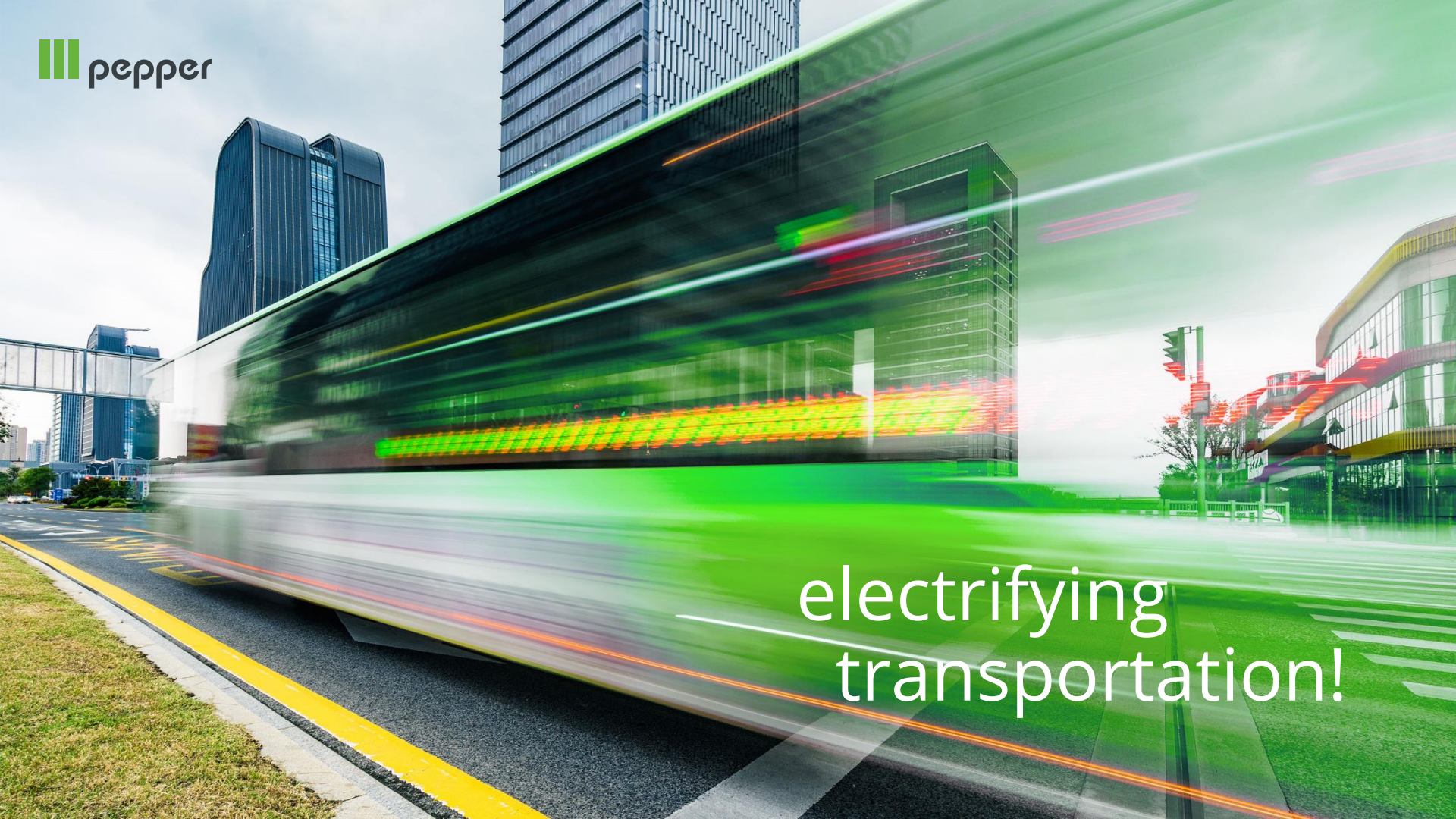




electrifying
transportation!

CONTEMPORARY CHALLENGES IN THE COMMERCIAL EV-MARKET

ELECTRIFICATION OF HEAVY VEHICLES

DR. MATTHIAS KERLER

THE PROBLEM



Trigger



Buses account for 2% of inner-city vehicles but 30% of emissions



5% of all vehicles but responsible for >25% of all global warming pollution



5m deaths per year, caused by air pollution

TAKE ACTION



Initiatives



**European Green Deal:
Zero greenhouse
emissions in 2050**



**Target for 50%
reduction in US
greenhouse gas
pollution by 2030**



**UN Sustainable
Development Goals
“Better & sustainable
future for all”**



**Immediate and functioning solutions
necessary to meet initiatives**

THE CHALLENGE



Functional problems of the Nikola BEV Truck and long development cycles

Not reliable



massive acceleration in growth and demand for raw materials is outpacing supply

Not scalable



Electric city bus expected to cost about 2.5 times more than conventional ones

Not cost-efficient



No reliable, scalable and achievable solution for electrification of commercial vehicles available

MASS MARKET ADOPTION



TESLA THROUGH THE YEARS

Mass market adoption requires resources and time

~185k cars delivered

Tesla Release
Roadster

2008 Q1

2010 Q1

2012 Q1

2014 Q1

2016 Q1

2018 Q1

2020 Q1



1st Generation Roadster



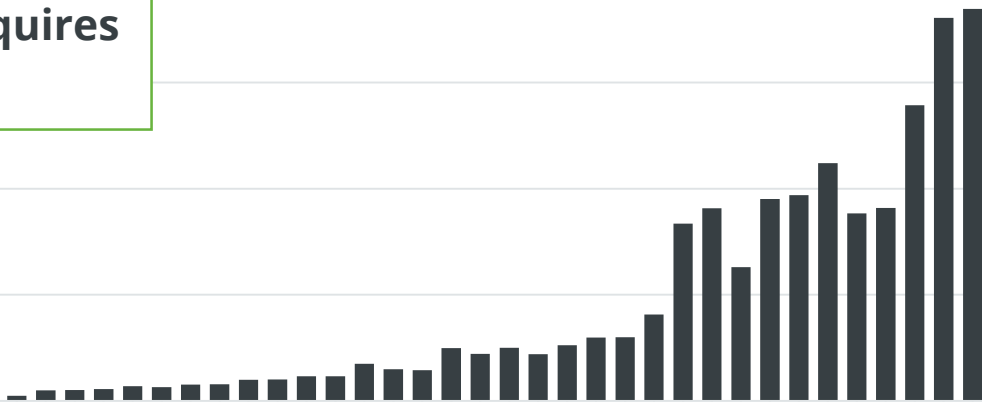
Model S



Model 3



New Roadster



COMMERCIAL EV-MARKET OVERVIEW



GLOBAL ELECTRIC TRUCK & BUS MARKET

- Numbers of electric bus & truck registrations are growing but still represent a small share
- Companies such as Daimler, MAN, Renault, Scania and Volvo have indicated they see an all-electric future
- Broadening range of available vehicles
- More than 20 countries have electrification targets

Barriers to EV adoption:

1. Lack of charging infrastructure
2. Lack of appropriate EV type
3. Capital cost of EVs
4. Operational change impacts (e.g. charging time)
5. Uncertain policy landscape



**pepper motion
addresses these barriers**



CLIMATE POLICIES AS MARKET DRIVER

WORLDWIDE & EUROPE

CLIMATE POLICIES AS MARKET DRIVER



POLICIES EUROPE

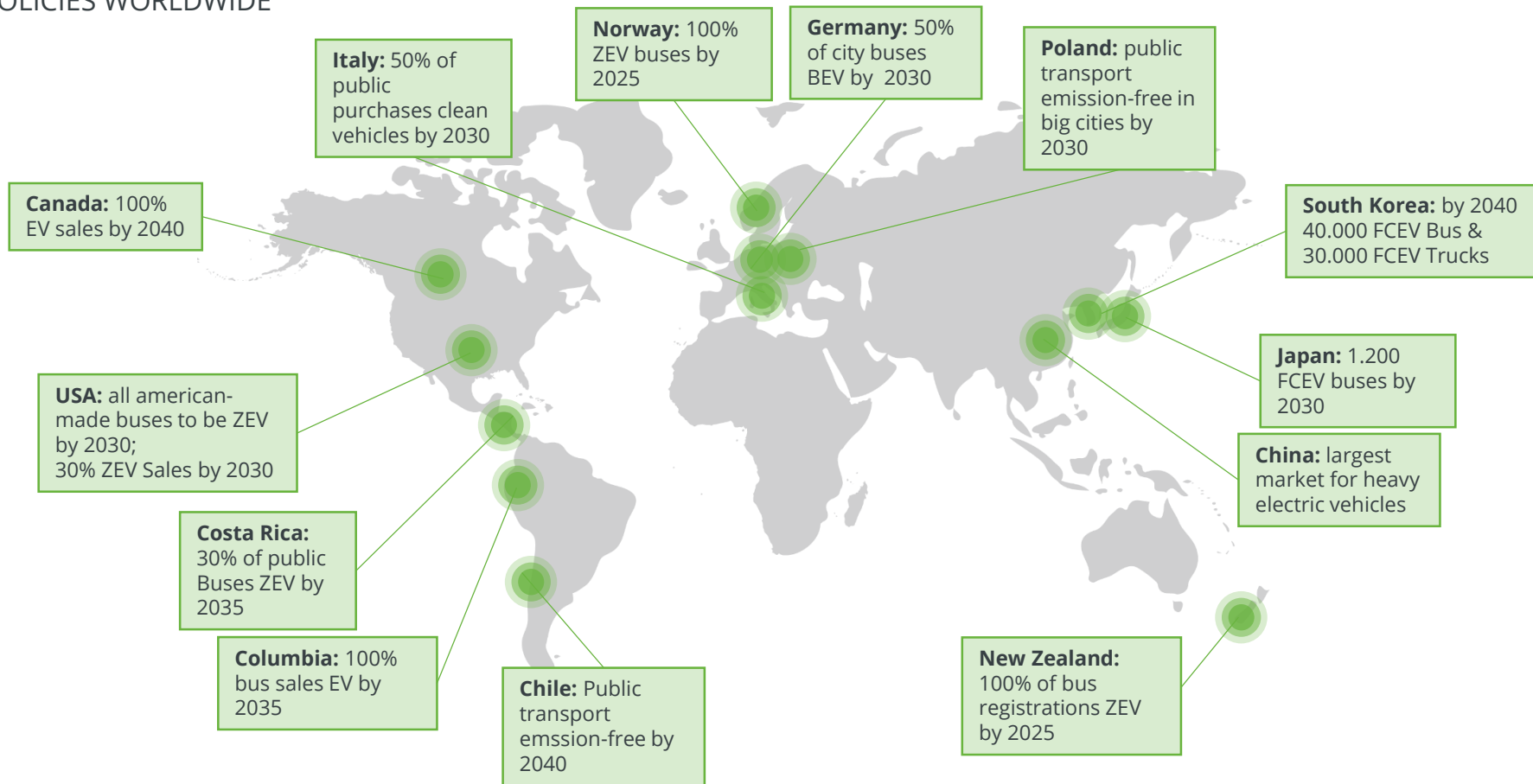
- CO₂-emission goals for heavy vehicles
 - 15% reduction by 2025
 - 30% reduction by 2030
- Clean Vehicles Directive regarding the procurement of clean vehicles
 - „clean vehicles“: BEV, FCEV, Gas, synthetic fuels, biofuels
 - emission-free vehicles: BEV, FCEV, trolleybuses

Period	Propulsion System	Truck (>3,5t)	Bus (>5t)
First Period: 2021-2025	Clean vehicles	10%	45%
	Emission-free vehicles	5%	22,5%
Second Period: 2026-2030	Clean vehicles	15%	65%
	Emission-free vehicles	7,5%	32,5%

CLIMATE POLICIES AS MARKET DRIVER



POLICIES WORLDWIDE





MARKET DEMAND

HEAVY ELECTRIC VEHICLES

MARKET DEMAND FOR ELECTRIC TRUCKS



ORDERS WORLDWIDE

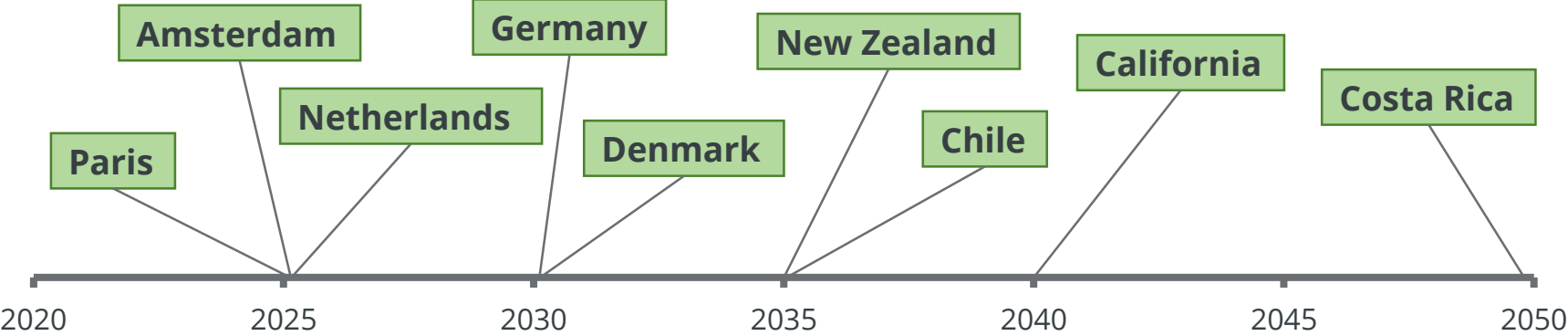
COMPANY	TARGET
Amazon	Orders 100.000 BEV light-commercial vehicles from start-up company Rivian. Amazon aims to be net-zero emissions by 2040.
DHL Group	Delivery of mail and parcels by EVs in the medium term and net-zero emissions logistics by 2050.
FedEx	Transition to an all zero-emission vehicle fleet and carbon neutral operations by 2040.
IKEA	Zero-emission deliveries in leading cities by 2020 and in all cities by 2025.
Walmart	Electrify the whole vehicle fleet by 2040.
Various companies	Walmart, Pepsi, Anheuser-Busch, FedEx, Sysco and other large multinational corporations pre-order 2.000 Tesla Semi models within six months of truck's debut.

MARKET DEMAND FOR ELECTRIC BUSES



PUBLIC TRANSPORT OPERATORS

100% of the city bus fleet to be zero-emission in...





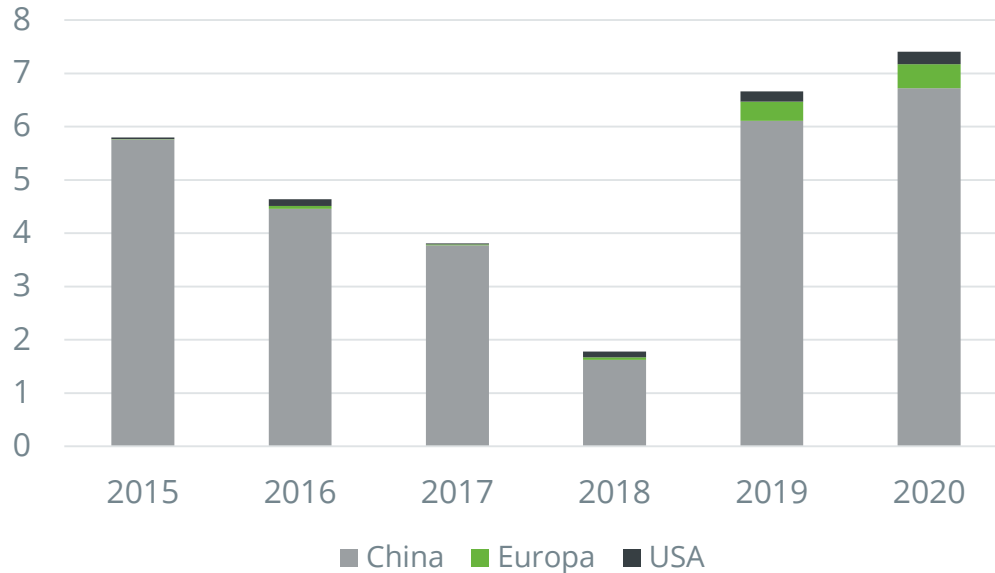
MARKET SUPPLY

HEAVY ELECTRIC VEHICLES

MARKET SUPPLY – ELECTRIC TRUCKS



Electric Truck Registrations (Thousands)



Truck market EU

- 6.230.000 Trucks in the EU (N2, N3)
- Only 15.000 are BEV

(2020)

Truck market Hungary

- 94.300 Trucks in Hungary (N2, N3)
- Only 7 are BEV (>16t)

(2020)

PRODUCTS - ELECTRIC TRUCKS



MARKET SUPPLY



Mercedes eActros



DAF CF/LF Electric



BYD (multiple)



MAN eTGM



Volta Zero



Volvo (multiple)



Renault D Z.E.

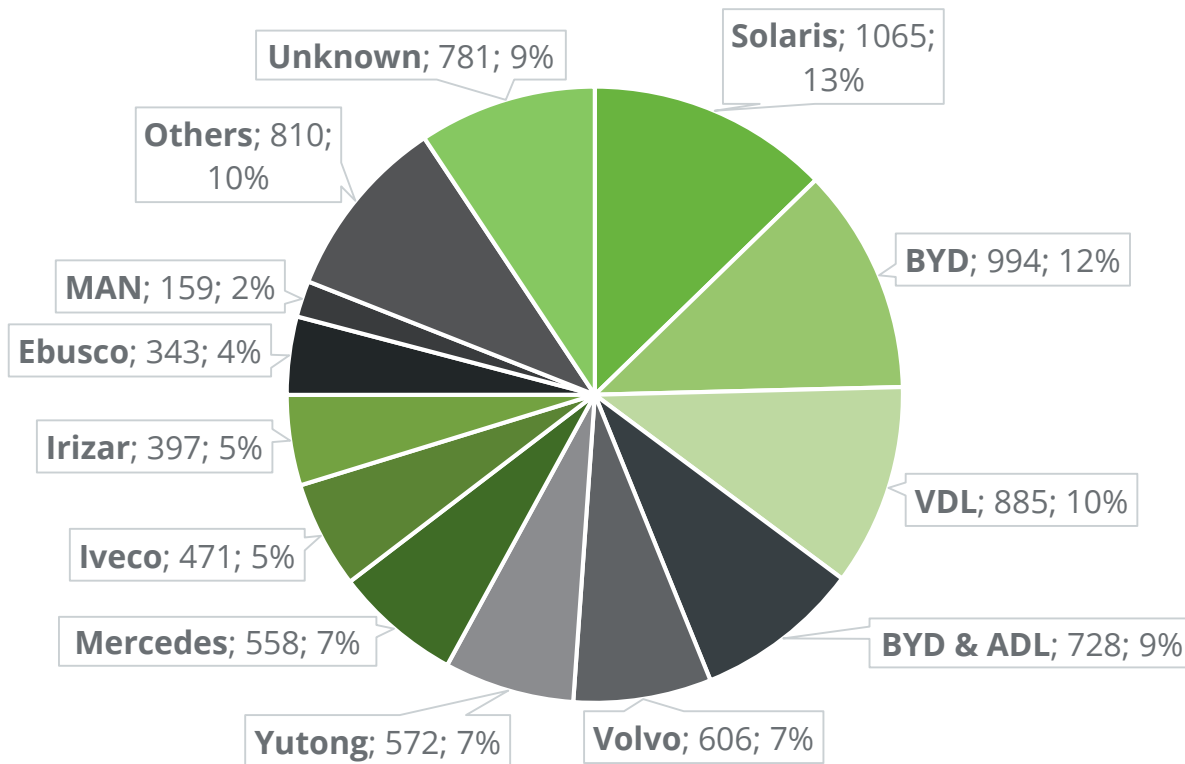


Tesla Semi Truck

MARKET SUPPLY – ELECTRIC BUSES



NUMBER OF ELECTRIC BUSES IN EUROPE BY MANUFACTURER



Bus market EU:

- 685.000 Buses in the EU
- Only 8.500 are BEV

(2020)

Bus market Hungary:

- 17.000 Buses in the EU
- Only 50 are BEV

(2020)

PRODUCTS

MARKET LEADERS ELECTRIC BUS



Mercedes eCitaro



Yutong (multiple)



BYD (multiple)



Solaris Urbino E



ADL Enviro 200EV



Iveco E-Way



VDL Citea Electric



Arrival Bus



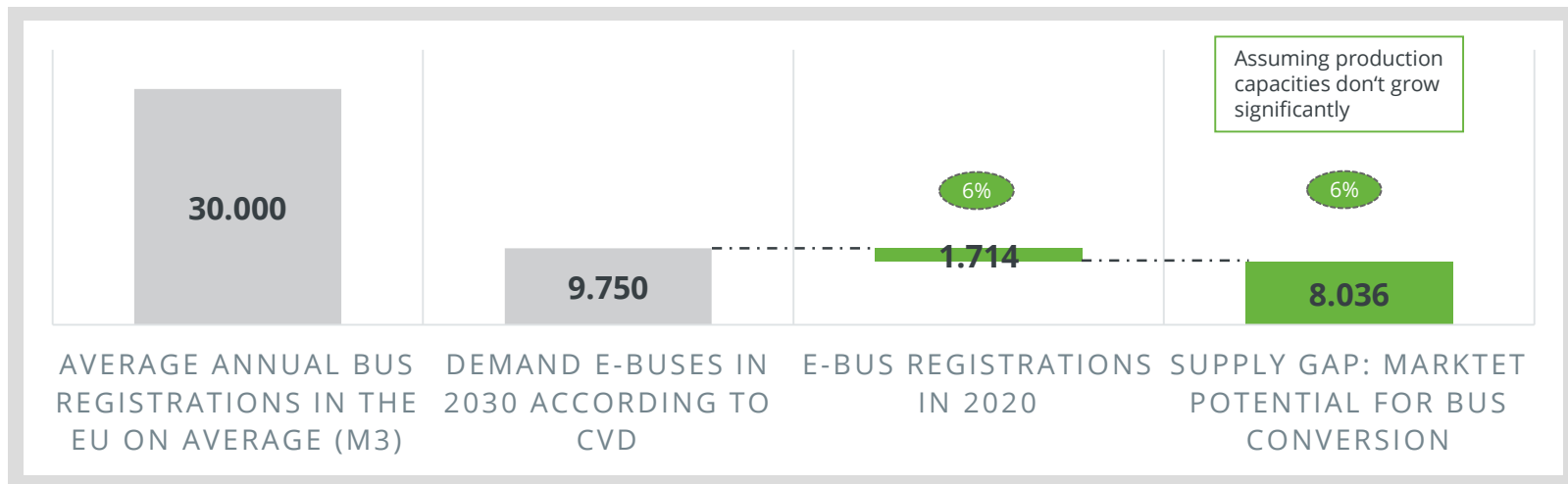
GAP OF ELECTRIFICATION

SUPPLY GAP OF HEAVY ELECTRIC VEHICLES

GAP OF ELECTRIFICATION - BUS



BUS MARKET IN THE EUROPEAN UNION



% EV Share



More than 50% gap between green deal and clean vehicle directive in 2030

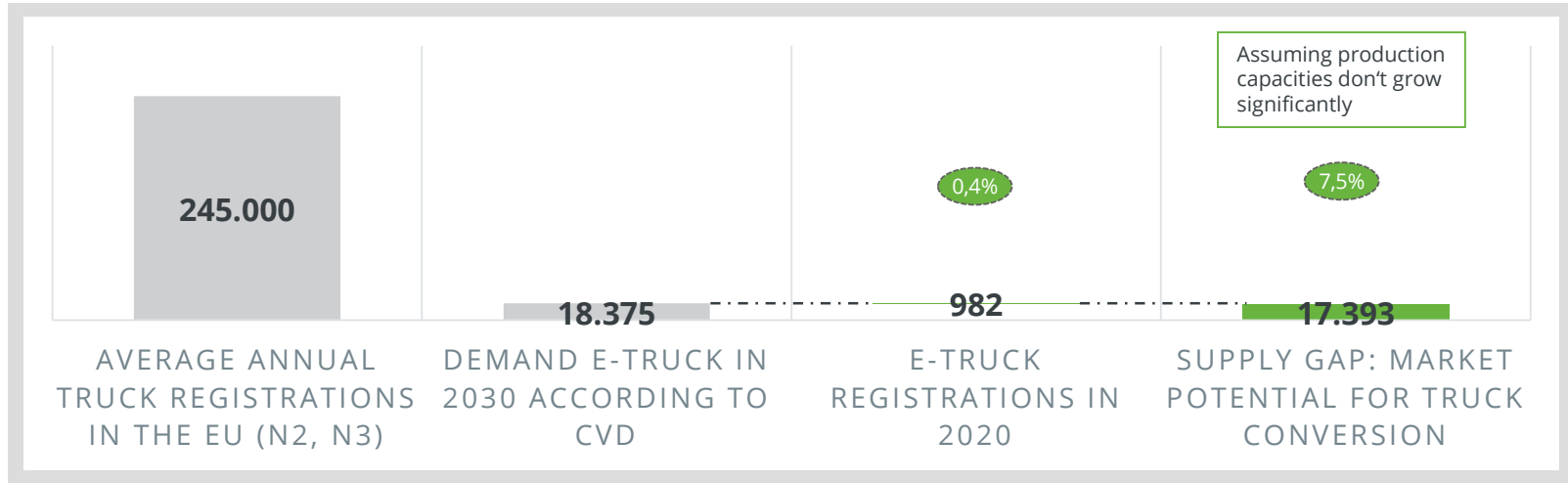


Not only electrification of new buses but also electrification of vehicle stock necessary

GAP OF ELECTRIFICATION - TRUCK



TRUCK MARKET IN THE EUROPEAN UNION



% EV Share



2.5m etrucks (>3.5t) need to reach EU climate goal 2030
→ electrification of vehicle stock



Market for electric trucks is much bigger but less advanced compared to electric bus market

GAP OF ELECTRIFICATION



SUMMARY



Increasing demand for electric CVs due to political and social pressure



-15% emissions by 2025
-30% emissions by 2030
-100% emissions by 2050



OEMs cannot meet rising market demand



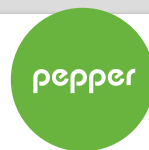
- Low quantities available
- Long time to market
- Lacking technology
- Low incentive to shift
- High TCO



Increasing gap of supply and demand



- ! Potential **driving bans and penalties** for operators
- ! Risk to **lose market position and reputation** for OEMs



pepper motion solves both issues by:

- ✓ Electrifying existing **vehicles** for operators
- ✓ Enabling OEMs and/or to become OME to **quickly bring new electric vehicles** to the market
- ✓ Enabling OEMs to **repurchased fleet** into electric saleable vehicles



CONVERSION AS THE SOLUTION

HEAVY VEHICLE CONVERSION BY PEPPER

SOLUTION

VEHICLE CONVERSION



Classical approach



Increase of vehicle base

Pushing additional vehicles with long & expensive R&D cycles

Slow time to market

Large order backlog and cannibalization of business model

Pushing new e-vehicle types

Production of additional vehicles

Reputation risk

Slow time to market and high TCOs can damage reputation

Retrofitting approach



Tapping into an installed base

Existing vehicle base **without** long and expensive R&D cycles

Fast & flexible implementation

Plug and play solution, fast time to market & high scalability

Conversion of vehicle base

Conversion into EV's instead of production of new vehicles

Strong brand creation for the future

Direct market share impact and strong brand awareness

TOTAL COST OF OWNERSHIP



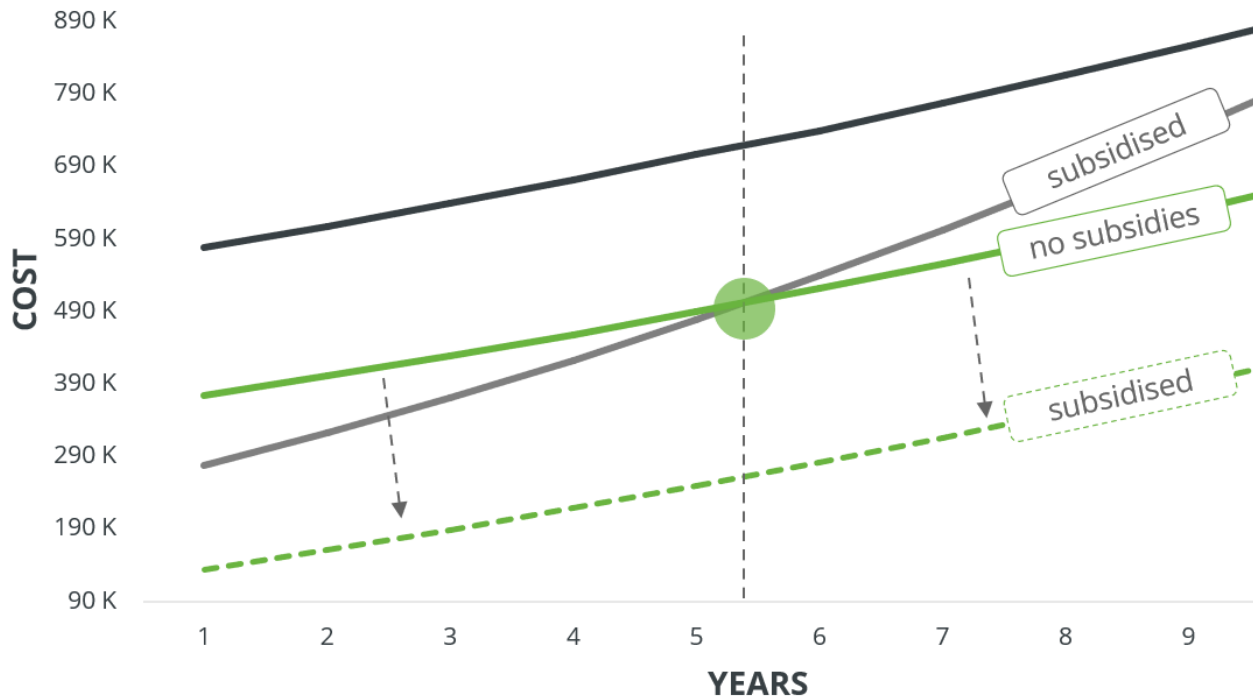
COMPARISON OF DIFFERENT BUS TYPES FOR HUNGARY

871.000 €
e-Bus new

782.000 €
diesel bus new

660.000 €
pepper motion Bus

380.000 €
pepper motion Bus





PEPPER MOTION

VEHICLE CONVERSION

E-TROFIT BECOMES PEPPER



THE REASON FOR THE CHANGE OF NAME IS THE CONSISTENT EXPANSION OF THE TECHNOLOGY-OPEN PRODUCT AND SOLUTION PORTFOLIO.



pepper embodies the company's mission for sustainable mobility in the commercial vehicle industry.

etrofit

etrofit continues to exist as a product line in the pepper Retrofitting business unit.

VISION & MISSION

WE WANT TO MAKE AN ACTIVE CONTRIBUTION TO
REDUCING EMISSIONS IN TRANSPORT.

VISION

The mobility of the future is green – climate-neutral, emission-free and energy-efficient. Our vision is that it is available to all people, affordable and tailored to their individual needs.

MISSION

As a digital OEM, we develop the most sustainable form of mobility in passenger and freight transport.



PEPPER AT A GLANCE

WITH OUR UNIQUE TECHNOLOGY, WE
MAKE A VALUABLE CONTRIBUTION TO
CLIMATE-FRIENDLY, EMISSION-FREE
MOBILITY IN OUR SOCIETY.



100+ EMPLOYEES

Multi-national
team of experts



4 LOCATIONS

Denkendorf near Ingolstadt (HQ)
Garching near Munich
Paderborn
Vienna (Austria)



3 DISTRIBUTORS

Italy
Poland
France



1. DIGITALER OEM

Providers of complete solutions:
From electrified commercial
vehicles to charging infrastructure
and service



ADVANTAGES RETROFIT



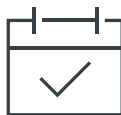
SUSTAINABILITY

- Resource-saving
- Second Life
- CO₂ savings



ECONOMY

- Cheaper than buying a new one
- Lower operating and maintenance costs, lowest TCO
- Term extension



AVAILABILITY

- Fast delivery capability for selected models
- Short development cycles
- Fast implementation



SAFETY

- Standards (e.g. ISO 26262)
- TÜV Certification
- Criteria catalogue of the Federal Ministry for Digital and Transport



11

[illegible]

PROJECT SCHEDULE



Analysis & Consulting

1

- Vehicle suitability
- Individual use case

Conception

2

- Vehicle specifications
- Dimensioning Charging infrastructure
- Finance plan

Conversion

3

- Refurbishment & Upgrades
- Electrification
- Commissioning

Operation

4

- Service & maintenance
- Staff training
- Innovative hard- & software updates



E-TROFIT BUS

BY PEPPER MOTION



ETROFIT KIT



ELECTRIFICATION OF EXISTING BUSES ON ELECTRIC DRIVE WITH
PEPPER'S OWN VEHICLE CONTROL UNIT (VCU) AND
COMPONENTS FROM RENOWNED SUPPLIERS.

Modular
Battery system

Telematics
Unit

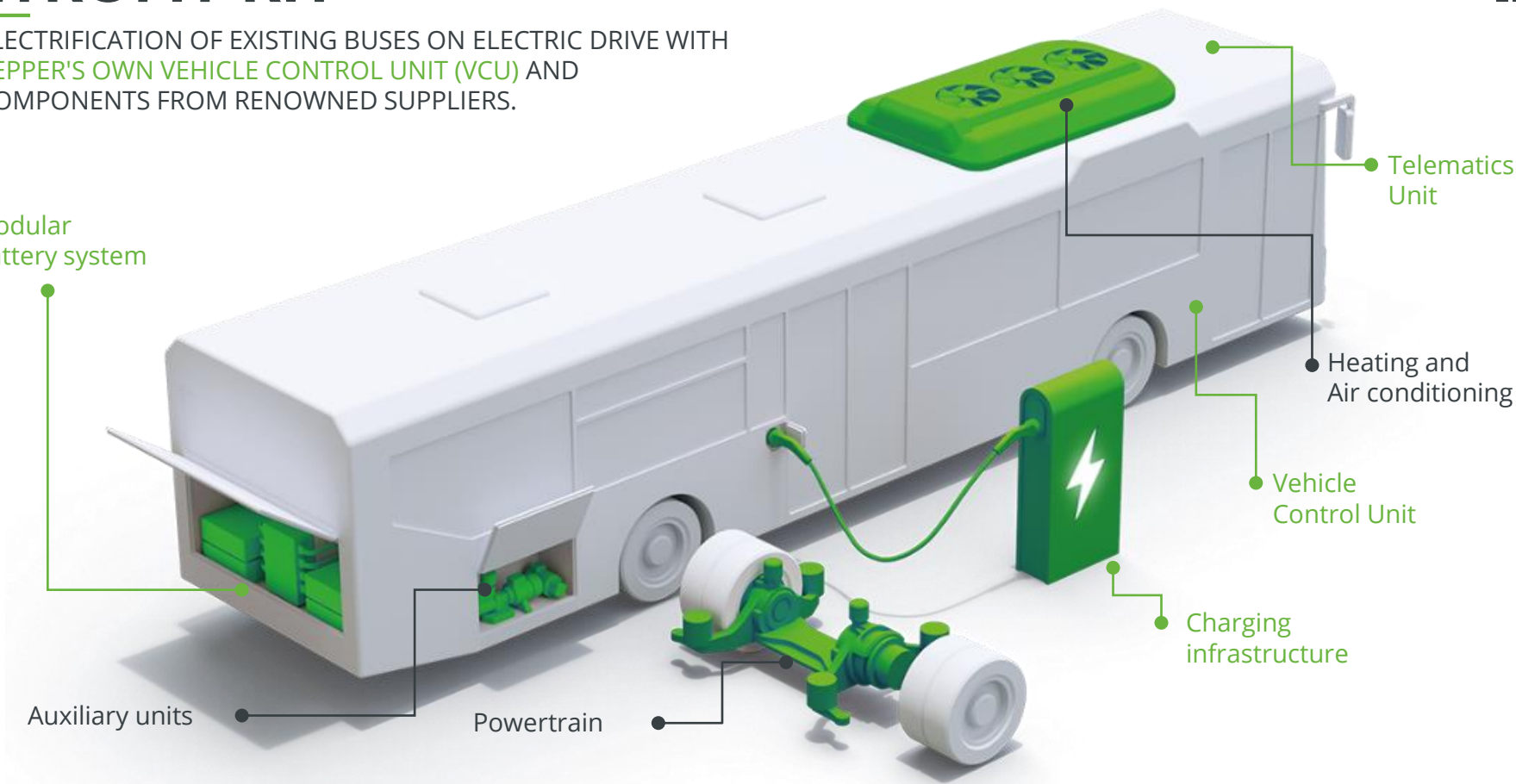
Heating and
Air conditioning

Vehicle
Control Unit

Charging
infrastructure

Auxiliary units

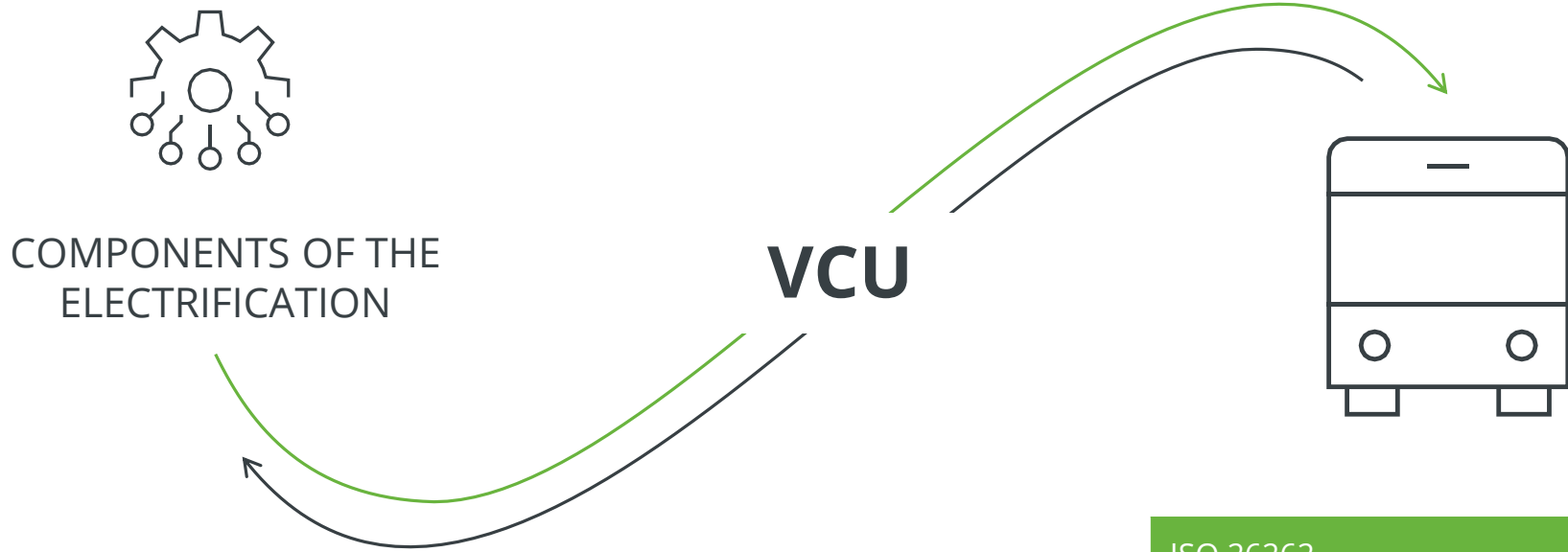
Powertrain



PEPPER OWN VEHICLE CONTROL UNIT



SOFTWARE ADAPTABLE TO DIFFERENT VEHICLE TYPES FOR BUSES AND TRUCKS



ISO 26262

The VCU has been developed according to ISO 26262 and represents the core element of the vehicle's electric architecture

TECH. DATA ABOUT THE ETROFIT KIT BUS



PEPPER VEHICLES CAN BE REGISTERED IN ALL EU MEMBER STATES.

POWERTRAIN

VCU pepper	- Interface between etrofit kit and vehicle - Developed according to ISO 26262
Rear axle	- Electric portal axle ZF AxTrax-AVE 130 2 wheel-close asynchronous motors - water-cooled
Torque [Nm]	2 x 485 = 970
After final translation [Nm]	2 x 11.000 = 22.000
Rated power [kW]	2 x 80 = 160
Peak power [kW]	2 x 125 = 250
Recuperation [kW]	Up to 250

BATTERY

Technology	NMC (nickel-manganese-cobalt)
Cooling	Water glycol (active battery cooling)
Usable battery capacity 8 pcs. [kWh]	240 (other configuration possible)
Charging power [kW]	Up to 150
Charging type	Type 2 CCS, DC charge
Range [km]	Up to 250
System voltage [V]	650

AIR CONDITIONING

Type	Air conditioning/ Heat pump
Electric auxiliary heater [kW]	2 x 7 = 14
Fossil auxiliary heater [kW]	23
Cooling capacity [kW]	25

WEIGHT

Gross vehicle weight [kg]	18.000
Curb weight [kg]	12.300

PEPPER BUS





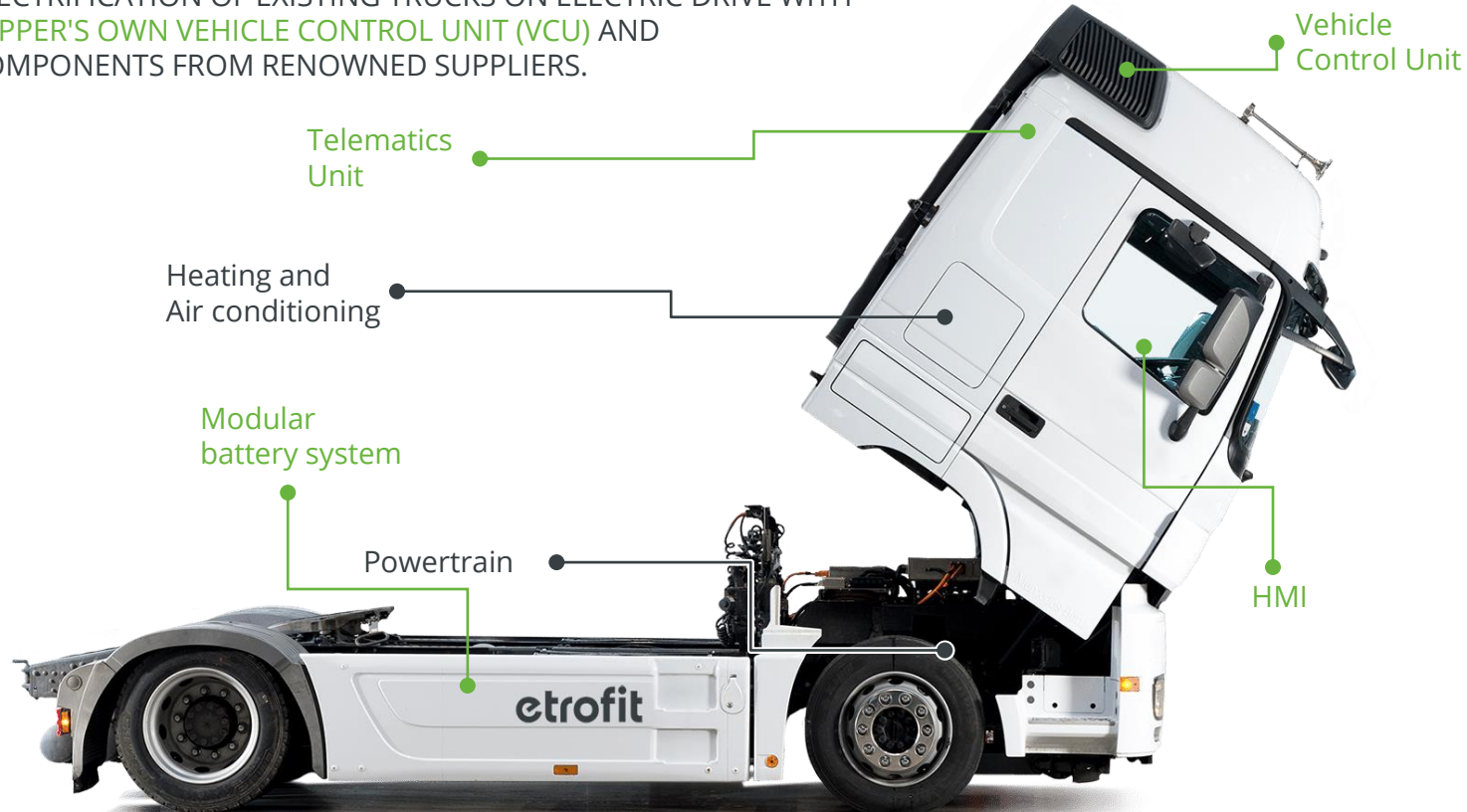
E-TROFIT TRUCK

BY PEPPER MOTION

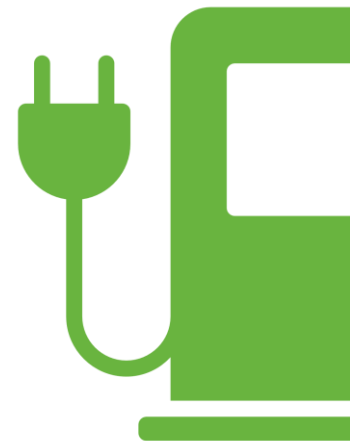


ETROFIT KIT

ELECTRIFICATION OF EXISTING TRUCKS ON ELECTRIC DRIVE WITH
PEPPER'S OWN VEHICLE CONTROL UNIT (VCU) AND
COMPONENTS FROM RENOWNED SUPPLIERS.



Charging
infrastructure



PEPPER OWN VEHICLE CONTROL UNIT



SOFTWARE ADAPTABLE TO DIFFERENT VEHICLE TYPES FOR BUSES AND TRUCKS



ISO 26262

The VCU has been developed according to ISO 26262 and represents the core element of the vehicle's electric architecture

TECH. DATA ON THE ETROFIT KIT TRUCK



PEPPER VEHICLES CAN BE REGISTERED IN ALL EU MEMBER STATES.

DRIVE SYSTEM

VCU pepper	- Interface between etrofit kit and vehicle - Developed according to ISO 26262
Central engine	- ZF CeTrax (up to 30t) - Asynchronous motor
Output torque (peak value / 30 min S2) [Nm]	4.500 / 2.170
Recuperation [kW]	Up to 250
Engine power (peak value / 30 min. S2) [kW]	300 / 200
Payload incl. trailer [t]	18
Maximum total weight [t]	26

BATTERY

Technology	NMC (nickel-manganese-cobalt)
Cooling	Water glycol
Usable battery capacity 8 pcs. [kWh]	240
Charging power [kW]	Up to 150
Charging type	Typ 2 CCS, DC charge
Range [km]	Up to 200

ANCILLARY UNITS

Retarder	Telma Retarder AF 83-60
Electric auxiliary heater	HVH 100 Webasto

PEPPER TRUCK



AWARDS



2022

ETPN Award for the etrofit
Electrification Kit for Trucks



2020

CLEPA – Innovation Award

FUTURE MOBILITY EUROPE
An **Automotive World** Event

2020

TOP 50 Startups in the Field
of Future Mobility in Europe



2018

German Mobility Award