Technology focus: Battery trolleybus & In-Motion-charging

Webinar Series

29th September 2022, 11.00-12.00 CEST

Mateusz Figaszewski

E-mobility Development and Market Intelligence Director at Solaris

The Clean Bus Europe Platform is financed by the European Union.

Mateusz Figaszewski
E-mobility Development & Market Intelligence Director, Solaris

- Graduated at University of Economics in Poznan, as well as at University of Poznan and London Chartered Institute of Marketing.
- Since almost 20 years working in public transportation and automotive industry.
- Director of E-mobility Development and Market Intelligence at Solaris Bus & Coach, focusing on business development for sustainable mobility of the future.
- Member of UITP Industry Committee and Trolleybus Committee, where he actively promotes zero emission solutions for public transportation.

Programme

Technology focus: Battery buses		
11.00 – 11.05	Welcome & Introduction	Aida Abdulah, UITP
11.05 – 11.40	• Introduction to battery trolleybus technology and In-Motion-Charging • Vehicle and components • Charging infrastructure • Main advantages and drawbacks • City strategies to deploy this technology	Mateusz Figaszewski , Solaris
11.40 – 12.00	Questions & Answers	

Today's goal

- Clear and complete overview of this technology
- What are the main features and main challenges of this technology?
- Which aspects should I consider upfront when considering this technology?
- Insights on safety aspects
- Which sources of information can I refer to, to further learn on a specific technology?

Etiquette for joint discussion

- Participants please mute yourself per default
- You can use the Chat to place your questions, share interesting info or make us aware of any technical issue
- Raise your hand and switch on your camera to ask to have the word
- The session will be recorded.

We count on your valuable contribution for a successful workshop. Thank You!

Solaris as a company focused on green solutions

Introduction

Public transport is fundamental to sustainable cities
Innovation means – new opportunities

Operated by buses that
do not emit exhaust fumes

Connected to both **the train network and the means of** micro-mobility

Maintenance-free
and intuitive use

High standards and a comfortable journey in modern conditions

Solaris – 26 years of experience

We have been
operating since 1996

We are a part of
the CAF Group

We have 6 facilities in Poland

1850

BOLECHOWO

Headquarters
Bus assembly

100

Central service workshop

MUROWANA GOSLINA

JASIN

50

Logistics centre

SRODA WIELKOPOLSKA

KIJEWO

POZNAN

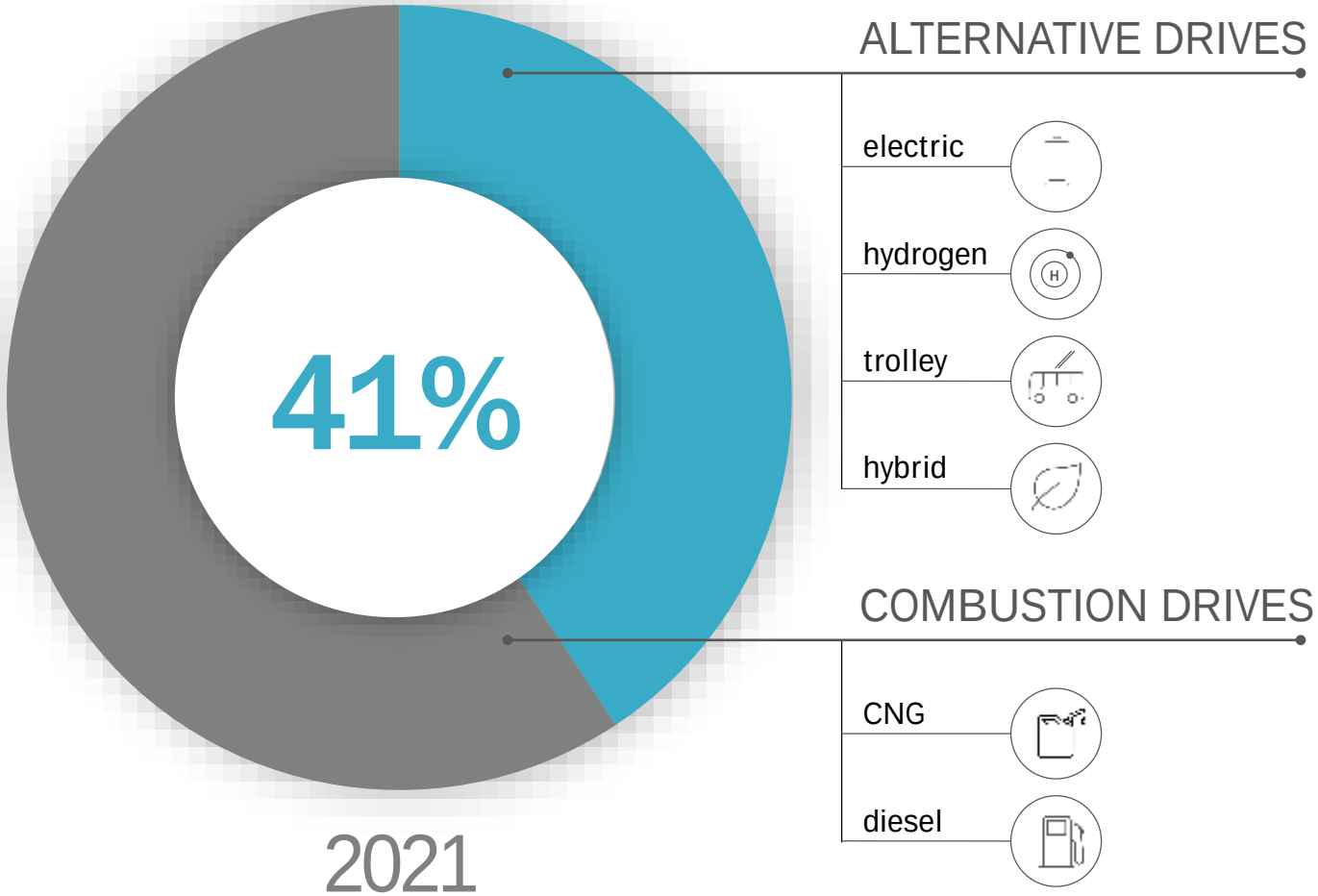
350

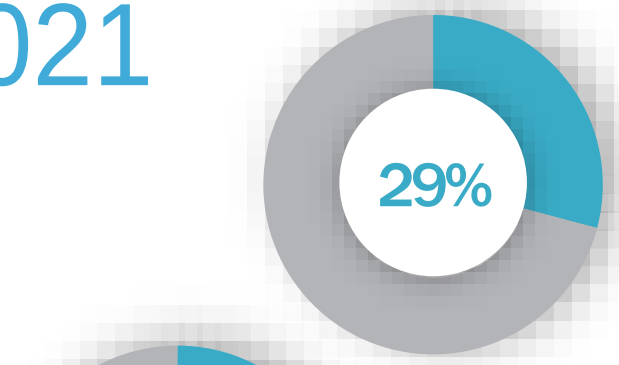
Bus welding plants

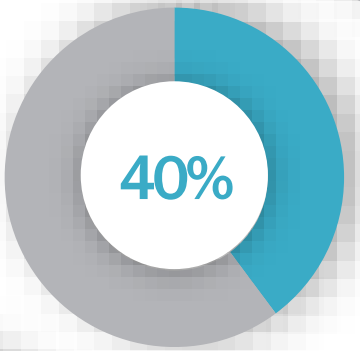
50

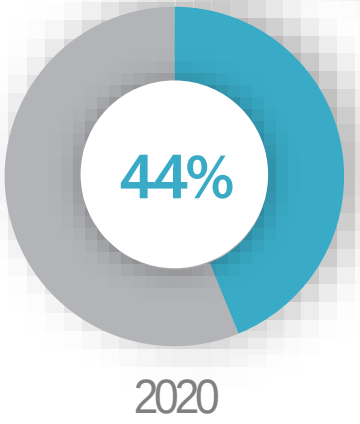
Support production

Share of alternative drives in Solaris buses between 2018-2021









Source: Solaris

Extensive drive portfolio

TROLLEYBUS

Zero-emission

HYBRID

Low-emission

ELECTRIC

Zero-emission

CNG

HYDROGEN

Zero-emission

EURO 6

Solaris experience in the trolleybus segment

General information

Experience

- Solaris is the number **1. manufacturer of trolleybuses in EU and EFTA states** – 40% share
- Experience in the assembly of trolleybuses since **2001**
- **3 vehicle lengths** (12, 18 and 24 m)
- 3 partners for **electric fittings** (Škoda Electric, Medcom, Kiepe Electric)
- **18** markets
- **60** cities

1824 **trolleybuses** delivered to **18 states*** in Europe

* as of **30.06.2022**

Experience

- Czech Republic
- Lithuania
- Bulgaria
- Poland
- Latvia
- Italy
- Romania
- Hungary
- Austria
- Estonia
- Slovakia
- Germany
- Switzerland
- France
- Norway
- Spain
- Sweden
- Portugal

Solaris Trollino

Trolleybuses

Electric motor

Quiet, emission-free

Traction batteries

In-Motion-Charging, the ability
to ride apart from overhead wires

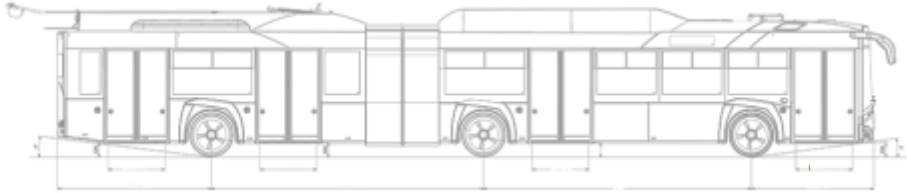
Safety

Double insulation
of the construction

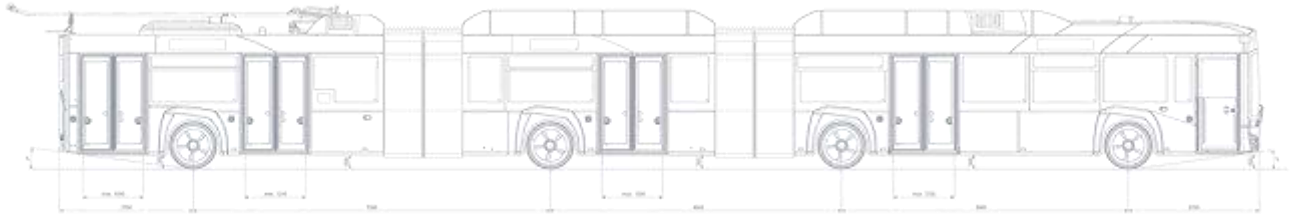
Trollino portfolio

12 m

18 m



24 m



Technical data

TROLLINO 12

LENGTH	12,000 mm
GVW (Gross Vehicle Weight)	18,000-19,000 kg
MAXIMUM SPEED	up to 70 km/h
AIR CONDITIONING	AC with electric compressor
HEATING	water heating with electric water heater
BATTERIES	option
BATTERY CHARGING	in-motion charging, plug-in

Technical data

TROLLINO 18

LENGTH	18,000 mm
GVW (Gross Vehicle Weight)	28,000-30,000 kg
MAXIMUM SPEED	up to 70 km/h
AIR CONDITIONING	AC with electric compressor
HEATING	water heating with electric water heater
BATTERIES	option
BATTERY CHARGING	in-motion charging, plug-in

Technical data

TROLLINO 24

LENGTH	24,000 mm
GVW (Gross Vehicle Weight)	38,000 kg
MAXIMUM SPEED	up to 70 km/h
AIR CONDITIONING	AC with electric compressor
HEATING	water heating with electric water heater
BATTERIES	option
BATTERY CHARGING	in-motion charging, plug-in

Power trains partners

MEDCOM (PL)

- Trollino 12
  Trollino 18
- Gdynia, Tychy, Lublin

ŠKODA (CZ)

- Trollino 12
  Trollino 18
- Plzen, Ostrava,
  Budapest, Sofia

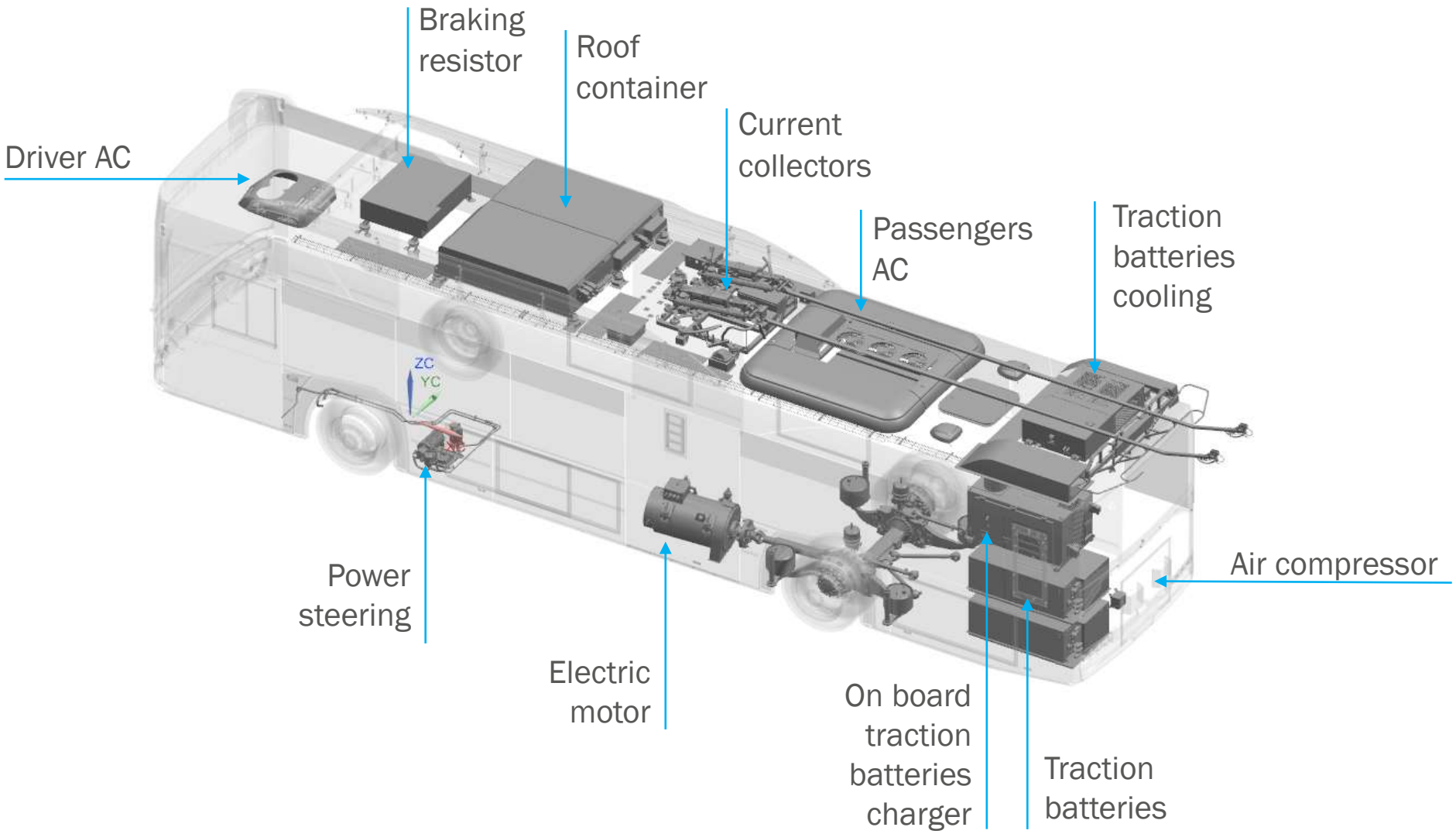
KIEPE ELECTRIC (DE)

- Trollino 12
  Trollino 18
- Esslingen, Solingen,
  Milano, Parma

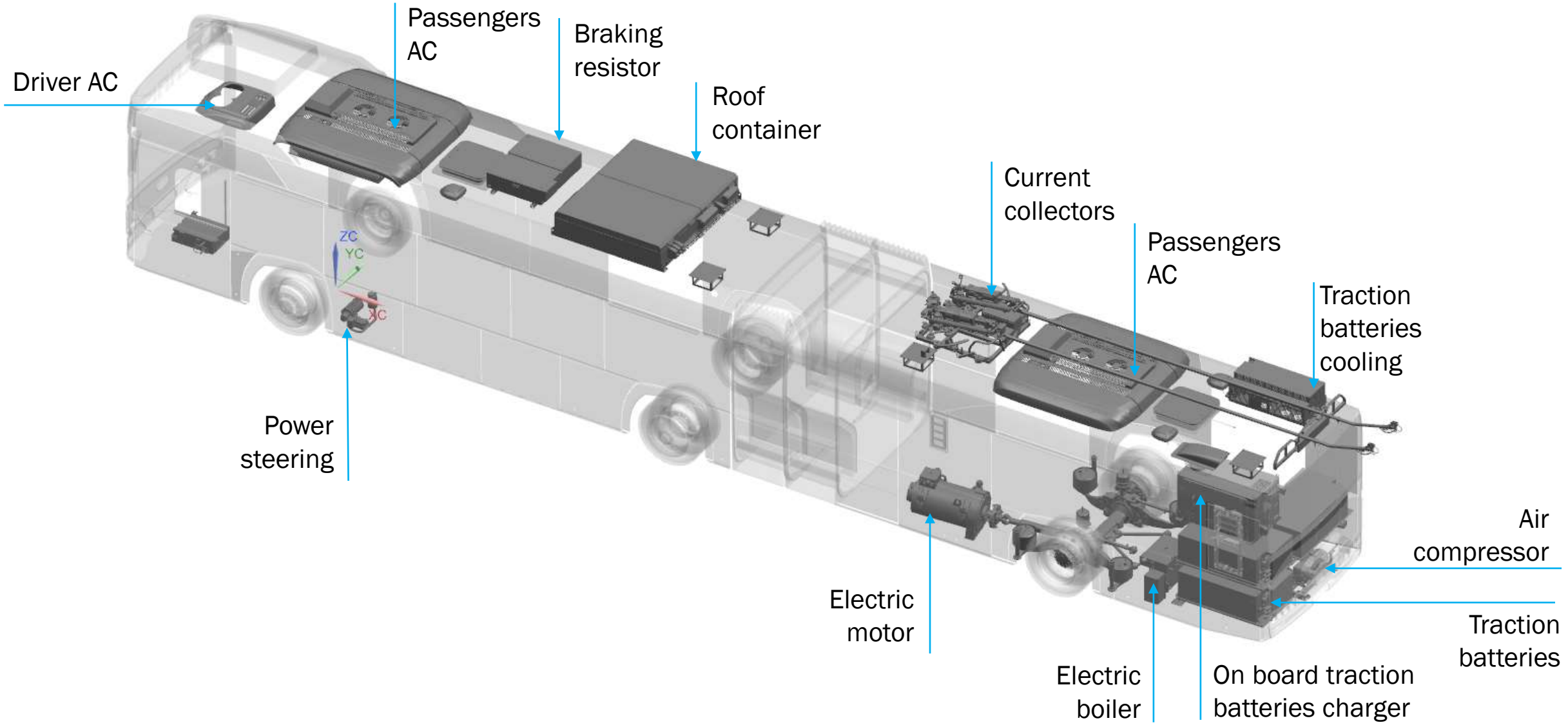
Solaris Trollino:

Layout of the components

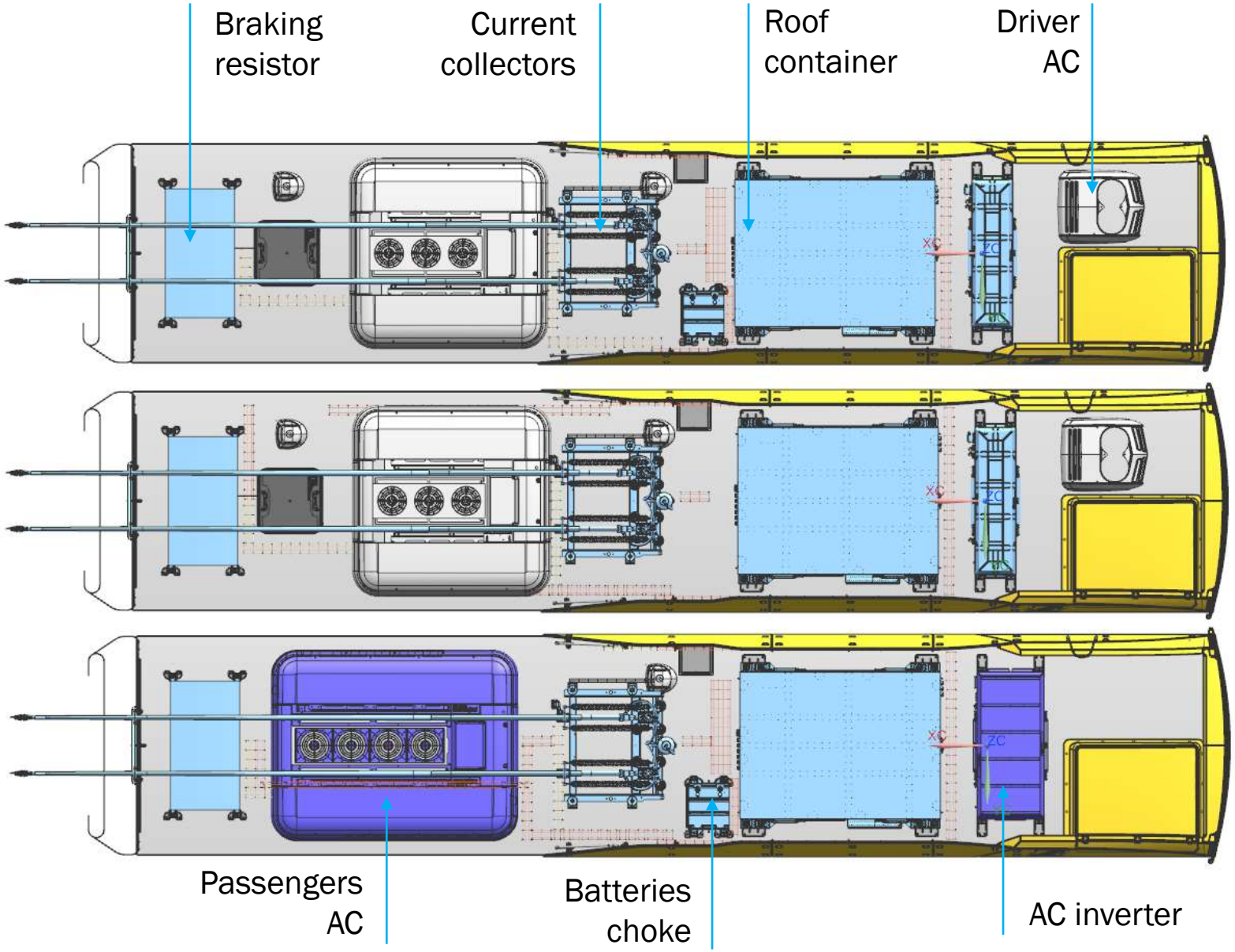
Trollino 12 – MEDCOM



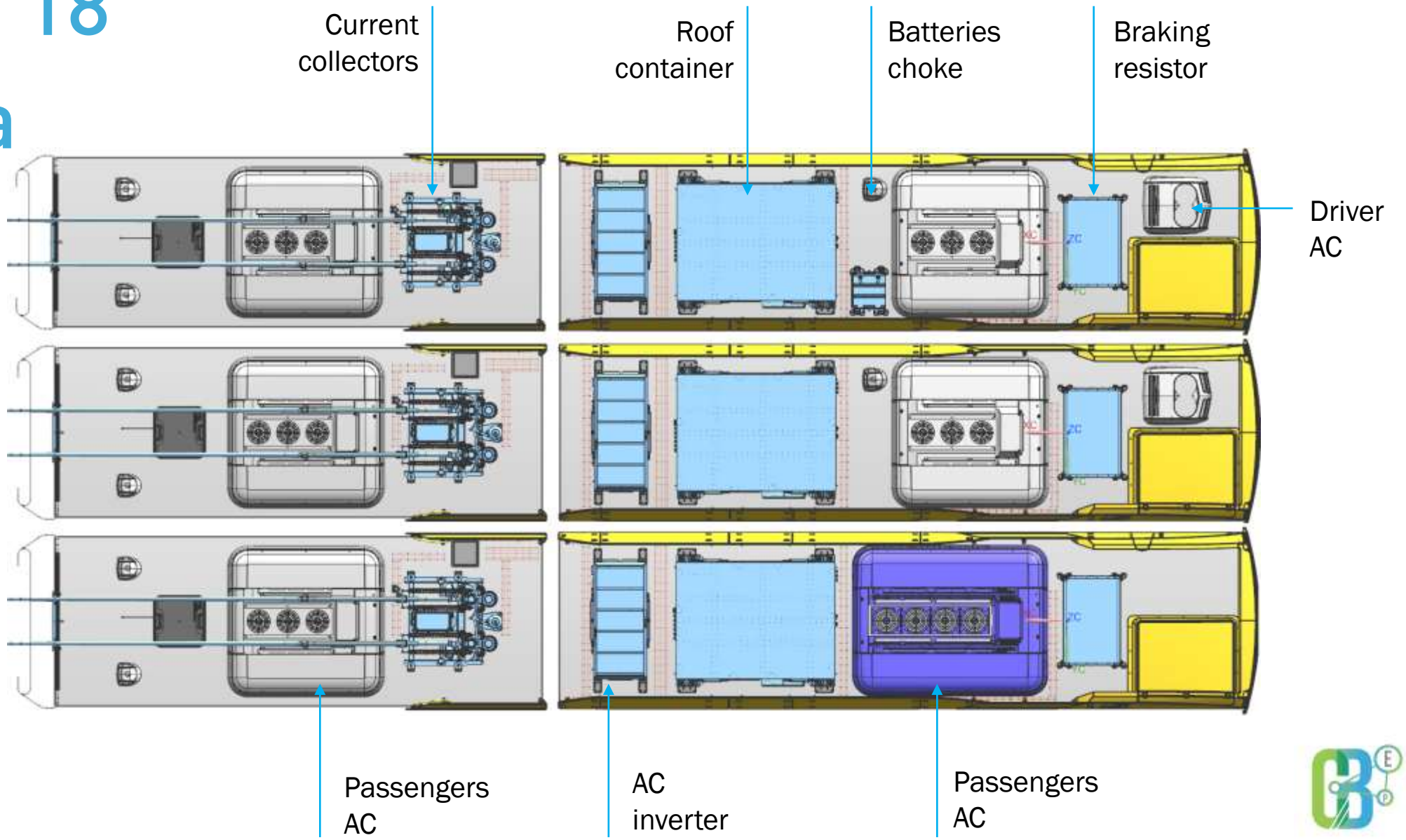
Trollino 18 – MEDCOM



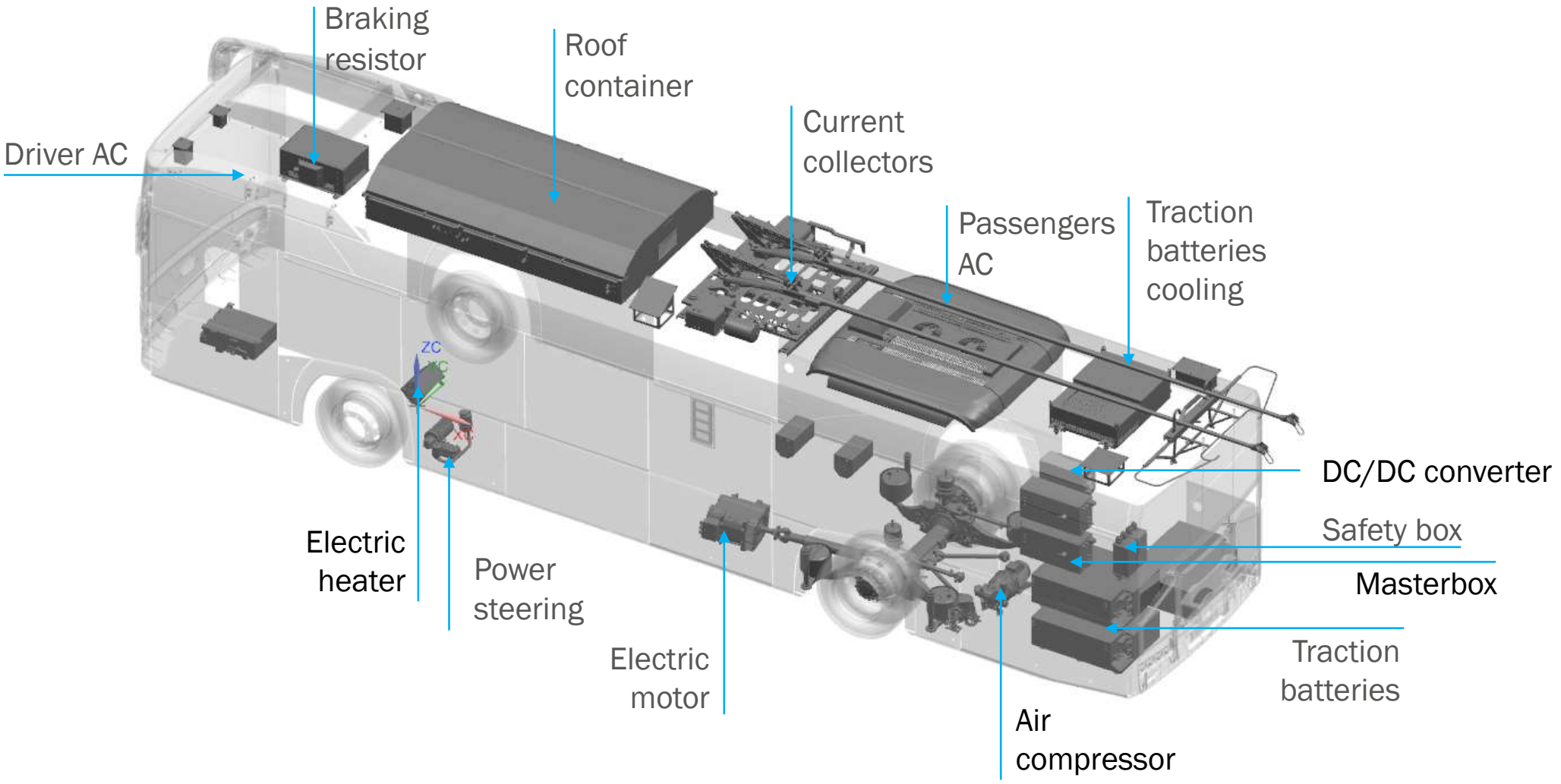
Trollino 12 – Škoda



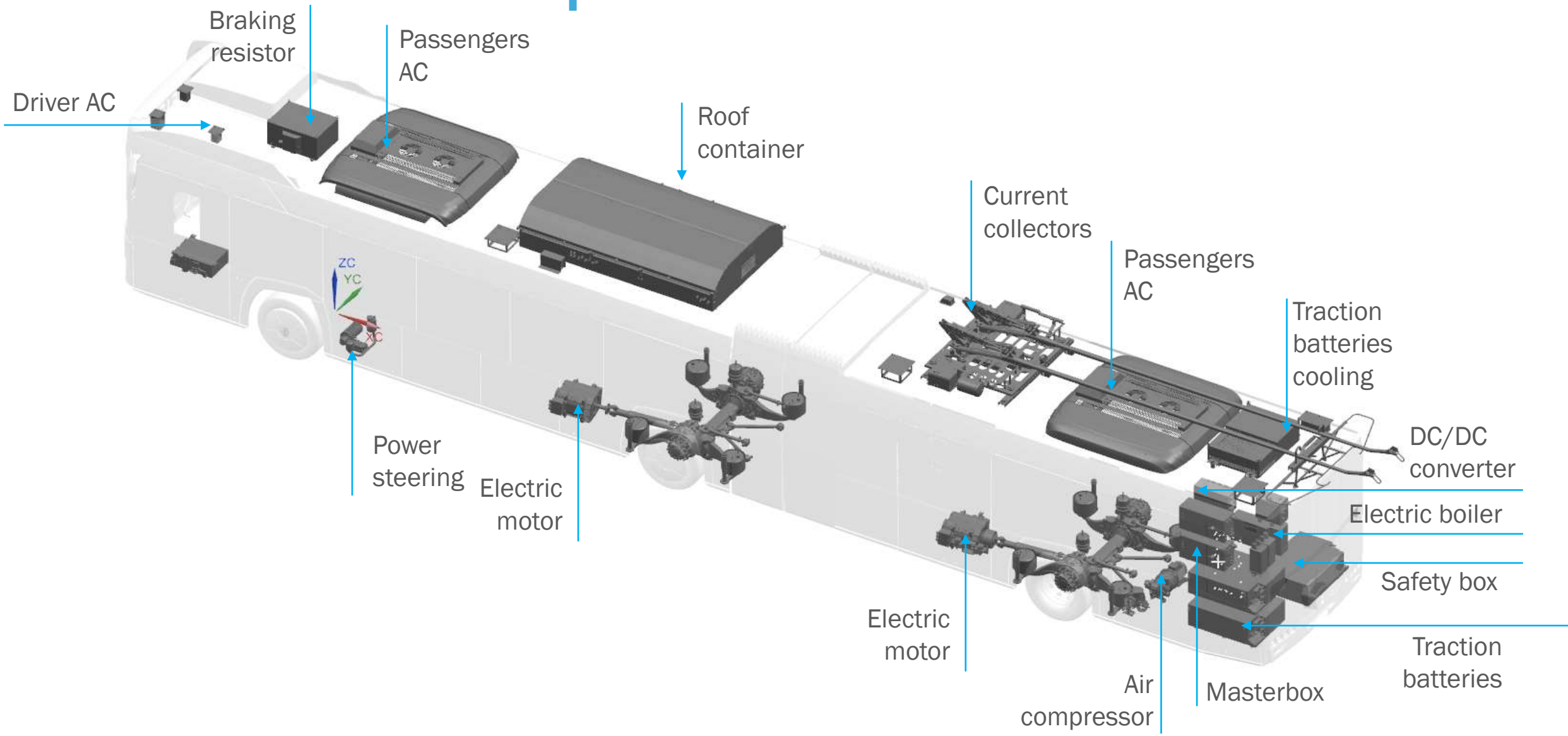
Trollino 18 – Škoda



Trollino 12 – Kiepe



Trollino 18 – Kiepe



Traction motors

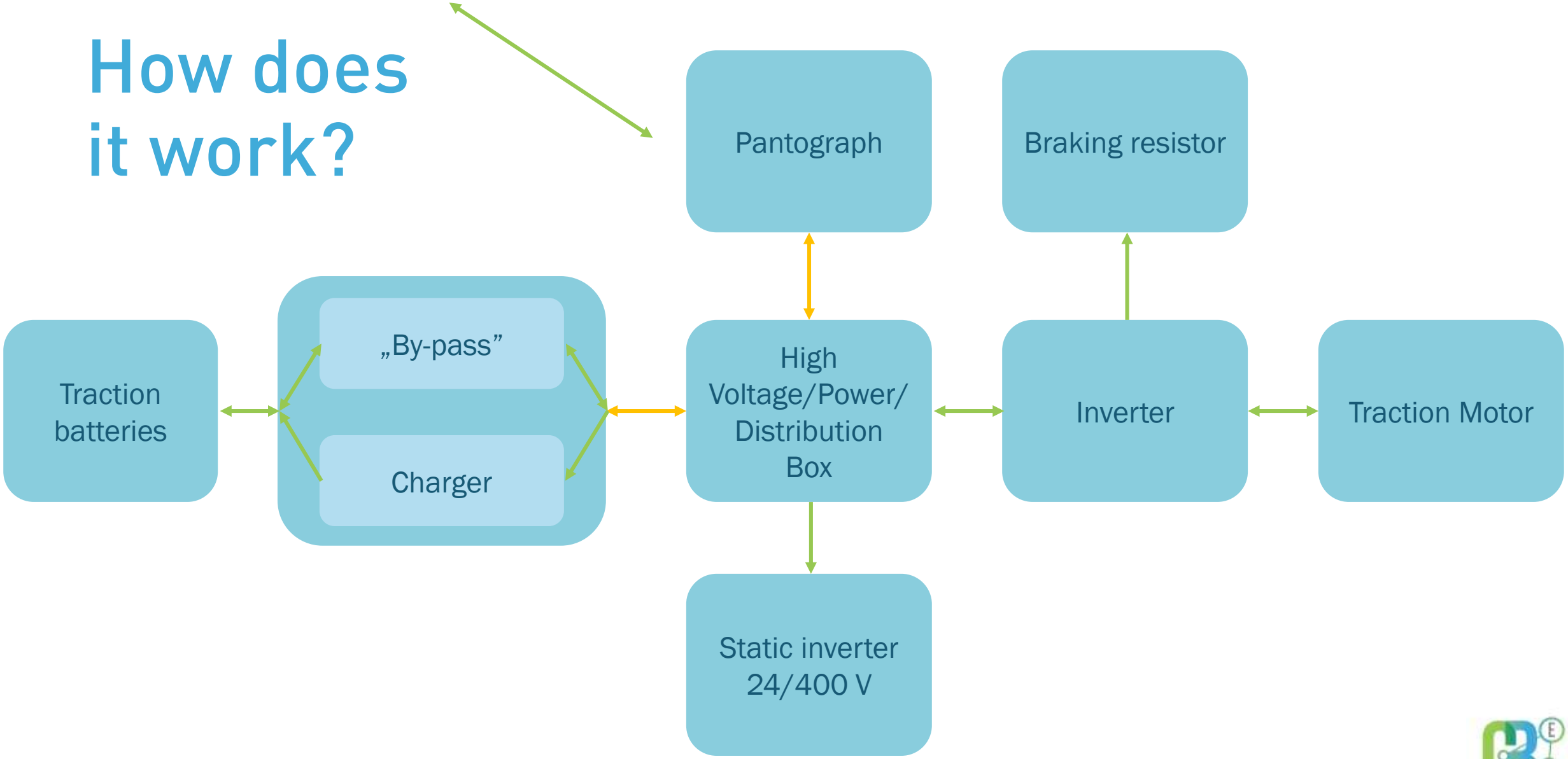
Asynchronous
central traction motor

TSA	Škoda	EMIT
NOMINAL POWER	NOMINAL POWER	NOMINAL POWER
160 kW (12 m) 240 kW (18 m)	160 kW (12 m) 250 kW (18 m)	175 kW (12 m) 251 kW (18 m)
COOLING	COOLING	COOLING
air	air	air
TORQUE	TORQUE	TORQUE
1.800 Nm (12 m) 3.750 Nm (18 m)	1.800 Nm (12 m) 3.750 Nm (18 m)	2.266 Nm (12 m) 4.200 Nm (18 m)

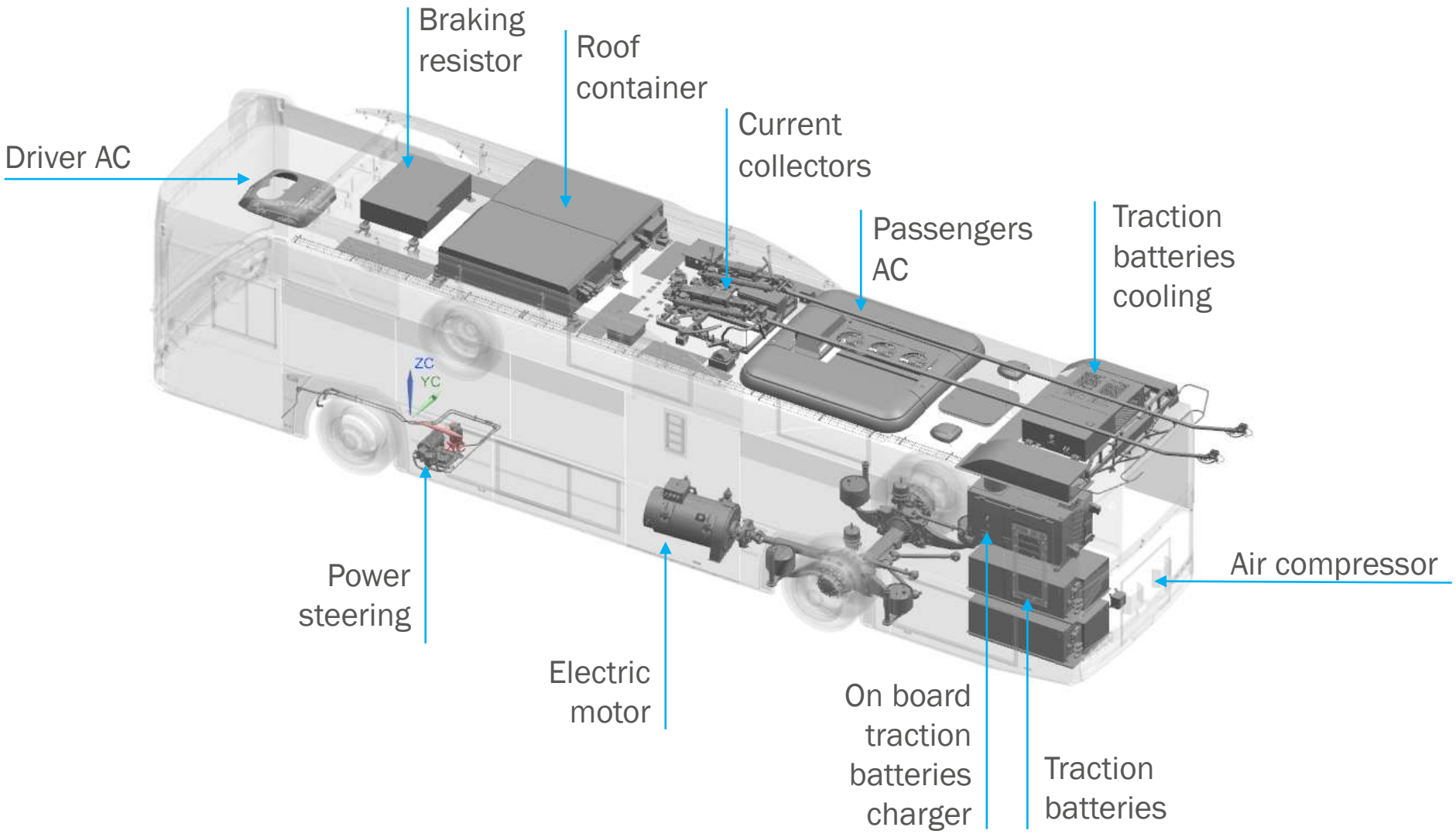
Technology focus: In-Motion-Charging – IMC

Charging infrastructure

How does it work?

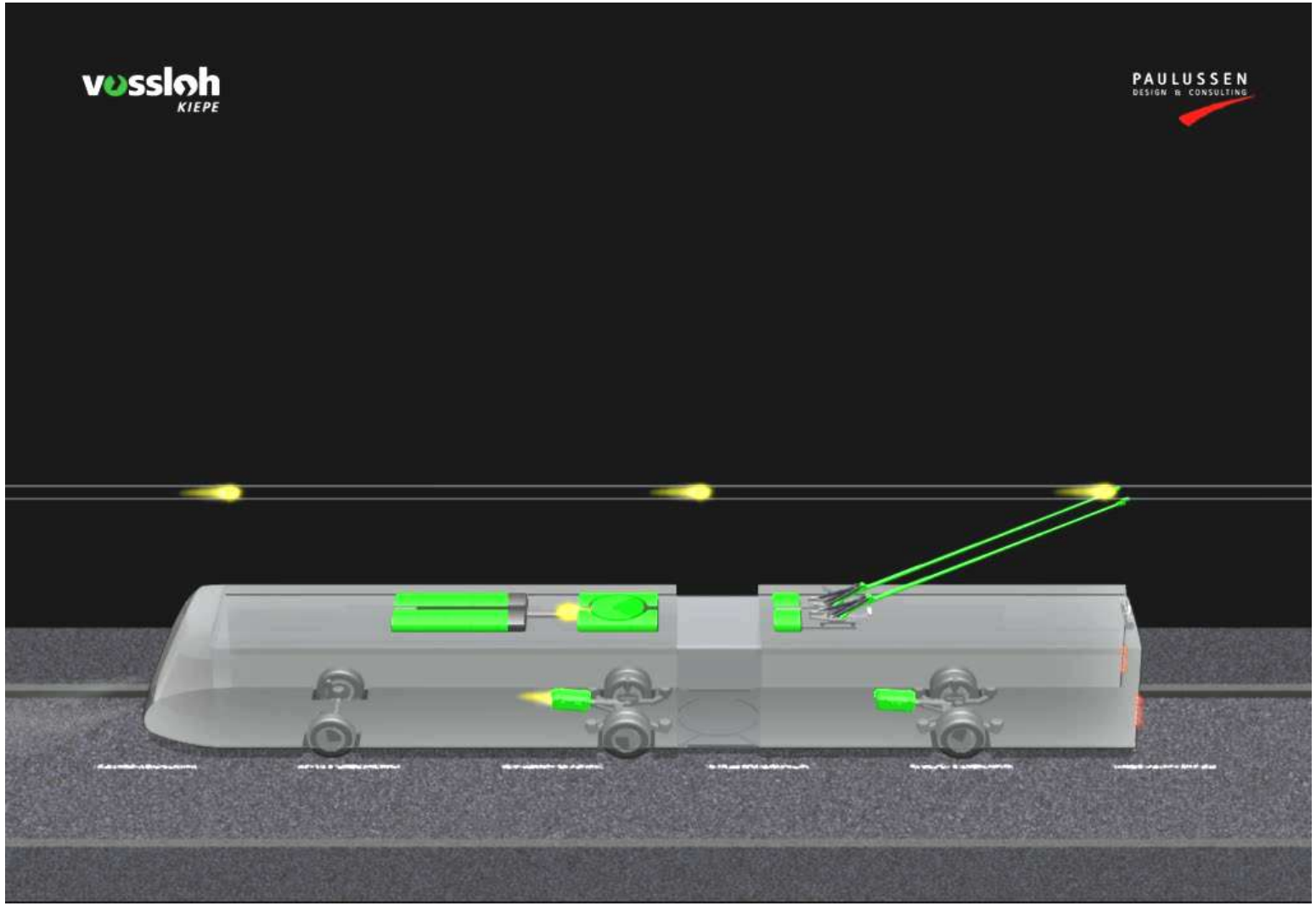


Trollino 12 – MEDCOM



In-motion charging

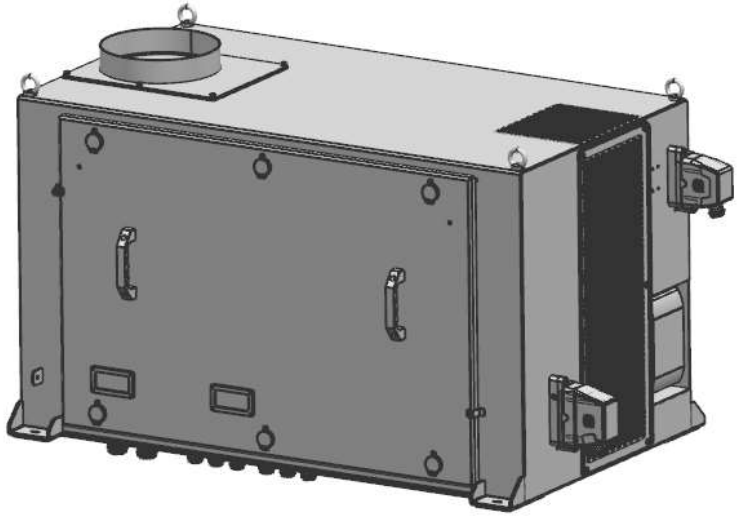
- Zero emission trolleybuses equipped with modern batteries and an in-motion charging system
- Possibility to drive without connecting to the traction network
- Low infrastructure development costs
- Proven and ecological technology



On-board charger parameters

- Maximum charging power (up to the battery rated voltage of 662V):

- 90A - 55kW
- 130A - 82kW
- 150A - 100kW



IMC/Infrastructure

Standard trolleybus traction

- The charging process may be limited by the necessity to reduce the power consumption from traction at a standstill (bus stop, intersection, etc.) for example to 150A

- If there is a voltage drop on a section of the traction caused by too many vehicles connected to the network, several options are possible depending on the priority:

  - if the battery charging priority is given, the heating system can be limited or disabled.

  - it is also possible to interrupt the charging for the period of disturbance

Solaris High Power batteries

Advantage of battery disconnector:

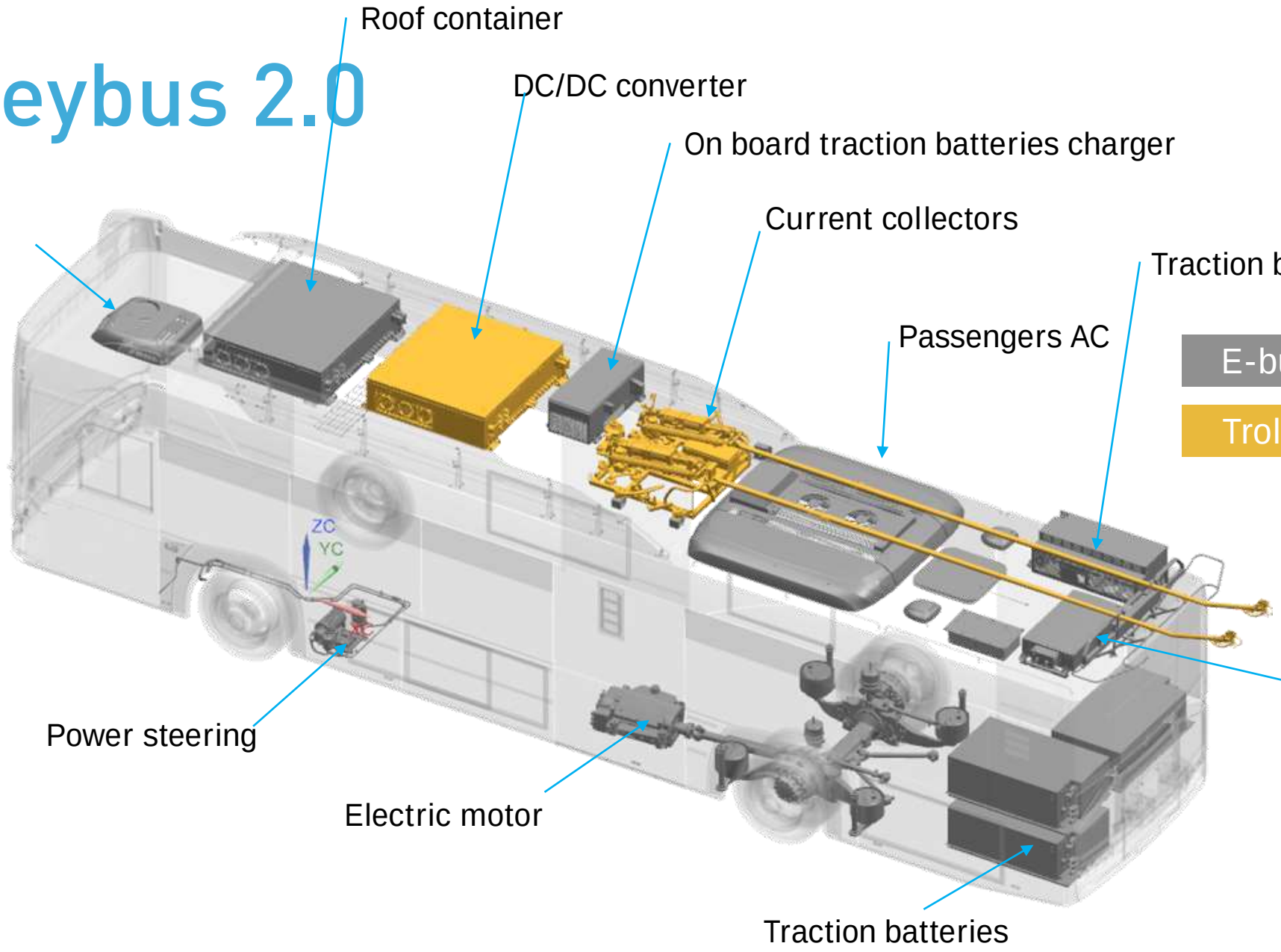
- safe operation with batteries
- with 2 batteries or more, it is possible to disconnect the damaged one and continue driving

up to 3 packs of batteries

Trolleybus 2.0

What is the difference?

Trolleybus 2.0



New product: Trolleybus 2.0

Przedsiębiorstwo Komunikacji Trolejbusowej Gdynia, Poland

6 x **Trollino 12 electric**
synergy of trolley and e-bus

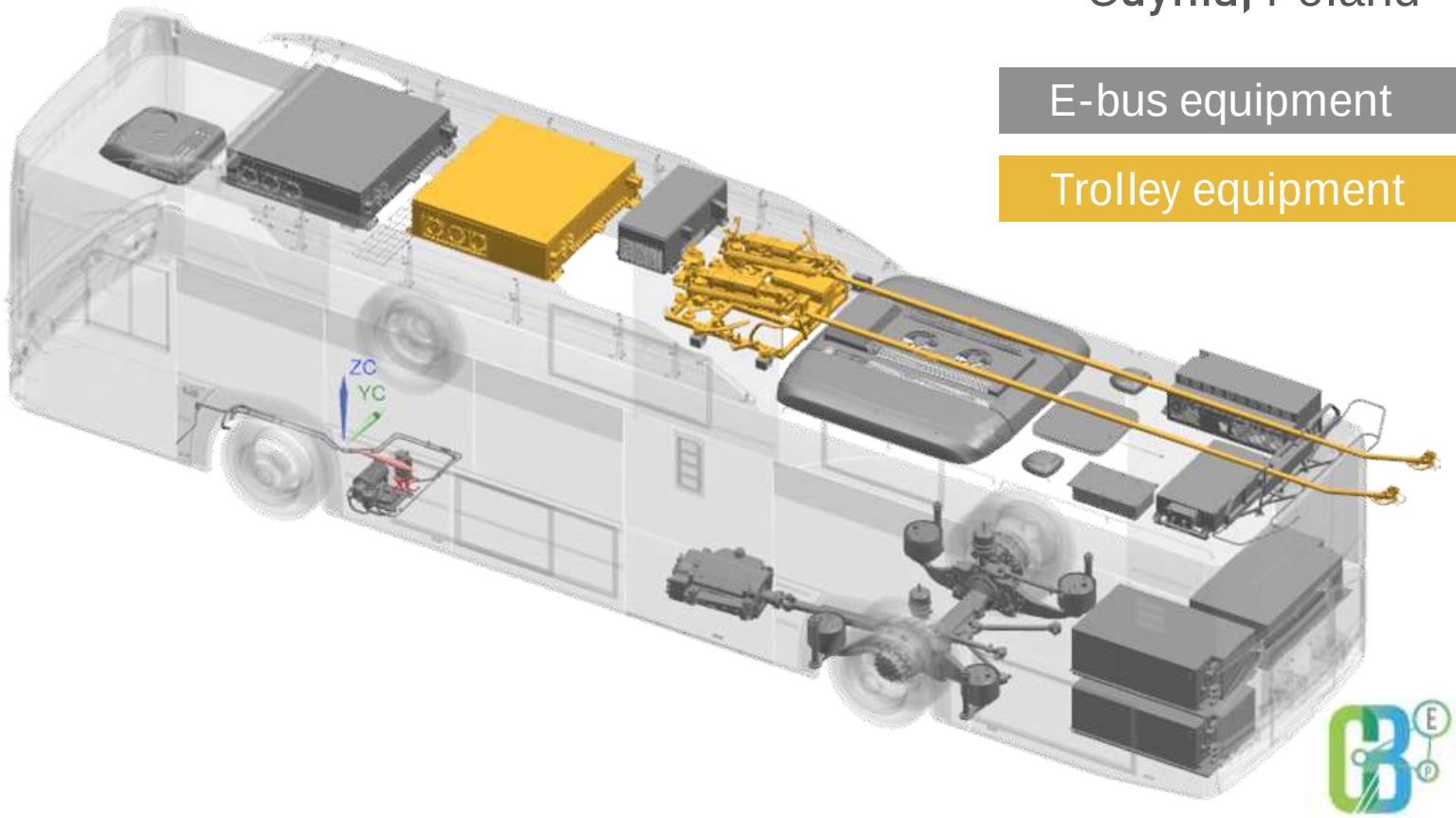
TECHNICAL DATA

IMC charger:
150kW double insulated

Solaris High Power batteries with capacity of 87 kWh

Electric motor
central motor 160 kW

E-bus
driveline



E-bus equipment

Trolley equipment

Trolleybuses with **hydrogen fuel cell as range extend**

These are the **1.** of this kind in Europe

100 [km]

The LTO batteries in the vehicles is recharged during the drive by means of a fuel cell, which allows the trolleybuses to ride on without connection to the overhead wires for up to 100 km

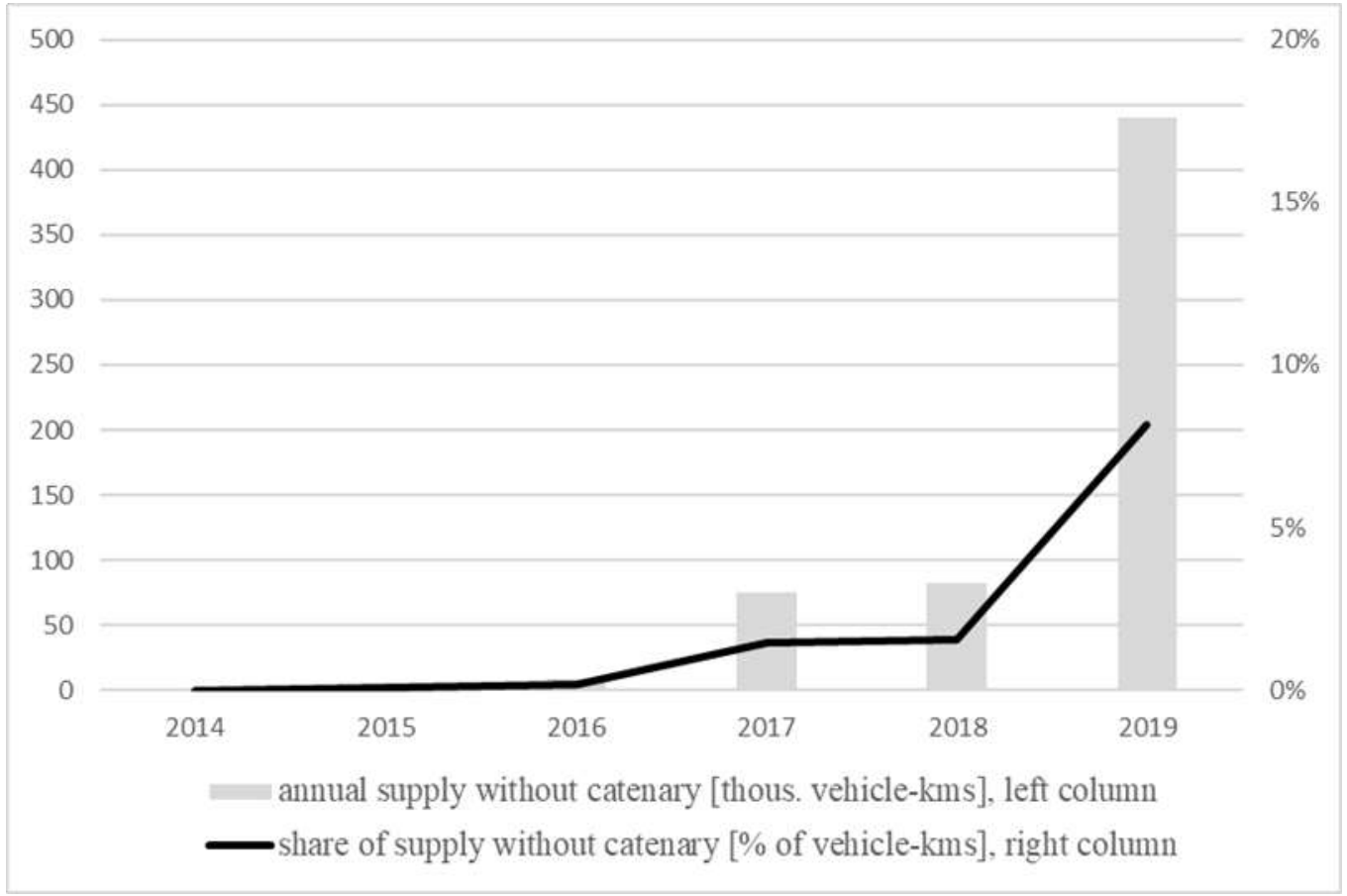
Use case

Brief overview of trolleybus transport
in Gdynia, Poland

Overview of trolleybus transport in Gdynia

- **100 vehicles** in the fleet
- 6 trolleybus lines **partially operating without catenary** (1,8 to 3,5 kms) – IMC under development
- Plans for further extension of services without catenary – significant growth in 2019/2020

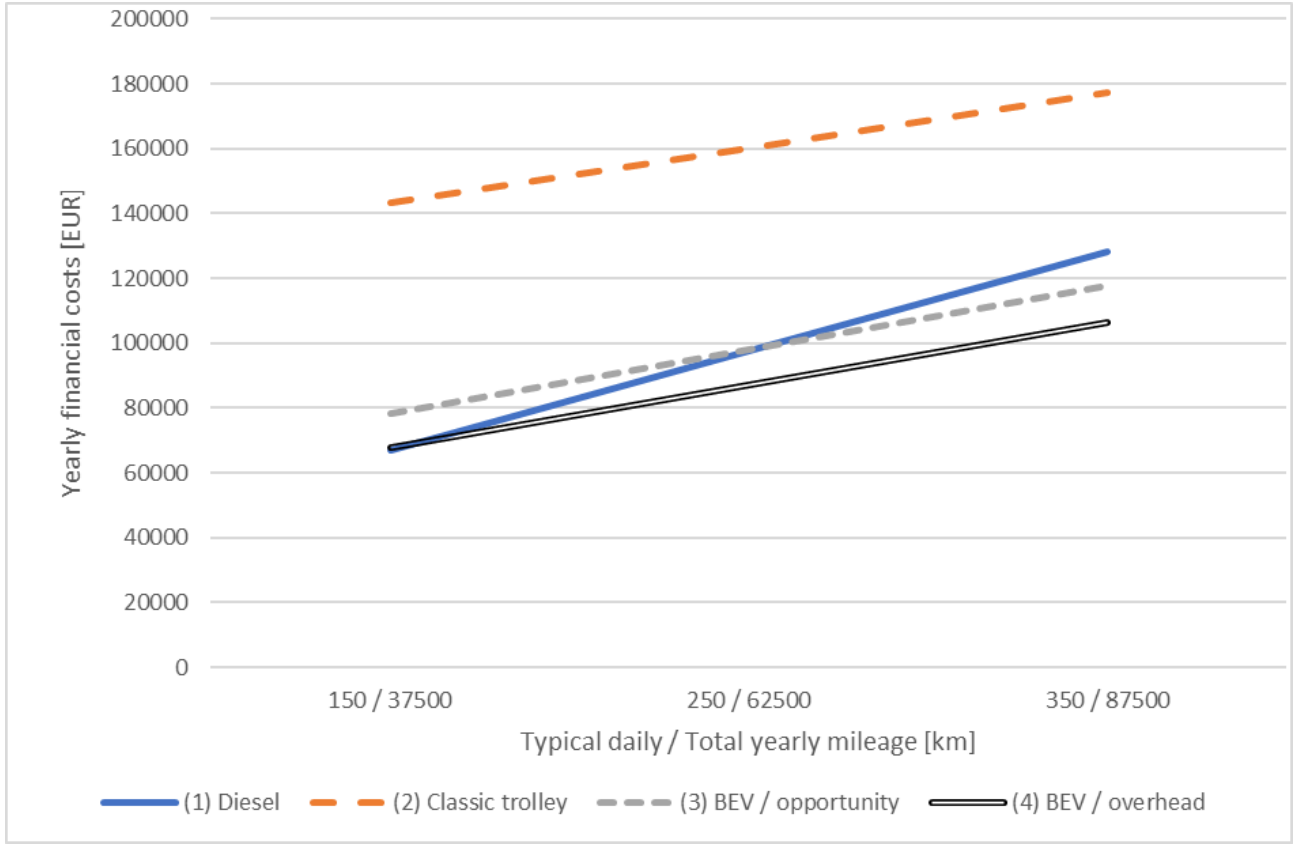
The results of the trolleybus IMC development in Gdynia



Source: M. Wolek, M. Bartłomiejczyk, M. Wolański, O,. Wyszomirski, K. Grzelec, K. Hebel: Evolution of sustainable urban public transport: A case study of trolleybuses in Gdynia and Sopot (Poland). Submitted to the *„Journal of Cleaner Production"*, March 2020, *during the review as of May 2020.*

Results of the model: economic analysis

- In an economic analysis taking external costs into account, the difference between variants (1), (3) and (4) remain very low.
- Much depends on the local energy mix that determines emission levels and local willingness to pay for the reduction of local emissions;
- An increase in renewable energy production locally would improve the competitiveness of EVs since charging during operation (i.e. IMC) significantly lowers emissions compared to diesel buses because the share of renewables, especially solar energy, in the electricity mix is at a maximum during daylight (Rupp *et al.*, 2019).



Annual economic costs of operation of a line (including externalities) under technological options (current Polish energy-mix)

Source: M. Wolek, M. Bartłomiejczyk, M. Wolański, O,. Wyszomirski, K. Grzelec, K. Hebel: Evolution of sustainable urban public transport: A case study of trolleybuses in Gdynia and Sopot (Poland). Submitted to the „Journal of Cleaner Production", March 2020, during the review as of May 2020.

Questions & Answers

Thank You!

The recording will be available soon at

www.cleanbusplatform.eu