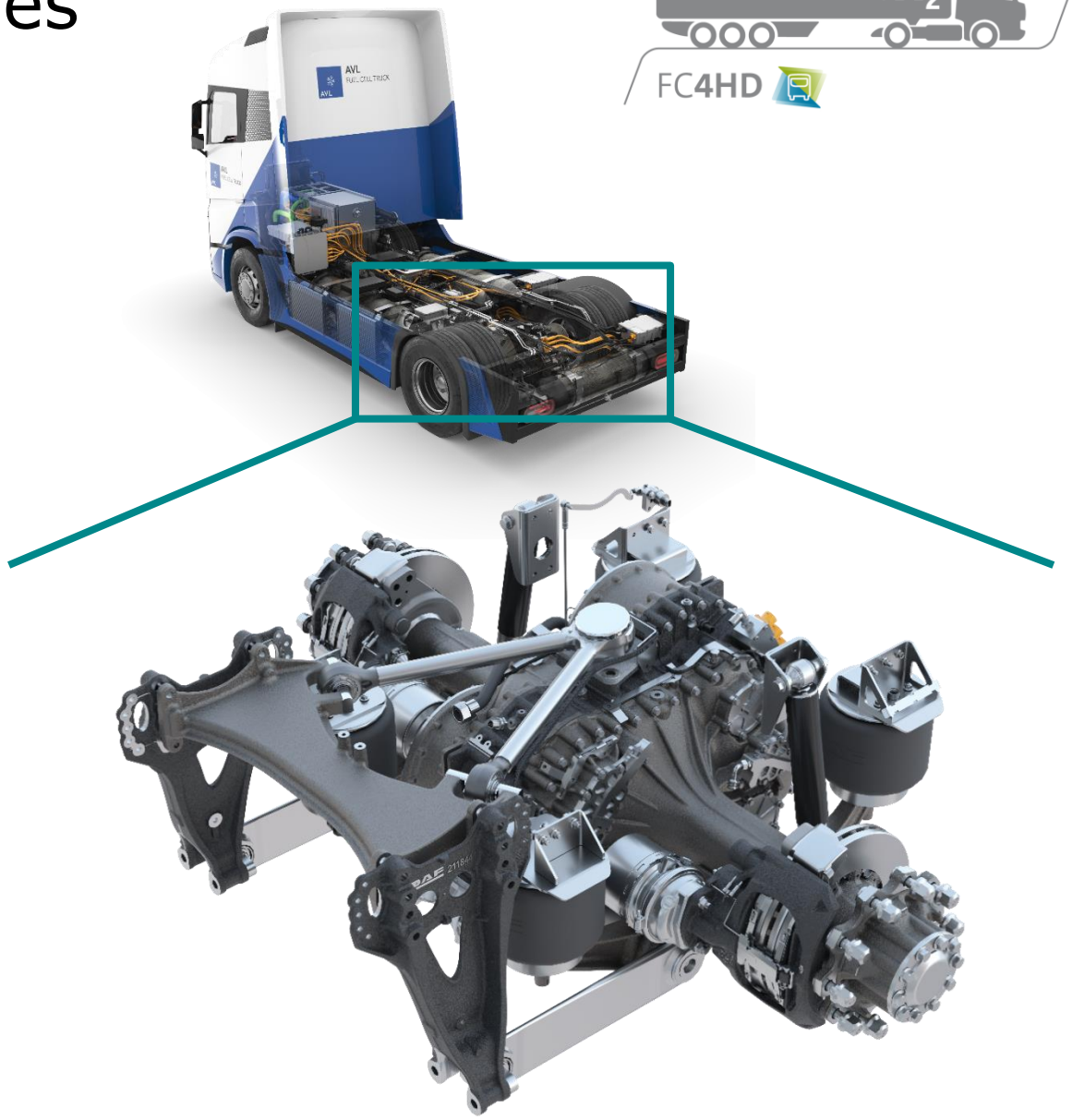


Fuel cell driven heavy duty vehicles
Solutions – e-drive

AVL HD e-Axle

- **Integration of e-motors** into drive axle increases packaging space within ladder frame

- **Free space** in ladder frame can be used for
  - Fuel Cells (In Engine space)
  - Batteries (In Transmission space)
  - Auxiliary integration (Space usually consumed by prop shaft)
- **400 kW continuous** power
- **540 kW peak** power



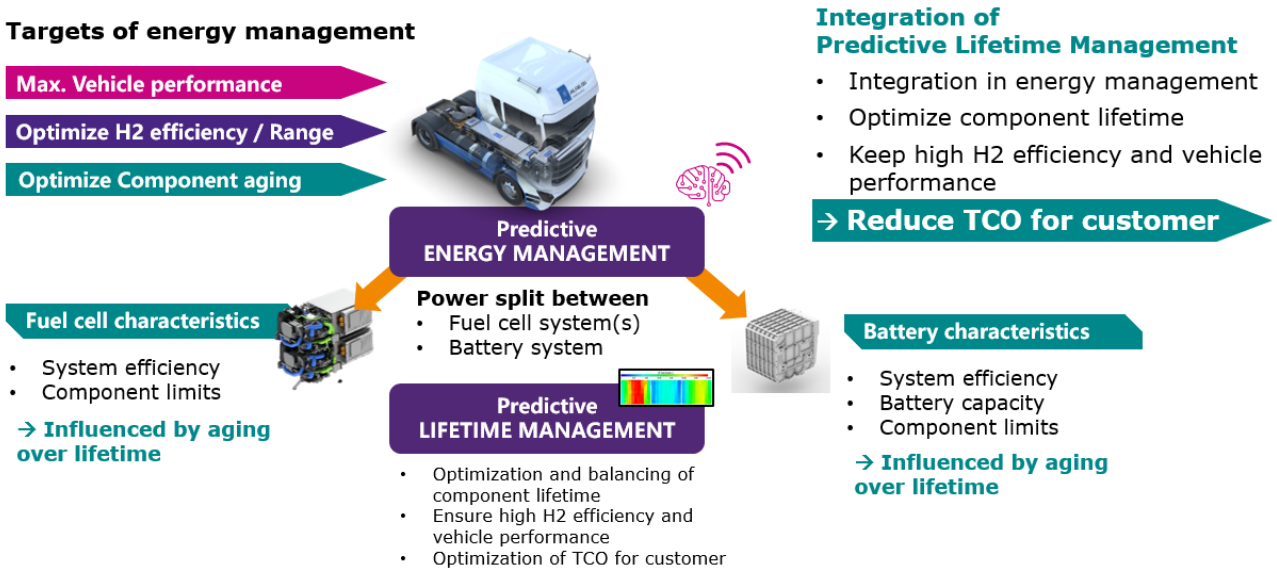
Fuel cell driven heavy duty vehicles
Solutions – Predictive Controls

AVL Predictive control solution

High system complexity requires

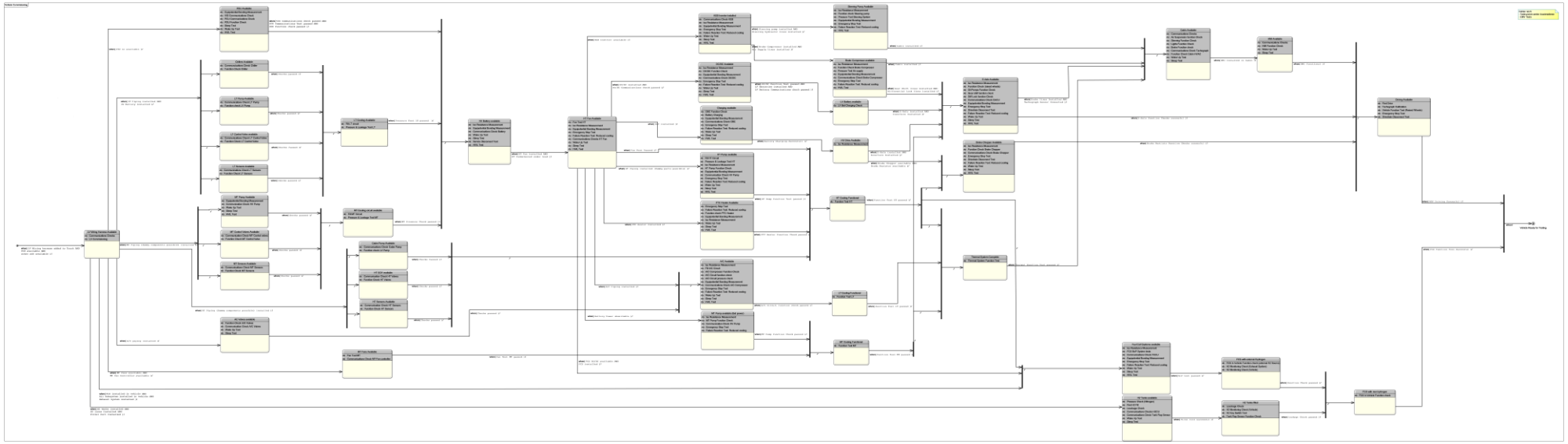
- Holistic development approach using **Model-based-development** (AVL Digital Twin)
- **Predictive Energy Management** to achieve **highest H2 efficiency** and performance
- Predictive **Lifetime Management** to optimize TCO
- Consideration of **all relevant sub-systems** is **key to optimize** the overall energy management

Predictive energy management



Fuel cell driven heavy duty vehicles

Current Tasks – Vehicle Commissioning



Vehicle Commissioning

- **Step-By-Step approach** from “Vehicle Available” until “Ready for test”
- Preconditions allow for **commissioning during assembly**
- **~100 test cases** necessary to ensure safety of workers and drivers

Vehicle Integration of a Fuel Cell Powertrain for 4x2 Heavy Duty Truck

Q&A

Public

Contact

LOCATION
AVL List GmbH
Schönauer Straße 5
4400 Steyr
Austria

PHONE
T: +43 316 787 2685
M: +43 664 88164434

EMAIL
felix.bayer@avl.com

WEBSITE
www.avl.com

THANK YOU

AVL

www.avl.com