MegaWatt Charging

A Critical Success Factor for Commercial Vehicle Electrification

Anne-Marie Schuppan

Today’s Presenter

Anne-Marie Schuppan

2010 – 2016	Diplom Mechatronics with specialization to electric drive and control @ TU Dresden
2016 – 2022	Expert Software and Functions Engineer for Electric Drive Control @ AVL SFR
2022 – today	Team Lead Charging @ AVL SFR

Today’s Agenda

MegaWatt Charging – A Critical Success Factor for Commercial Vehicle Electrification

About Us

Reimagining Motion

"We are driven by a **passion** to examine the science, mechanics and philosophy of movement. To help create a world that is climate-neutral and one that makes **safe, comfortable, green mobility** a reality for everyone."

Helmut O. List

Chairman and CEO

AVL List GmbH

AVL at a Glance

1948
Founded

75+
Years of Experience

26
Countries Represented

45
Global Tech and Engineering Centers

12,200
Employees Worldwide

68 %
Engineers and Scientists

10 %
Of Turnover Invested in Inhouse R&D

2,200
Granted Patents in Force

Redrawing the Lines of Electrification

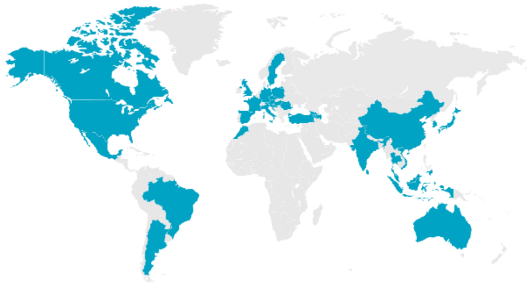
E-Mobility

We are relentlessly striving towards climate-neutral mobility. Not just by increasing the efficiency of multiple propulsion systems, but also by pioneering energy from green resources.

20+
Years of Experience

5,700+
E-Mobility Experts

900+
Executed Battery Projects



15+
Locations for Battery Development

MegaWatt Charging – A Critical Success Factor for Commercial Vehicle Electrification

Introduction to MegaWatt Charging

Public

Charging Infrastructure for BEV HD Vehicles

Motivation

Allowed non-stop driving time (EU)

4,5 h driving
45 min break
4,5 h driving

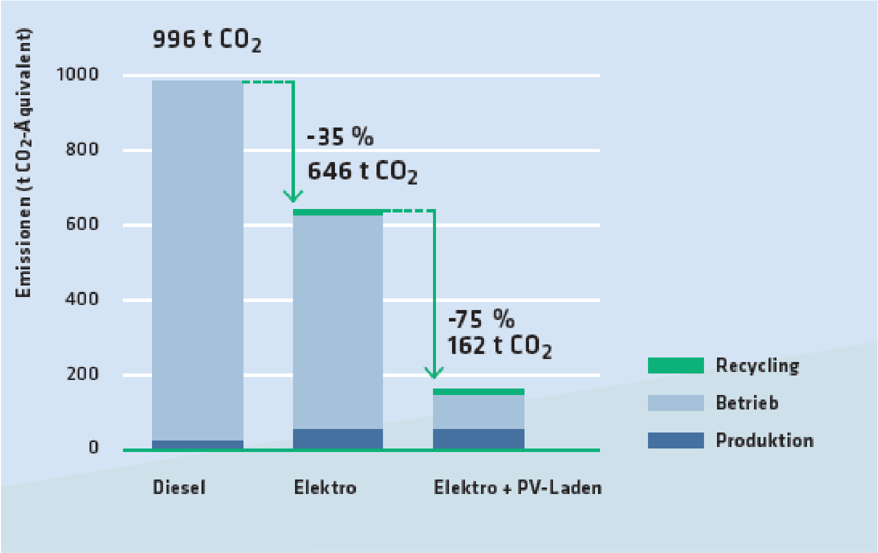
Consumption

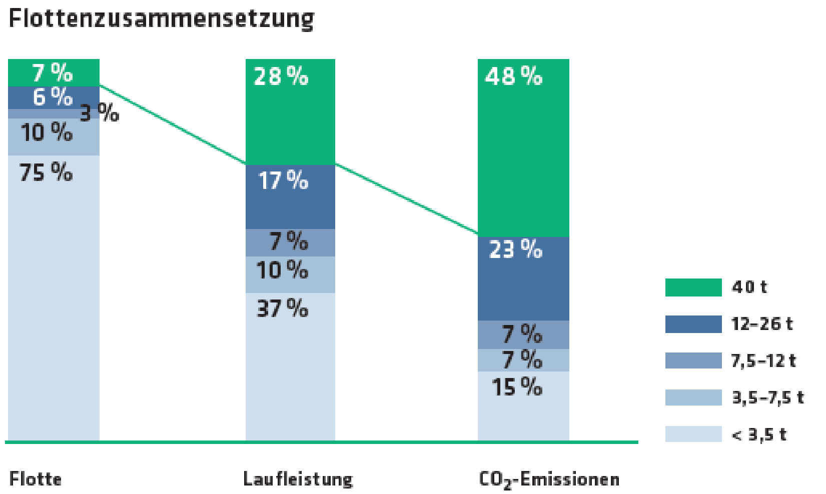
110–200 kWh / 100 km
400–800 km / day
360–800 kWh Battery

Charging Power

> 1000 kW
(during break stop)

Legislation / Emissions / Decarbonization





Legislation

- Reduction of emmissions per kilometer by 8.5 % since 1995
- EU-Target: Reduction of 45 % until 2030

Emissions over product lifecycle

- Majority of emissions are generated during operation
- Majority of emmissions are generated by 40 t truck fleet

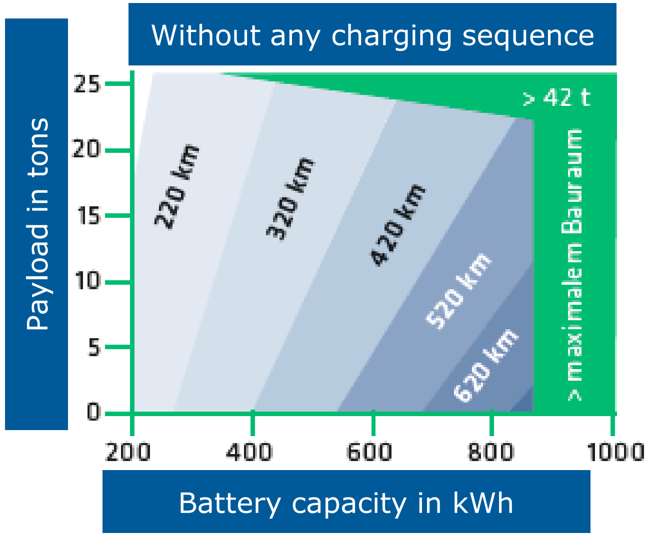
The biggest lever in decarbonization is therefore the driving technology

Today's presentation focuses on battery electric trucks only

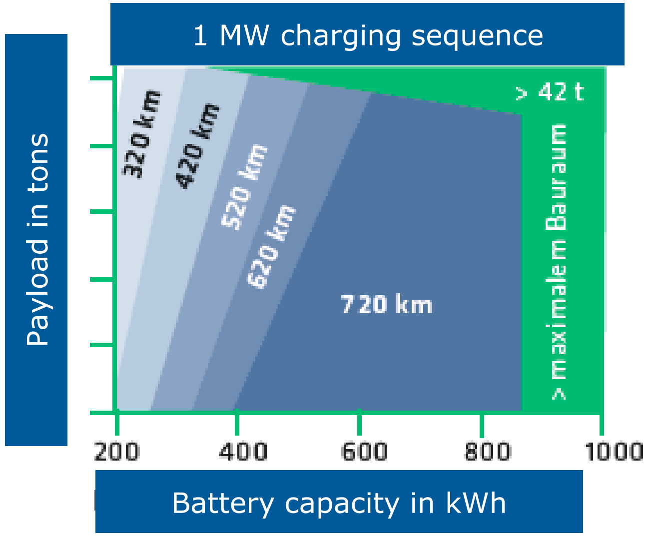
Electrification of Freight Transport
Challenges

Influence of battery capacity / payload on range

Targeted Range: 720 km @ 9 hours driving time



Result: > 800 kWh battery pack, no payload



Result: 600 kWh battery pack, full payload

MegaWatt charging infrastructure on a large scale is mandatory

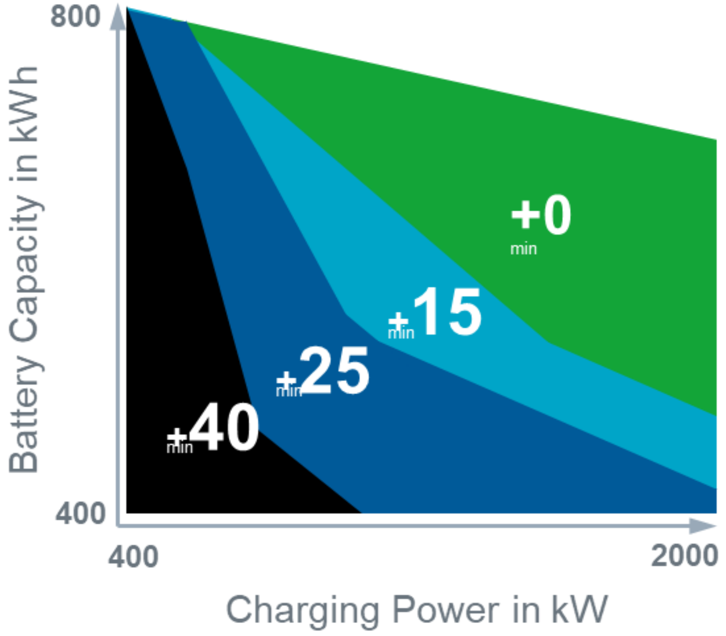
Electrification of Freight Transport
Challenges

Influence of charging power / installed infrastructure on the time loss per 9 h driving time

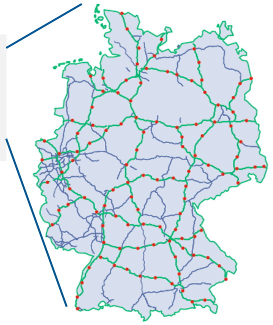
Starting Conditions
100 % SOC
700 km driving distance
> 750 kW Charger every 50 km

State of the Art
400 kWh battery capacity
400 kW charging Power
▶ 7,4 % time loss

Future
600 kWh battery capacity
1500 kW charging power
▶ **No time loss**



Every 50 km one chargepoint with > 750 kW

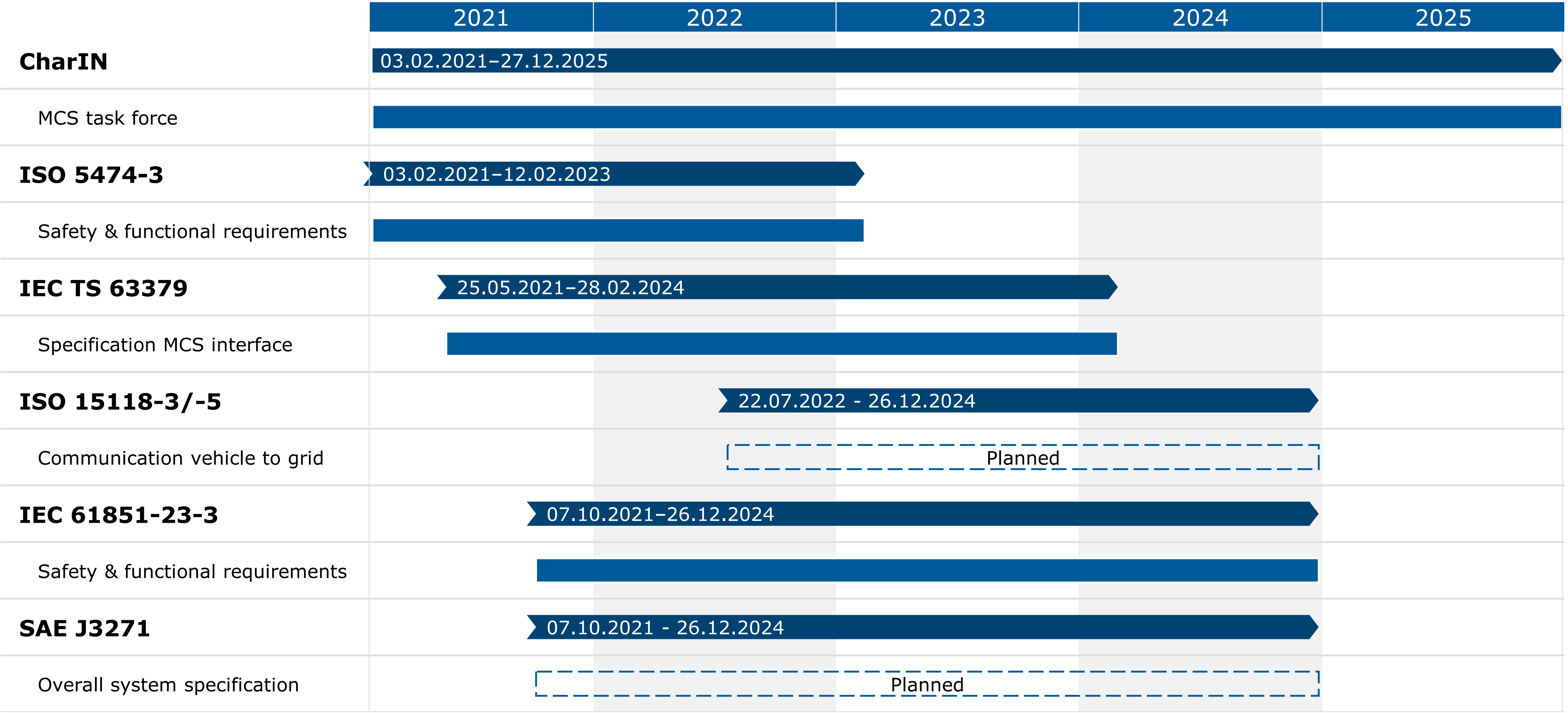


MegaWatt charging technology for trucks is mandatory
MegaWatt charging tnfrastructure on a large scale is mandatory

MegaWatt Chargig – A Critical Success Factor for Commercial Vehicle Electrification

Standardization

Standardization Overview



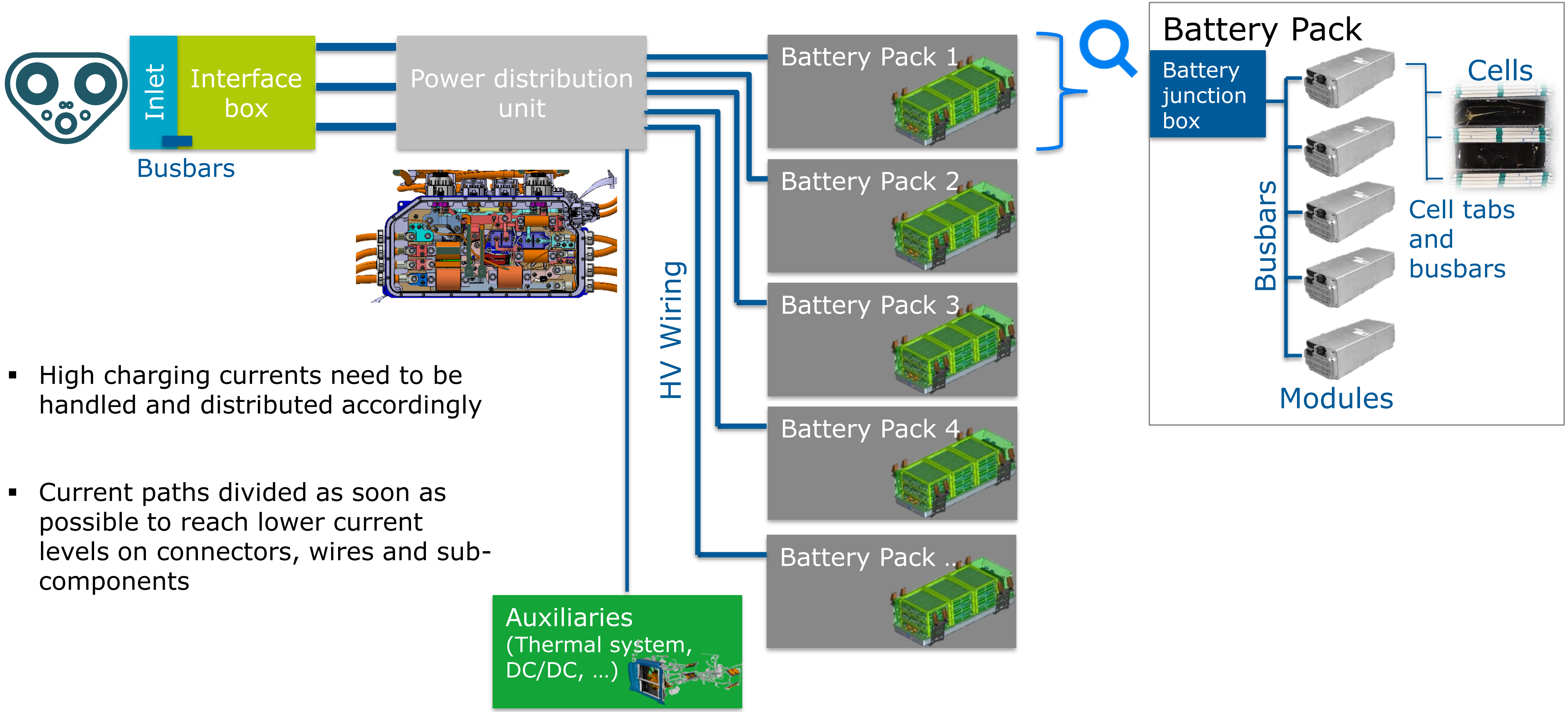
MegaWatt Chargig – A Critical Success Factor for Commercial Vehicle Electrification

MCS System Architecture, Power Electronics & Control

Public

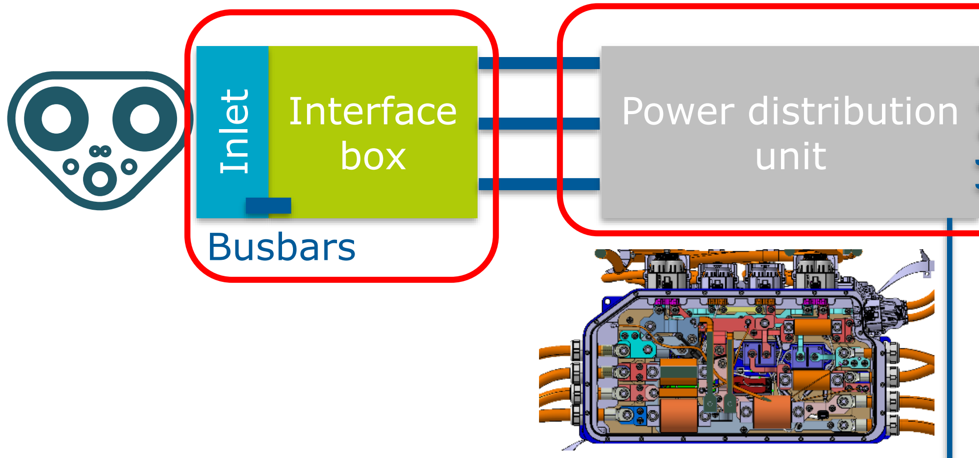
Vehicle Architecture (AVL Proposal)

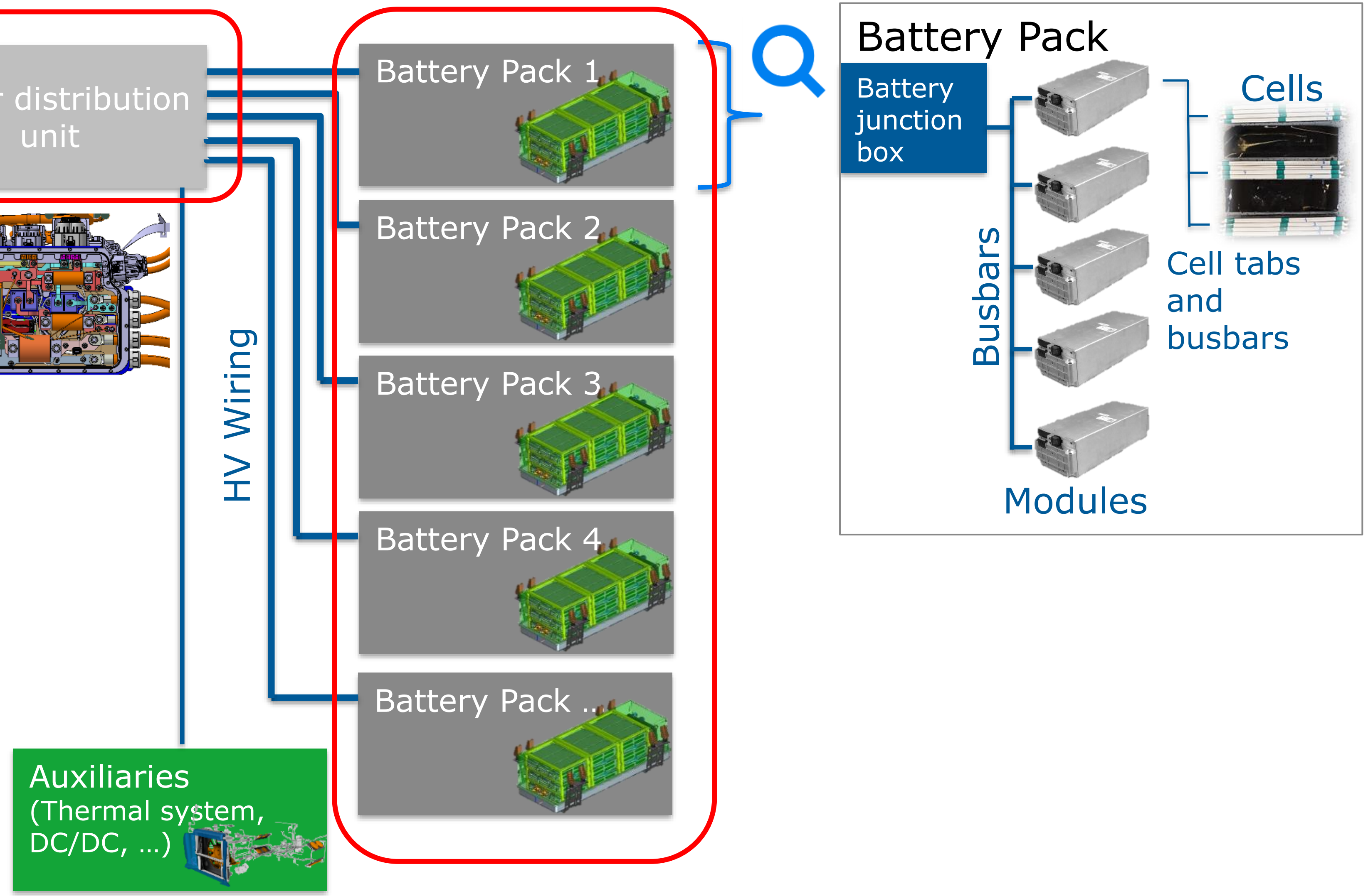
Power Distribution



- High charging currents need to be handled and distributed accordingly
- Current paths divided as soon as possible to reach lower current levels on connectors, wires and sub-components

Vehicle Architecture (AVL Proposal) Cooling





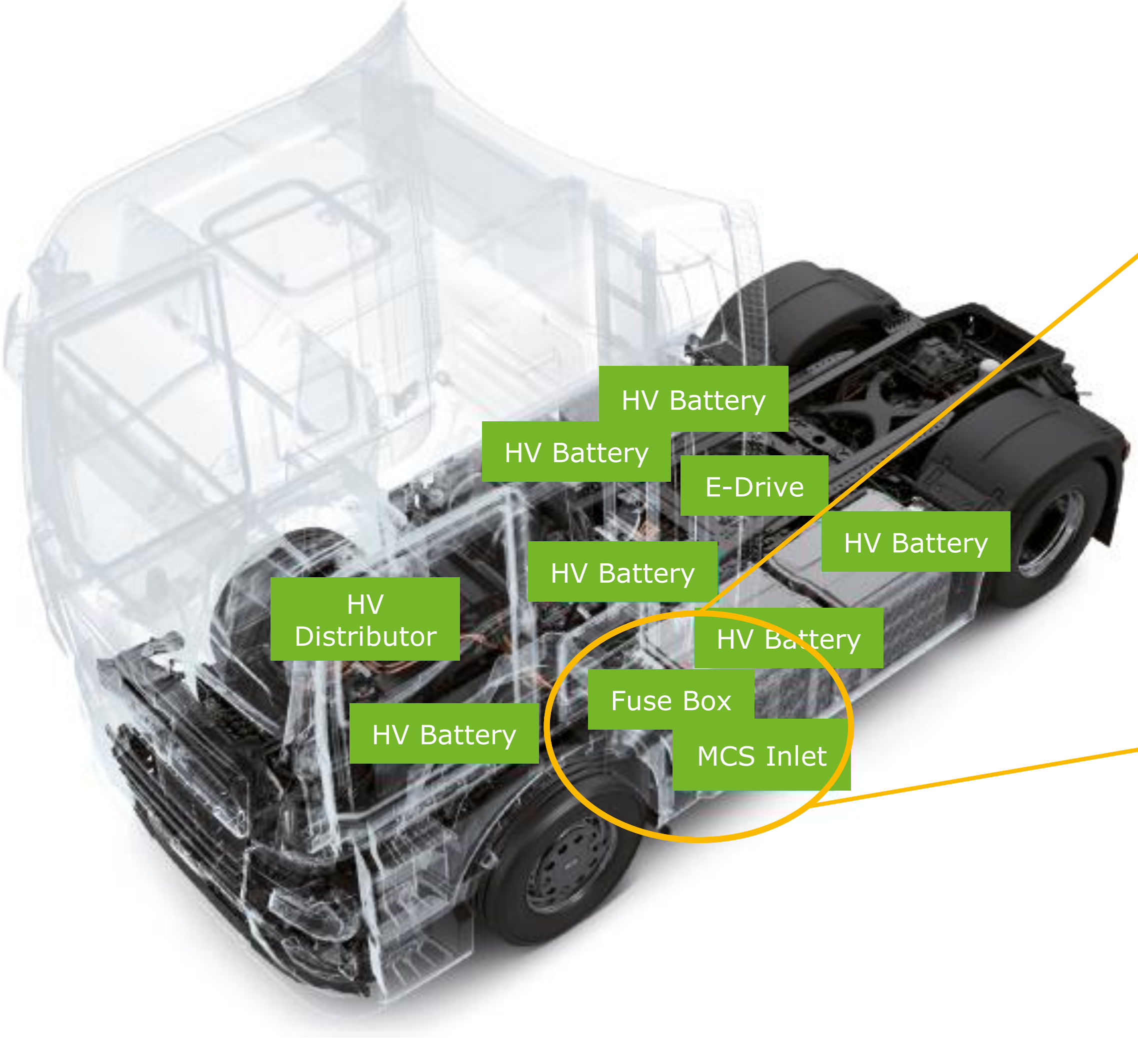
Heat losses to be cooled in:

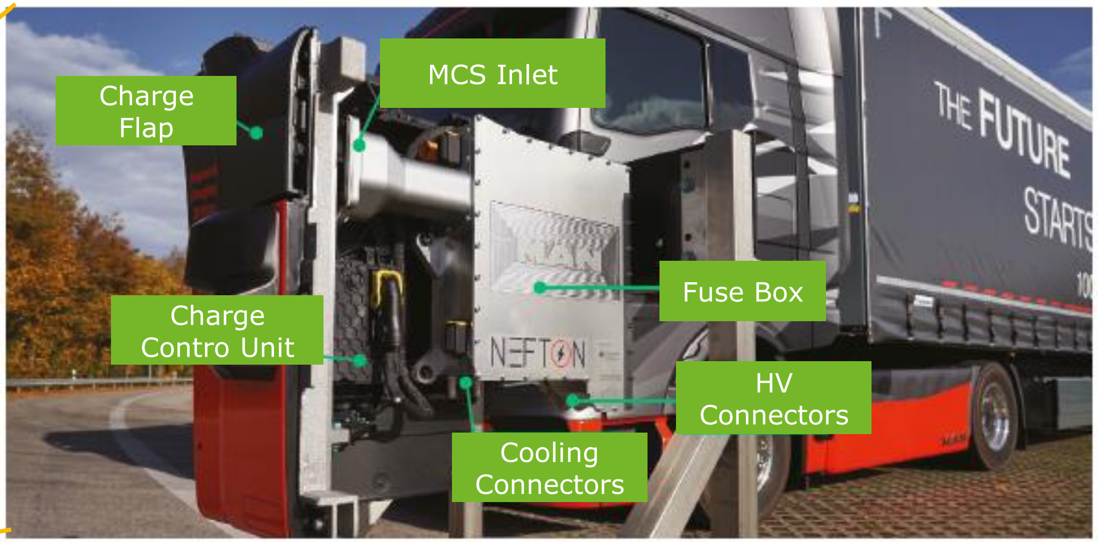
- Interface Box
- PDU
- Battery
- Inlet

NEFTON

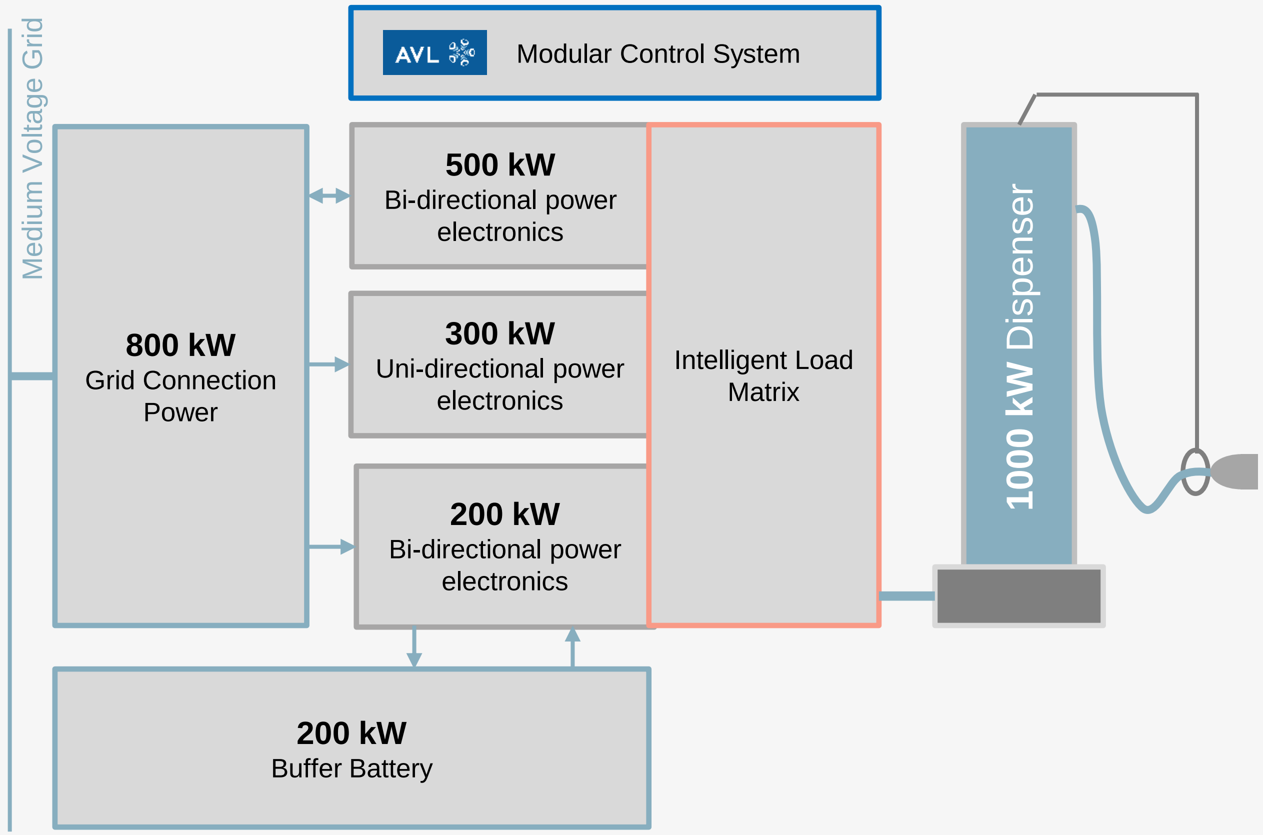
Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

Vehicle Architecture
MAN Example from the NEFTON Project



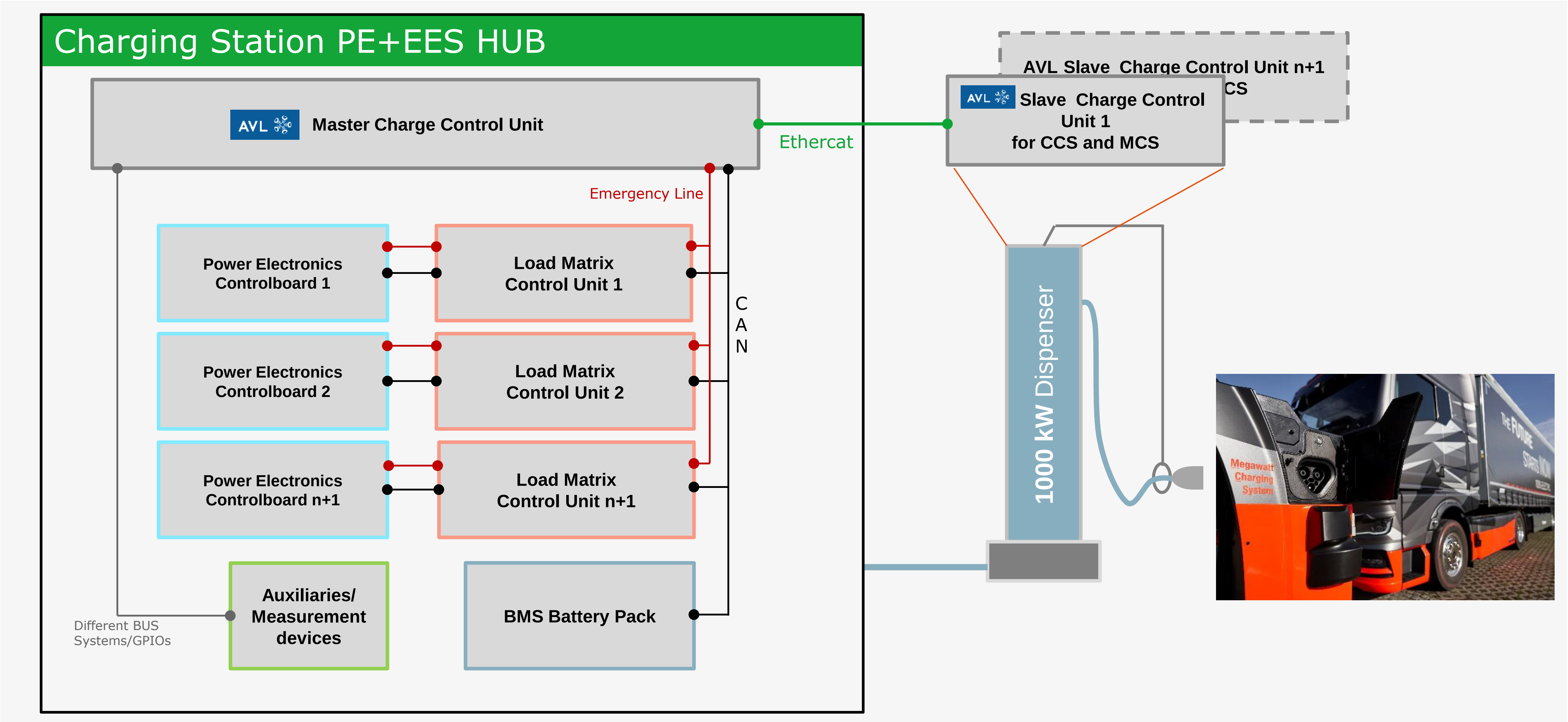


Efficient Setup of a 1 MW Charging Station
Example from the NEFTON Project



- Modular power electronics & control system
- Efficiencies above 98 % (PE only) reduce TCO and cooling requirements to a minimum
- Intelligent dynamic interconnection of unidirectional and bidirectional power electronics enables efficient overall energy management
- Reduced grid connected load lowers performance-based network charges

AVL's Modular Control System
Example from the NEFTON Project



MegaWatt Chargig – A Critical Success Factor for Commercial Vehicle Electrification

Energy Flow & Losses from Grid to Vehicle

Simulation
Description of BEV Charging Use Case

- Cell Data

Parameter	Value
Chemistry	LFP (cost efficient cell)
Nominal Voltage	3.3 V
Capacity	27 Ah

- Battery Pack data

Parameter	Value
Config	242 series / 4 parallel
Nominal Voltage	800 V
Capacity	86.2 kWh
Charging energy (20–80 %)	51,7 kWh
Charging power limit (~ 2C)	174 kW

- BEV Battery System data

Parameter	Value
Number of Packs	6
Nominal Voltage	800 V
Overall Capacity	**517.2 kWh (long haul truck)**
Charging energy (20–80 %)	310.3 kWh
Overall charging power (2C)	**~ 1000 kW**

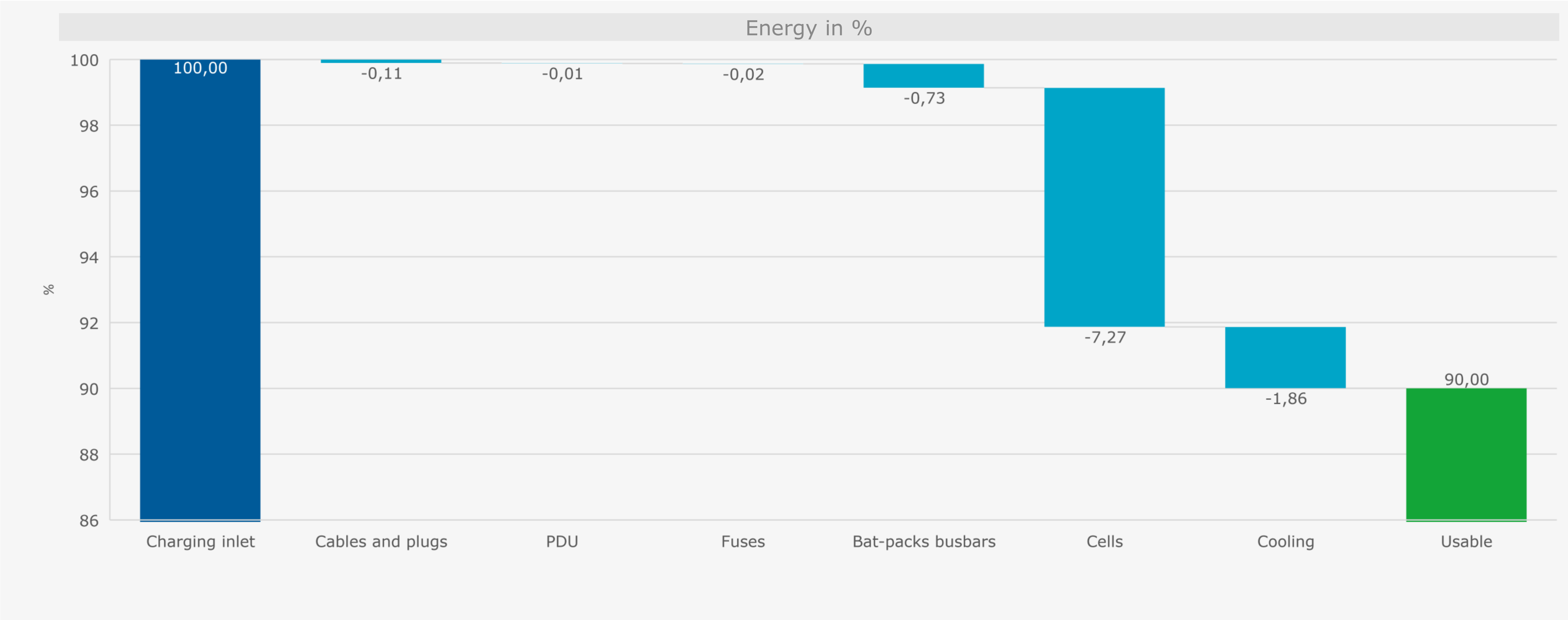
Charging Use Case (Defined for 1 Bat-Pack)

Parameter	Value
Battery Charging Power (~2C)	174 kW const
Charging energy (20→80 % SOC)	51.7 kWh

- Battery Pack Charging Key Facts

Parameter	Value
Battery Charging Power (~2C)	174 kW const
Charging energy (20→80 % SOC)	51.7 kWh
Charging Time	**~ 20 min**
Mean Battery Terminal Voltage	865 V
Mean Battery Charging Current	**201 A**
Mean Cell Charging Power	161 kW
Mean Cell Charging losses	**13 kW**

Resulting Energy Split



MegaWatt Chargig – A Critical Success Factor for Commercial Vehicle Electrification

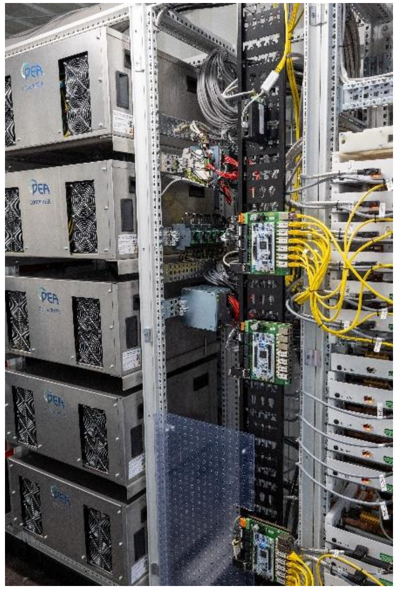
Status Funding Project NEFTON

NEFTON Project Insights
Current Status, Site: Plattling, Germany

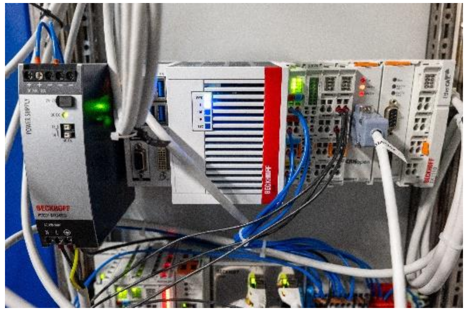
NEFTON Project Insights

Current Status, Site: Plattling, Germany

Load Matrix and Power Electronics



Modular Control System



Dispenser & Energy Storage

19th of July 2024

Public Demonstration of MegaWatt Charging

Registration:

www.nefton.de

Looking forward to see you in Plattling, Germany

MegaWatt Chargig – A Critical Success Factor for Commercial Vehicle Electrification

Outlook

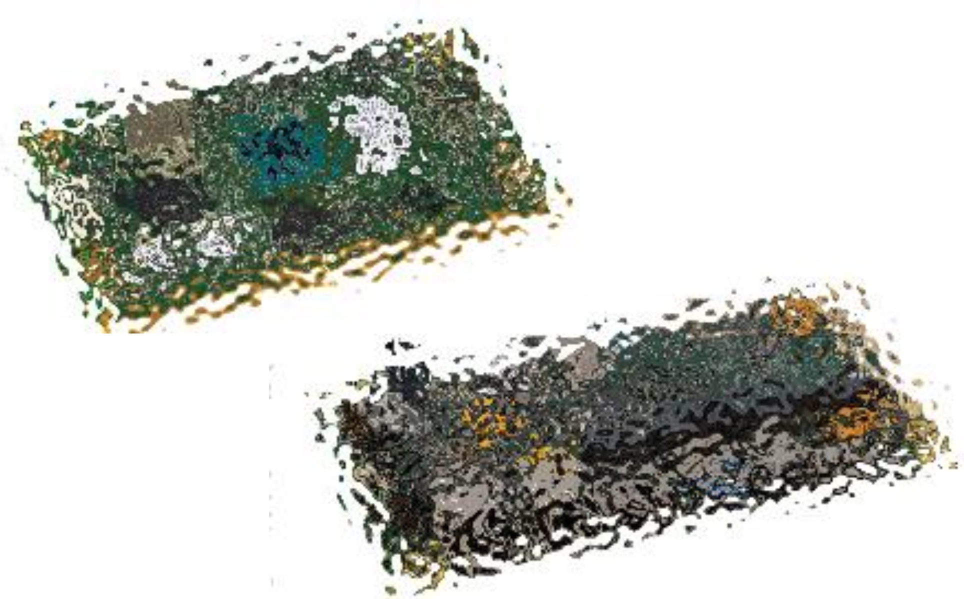
AVL EVSE Controls
Solution for Charging Stations

Overview - Benefits of AVL EVSE Control System:

- Modular & scalable controller concept
- Fast time to market solution
- Software for complete Charging Station Control
- Customized development on demand
  - Full access to all modules and interfaces
- All Components integrable via cap rail system
- Support of latest Charging Standards
  - CCS (ISO 15118-2 & -20 & DIN70121)
  - Chademo 0.9-2.0
  - China GB/T ready
  - MCS (preliminary version)
- Optional: White Box design data for Software and Hardware

Solution for DC Wallbox to MCS Charging Station

EVSE Controller Reference



EVSE Controller

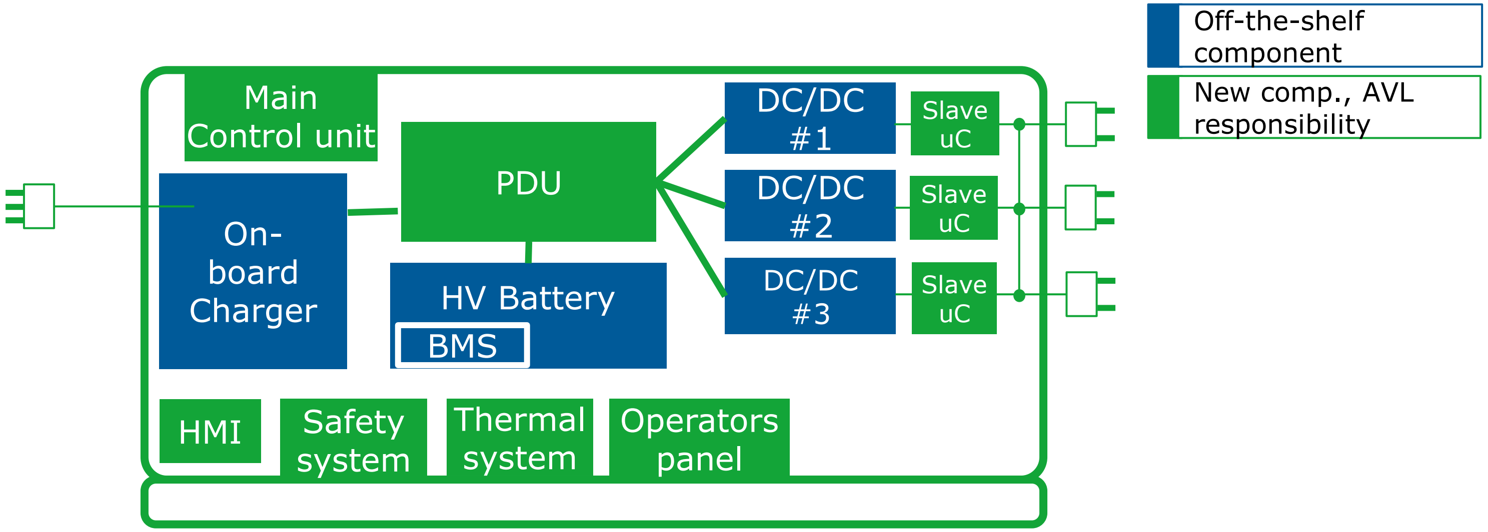
Customized series development

Confidential

AVL contributions

- **System spec & design**
- **HW Design**
- **Software Development CCS 1/2 and Chademo**
- **Control Unit build-up**
- **Testing**

Mobile Battery Station Reference



Charging Station

Prototype development

AVL contributions

Market Screening & Pre-Selection

System Specification & Design

Charge Control Unit & Plant Control

Charging Station Prototype Build-up

Commissioning & Testing

SOP Project Reference
EVCC Development & Validation

Requirements Engineering

Software development for CCS Standard

Integration of VCU and EVCC functionality into on eCU

Safety development support

In-house HIL Testing with Vector VT System

Vehicle and charging system calibration

Charging in-field testing in Europe

Vehicle testing with AVL Rapid Charger

CCS SOP Software development / charging system vehicle calibration and validation

Project

- EV C-SUV Segment
- EV Lead SOP
- VCU & EVCC Platform development
- Target: European & US Market
- Project Start: 2018
- Duration: 3 years

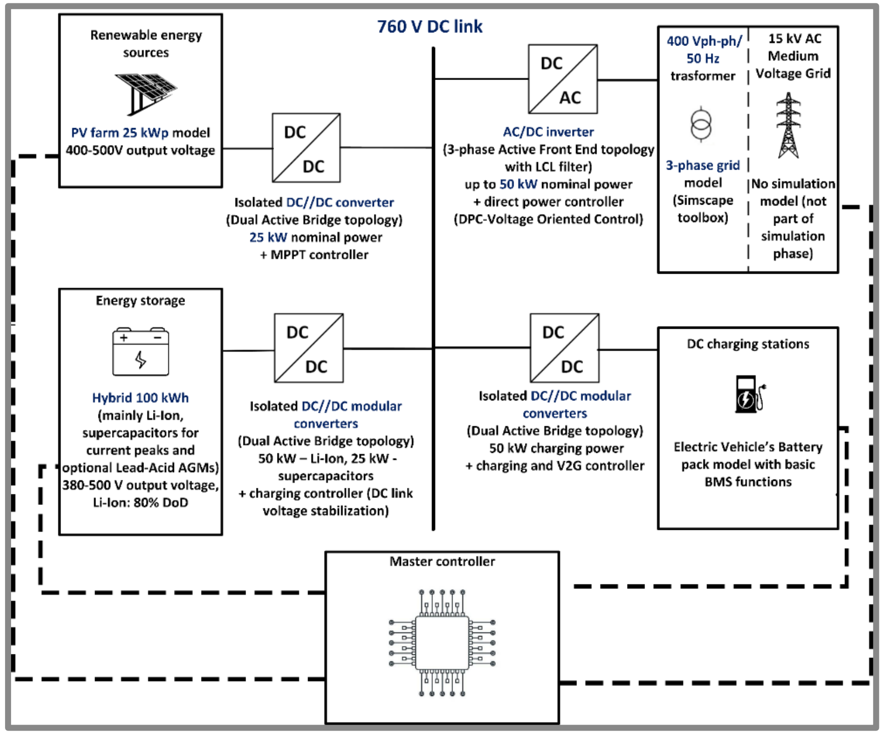
Specific Project Challenges

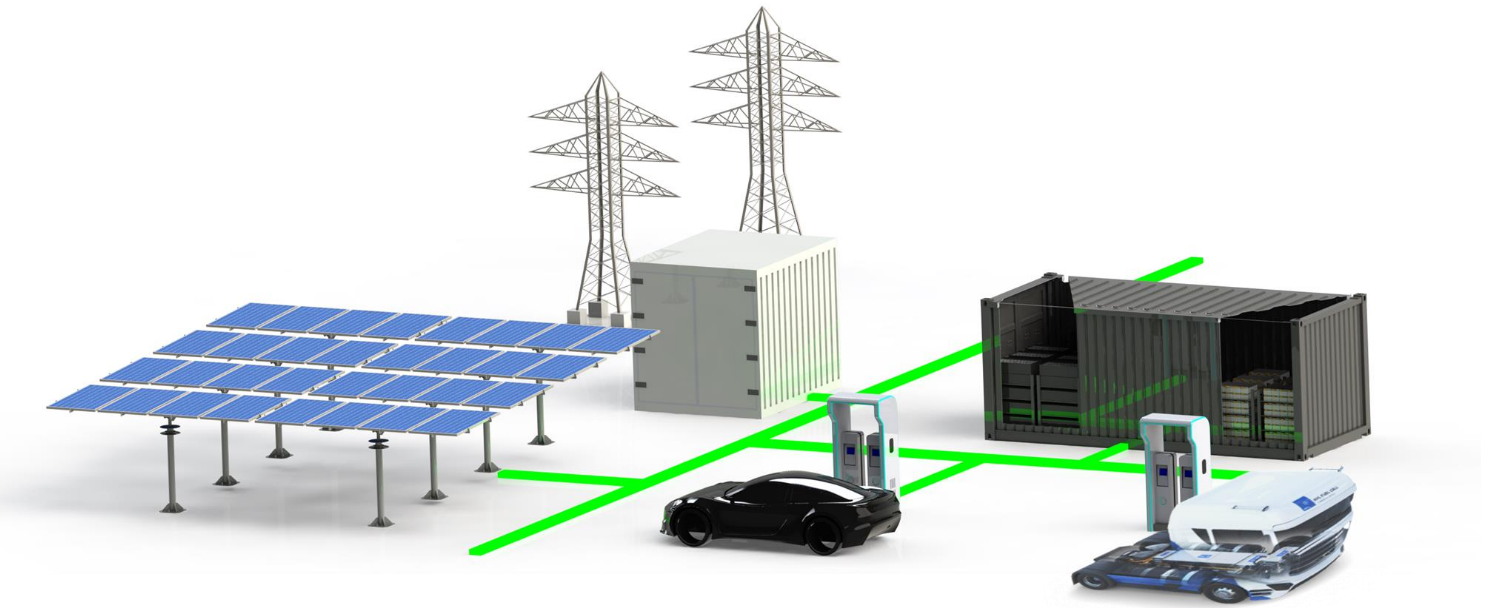
- Agile and challenging timeline
- Functional integration of EVCC into VCU
- Testing and Validation

Methods

- Agile SW development
- Dedicated Charging Validation Plan

Charging Park Simulation
AVL Proven Simulation Models





- Simulation of different topologies (e. g. solid state transformer)
- Simulation of failures (e. g. load dump)
- Simulation of different power classes up to MegaWatt charging
- Simulation of different load scenarios

MCS Summary & Outlook

2024

- 01/24 MAN & ABB Joint Venture for MCS Solutions
- 05/24 first MCS charge point with Kempower HW in Sweden
- 06/24 Shell presents MCS charge system for trucks and ships
- 07/24 NEFTON Final Event

2025

- Finalization of MCS standard
- Alpitronic MCS charging station

Future

- Efficient MCS charge park setups with intelligent energy management
- Charge points with up to 3 MW
- Reliable MCS infrastructure with (charge point every 50 km, > 750 kW)
- MCS for road freight transport, freight shipping and aviation
- 350 charging parks for trucks (with CCS & MCS) in Germany until 2030

MegaWatt Chargig – A Critical Success Factor for Commercial Vehicle Electrification

Q&A

Contact

LOCATION

AVL Software and Functions GmbH
Im Gewerbepark B29
93059 Regensburg
Germany

PHONE

+49 94163089363

EMAIL

anne-marie.schuppan@avl.com

WEBSITE

www.avl.com

Thank you

www.avl.com