

A high-speed train, likely a TGV, is shown in motion, blurred background, with text overlay. The train is silver and blue with yellow accents. The text is white and bold, centered in the upper half of the image.

***Lithium Battery Integrator
Electric Drive Assembler
From Czechia***

***EVC Group s.r.o.
Q2/2021***

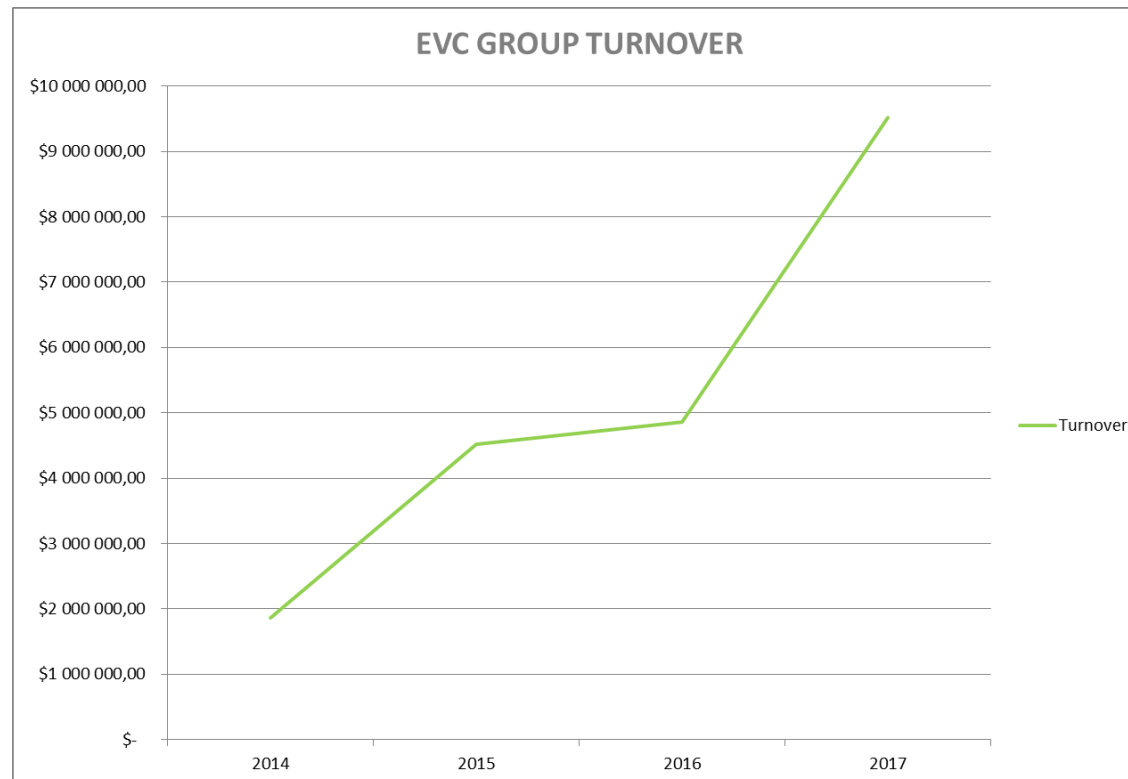
Basic Company Overview

- ✓ Czechia Based R&D Company
- ✓ Established in 2007
- ✓ HQ and Production plant in *Hulín*
- ✓ 40 core employees
- ✓ 10 R&D workers
- ✓ Commercial and production background of *PILANA Knives a.s.* – the third world largest producer of *industrial blades and knives* (> 750 employees)
- ✓ BS EN ISO 9001:2015



Financial Overview

- ✓ First five years in name of massive R&D investments (world financial crisis)
- ✓ In comparison to 2014 the 2018 turnover is more than quintuple
- ✓ The 2018 result was almost 10 mil. € – rising demand all over the EU / CEE
- ✓ Big investments in public e-mobility in after-Covid 19 EU market forseen



Key Competence Overview



Electric Drives

Electric Motors - Inverter - Controlling Units - Traction
Battery



Battery engineering

Cell Selection - BMS - Modularisation - Homologation



Research & development

Cell Testing - E-Drive Design - Controlling Units Development



Fast charging stations

Stationary / Mobile - AC - DC (Combo 2 >500 V)



Energy storage

Thoroughly Tested Cells, BMS, Knowledge



Vehicles

Utility - Personal - Special Use EVs

2007-2011: Early Years of E-Mobility (B2C)

- ✓ Prototypes/small series of **ICE conversion to fully BEVs**:
 - ✓ TOYOTA PRIUS II PLUG-IN (range extending kit)
 - ✓ SMART FORTWO ELECTRIC
 - ✓ ŠKODA FABIA (model „EVC F3“)
 - ✓ ŠKODA ROOMSTER (model „EVC R7“)
 - ✓ ŠKODA SUPERB (model „SUPER-EL“)



2007-2011: Early Years of E-Mobility (B2C)



2012 – Present: Industry Applications (B2B)



Lithium Battery Systems

Cell Testing -> Cell Selection -> Modularisation -> BMS ->
Certification -> Charging -> After Sales/Serviceing



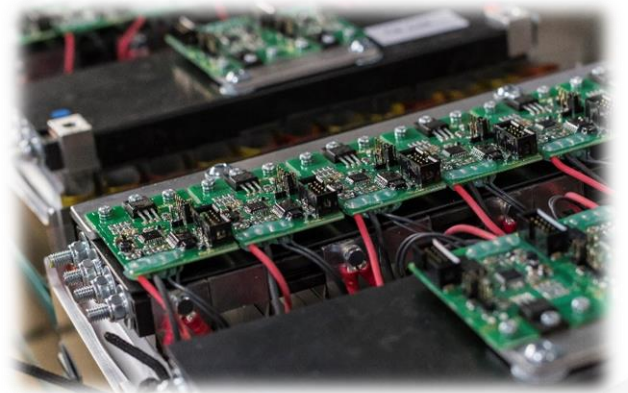
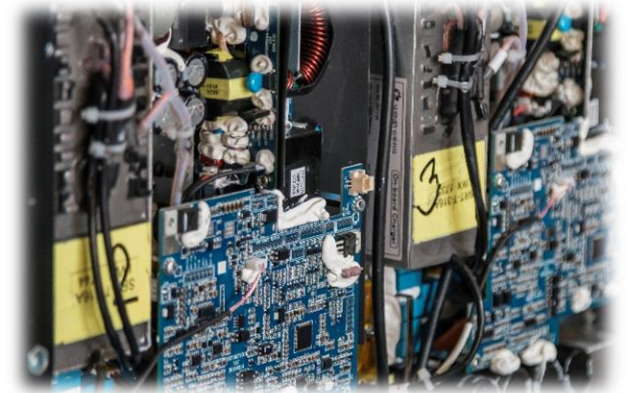
EVC Lithium Battery Systems – Long-term testing

- ✓ **What do we test – cells or batteries?**
 - ✓ The smallest part – 1 cell or maximum a few in a parallel string
- ✓ **Why do we run the tests at all?**
 - ✓ The manufacturers never provide true data – some underestimate and most of them cheat
- ✓ Cells are tested in EVC through „*cycling*“ since **2009**
- ✓ **Features measured during each cycling:**
 - ✓ *Voltage (V)*
 - ✓ *Current (A)*
 - ✓ *Temperature at multiple locations (°C)*



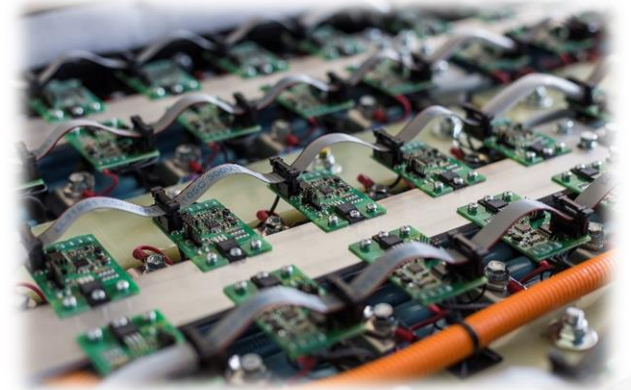
EVC Lithium Battery Systems – Longterm testing

- ✓ **Features measured during each cycling (cont.):**
 - ✓ Capacity decrease – linearity (Ah)
 - ✓ Inner resistance (through estimate - mOhm)
 - ✓ Physical state of the cell body on testing
 - ✓ Cycle effectiveness (culombic)
- ✓ **How many cells can be measured at once?**
 - ✓ Currently we dispose of 25 test beds
- ✓ **What are the common testing conditions?**
 - ✓ Simulation of normal service/drive – cca 23 °C
(-20° to 60° C)
 - ✓ Complete or hybrid (incomplete DOD) discharge cycle



EVC Lithium Battery Systems – Long-term testing

- ✓ **What are the common testing conditions (cont.)?**
 - ✓ Cell quality dependent: low-quality fail fast (Ah falls rapidly), quality ones take years...
 - ✓ The longest cycling achieved: since 2011 with over 35 k cycles, currently at 60 % SOH
- ✓ **What HW & SW is used for testing?**
 - ✓ HW & SW are of complete EVC development and/or production
 - ✓ Main focus put on functionality
 - ✓ Data measurement/cycling is fully automated
 - ✓ Measured data can be accessed remotely



EVC Lithium Battery Systems – Cell Selection

✓ We build batteries from cells of different *producers and chemistries* based on your/project requirements:

- ✓ **LFP** – high energy density & safety
- ✓ **NMC** – high power & energy density
- ✓ **LTO** – the highest power & cycles/lifespan

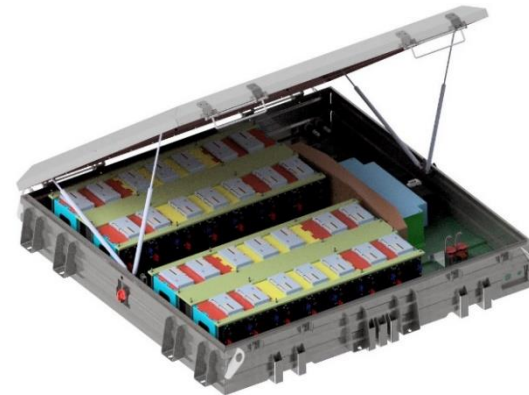
✓ **Modularisation** including our own **EVC BMS**:

- ✓ *Pouch cells* (coffee pouch type)
- ✓ *Prismatic cells* (solid-boxed cells)
- ✓ *Cylindrical cells* (automated modularisation)



EVC Lithium Battery Systems – Cell Selection

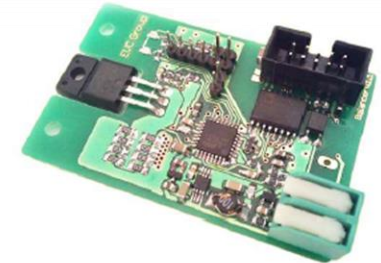
- ✓ **Battery box development and production** under the industrial standards - including the latest certification **ECE 100.02**
- ✓ Possibility to test the very boxes for fire resistance using the local PILANA heat furnaces – cost savings & knowledge database.



EVC Lithium Battery Systems – Cell Protection

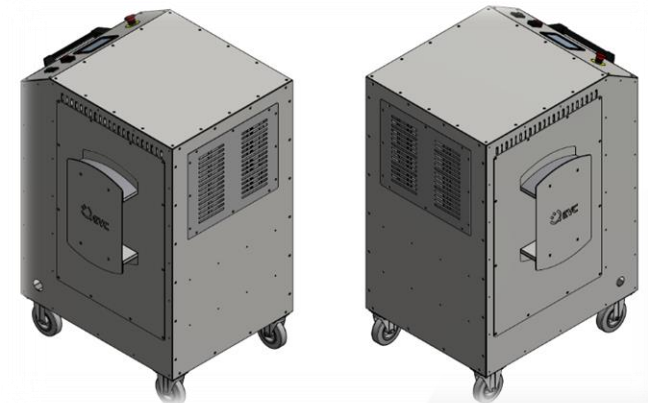
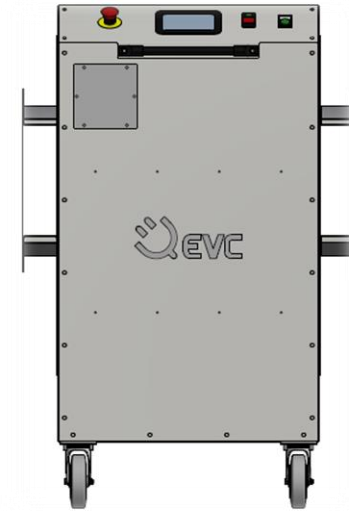
✓ EVC BATTERY MANAGEMENT SYSTEM (BMS)

- ✓ **In-house** continuous R&D since 2008
- ✓ Comprising of a balancer (per series string) and BMU
- ✓ Build generations evolving based on operating data and experience stemming from more than 400 daily operating vehicles / applications
- ✓ **> 40 000 pcs of balancers produced and running**
- ✓ Service & Fine tuning through a bluetooth app
- ✓ **Remote diagnostic of the traction battery possible through an integrated GSM module**



EVC Lithium Battery Systems – Battery Charging

- ✓ **EVC Slow/Night Charging Transportable Charger:**
 - ✓ Power 18/36 kW (next gen 22/44 kW)
 - ✓ Charging speed adjustable per 1A increments
 - ✓ Connectible to standard 3phase 5 pin sockets
 - ✓ Transferable (on wheels)
 - ✓ Robust design for in-house use
 - ✓ Optional outer shell providing basic IP protection



EVC Lithium Battery Systems – After Sales

- ✓ **Servicing & After Sales EVC Programme:**
 - ✓ **English Speaking Servicing Team**
 - ✓ **Whole Europe Standard On-Site Servicing**
in 5 Days (under discussion may be altered up to 48 hours)
 - ✓ **Direct Call or Predictive Servicing Assistance**
 - ✓ **Servicing Tutorial For Local Garage**
Servicemen (basic upkeep operations / balancer exchanges)



Lithium Battery Systems

Reference Projects



Lithium Battery Systems – Reference Projects

✓ 2015 – ZERO EMISSION URBAN SYSTEMS PROJECT (ZEUS) – PILSEN (CZ)

✓ EU Co-Funded E-Bus R&D Project (UITP)

- ✓ New Rapid Charging Infrastructure

Ultra High Power (600 kW / 6 mins recharge)

- ✓ First of its kind in Central & Eastern Europe



✓ Tailor Made Solution By EVC:

- ✓ Vehicle – rapid charging communication prot.

- ✓ 18kW mobile charger including CCS interface

(CCS >500 V – novelty)



Lithium Battery Systems – Reference Projects

✓ **2010–Today: Czechoslovak Market: > 100 Traction Battery Sets**

✓ E-Buses & Trolleybuses by **ŠKODA ELECTRIC (CZ):**

- ✓ 12m & 18m pure battery & trolley solutions
- ✓ Largest world producer of trolleybuses with >100years production heritage



✓ **Tailor Made Solution By EVC:**

- ✓ > 30 battery bus systems – NMC/KOKAM
- ✓ > 70 trolleybus battery systems – NMC/KOKAM
- ✓ Remote supervision through EVC BMS



Lithium Battery Systems – Reference Projects

✓ **2010–Today: Czechoslovak Market: > 200 Traction Battery Sets**

✓ E-Buses by **SOR Libchavy a.s. (CZ):**

✓ 12m pure battery e-buses

✓ Daily service in public transport service

= high demand on service availability



✓ **Tailor Made Solution By EVC:**

✓ > 100 battery systems of 178 kWh (EBN)

✓ > 100 battery systems of 242-615 kWh (ENS)

✓ Remote supervision through EVC BMS



Lithium Battery Systems – Reference Projects

✓ 2020–Today: Central-European Market

✓ Modulo E-Buses by **Mobility & Innovation (SK)**:

- ✓ 7/9/11 m pure battery e-buses
- ✓ former EvoPro design with updated battery
- ✓ Ultra-light composite chassis



✓ Tailor Made Solution By **EVC**:

- ✓ Completely modular battery system in one pack
 - ✓ Type of cells (capacity & cycle life)
 - ✓ Number of used battery slots
- ✓ Battery / H2 ready



Lithium Battery Systems – Reference Projects

✓ 2021–Today: Lithium Traction Battery for Skid-Steer Loader

- ✓ New design Slovak manufactured
- ✓ Battery electric vehicle from first design

✓ Tailor Made Solution By EVC:

- ✓ PoC LFP battery solution as a Pb battery replacement
- ✓ 48V system with different capacity solutions
- ✓ Designed and EVC lab tested to pass ECE and UL homologation requirements



Lithium Battery Systems – Reference Projects

LUBLIN (PL) – 38 trolleybus batteries (34kWh)
for URSUS vehicles with CEGELC e-drive

Central and Eastern Europe – >200 traction batteries
for SOR/CEGELEC e-buses (178/242/272/388 kWh)

TRINEC (CZ) – 10 traction batteries (200kWh)
& 10 chargers (40 kW) for ŠKODA/SOLARIS e-buses

HRADEC KRALOVE (CZ) – 20 traction batteries
(242kWh) for SOR/CEGELEC e-buses

EBERSWALDE (DE) – 12 trolleybus
batteries for SOLARIS/NanoPower vehicles

CESKE BUDEJOVICE (CZ) – 11 traction batteries
(150kWh) for ŠKODA/SOLARIS 9m e-buses

BUDAPEST (HU) – 35 trolleybus batteries
for ŠKODA/SOR (12m & 18 m) vehicles

SZEGED (HU) – 13 trolleybus batteries
for 18m ŠKODA/IKARUS vehicles



Electric Drives

Electrification of originally petrol/diesel engine equipped vehicles/applications.

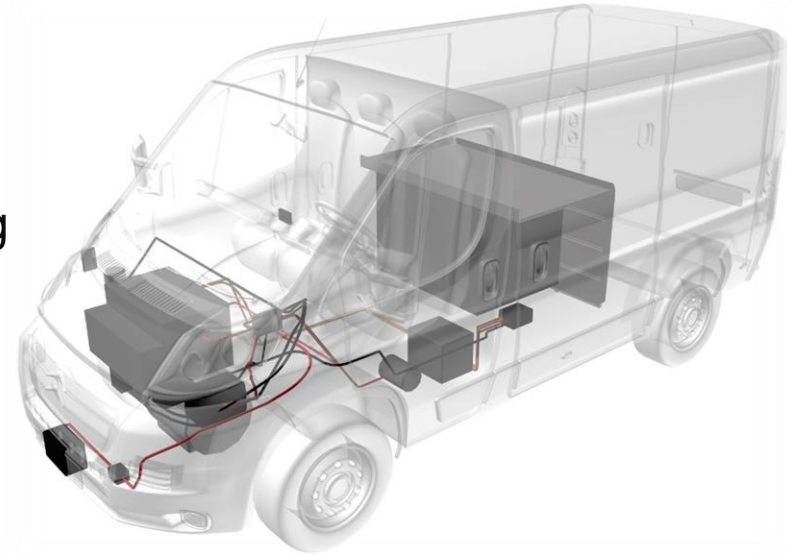


Electric Drives

✓ **Tailor Made Solutions Using The Latest Inventions in Power Electronics & Drives:**

✓ **Electric Motors & Regulators**

- ✓ 150kW PMAC salient magnet motor - 42kg
- ✓ Sevcon Gen4 Size10 - 11kg
- ✓ Nominal Voltage 650 VDC
- ✓ Powerful Regulators – Brand OBC & DC/DC units



Electric Drives

Reference Projects



Electric Drives – Reference Projects

✓ 2012-2016 – Utility Vehicles Built On Citroën Jumper Chassis

✓ Custom made vehicle conversion for an investor seeking freight vehicles with changeable traction battery – inspired by the Israel EV system

BETTER PLACE

✓ Tailor Made Solution By EVC:

✓ 20 vans *EVC J10*

With patented system of exchangeable traction battery (60 kWh @ 600 V)

✓ On-board charger 18kW



Electric Drives – Reference Projects

- ✓ **2011-Today: EVC IVECO eDRIVE - City / School / Shuttle 7,5t E-Midibuses**

- ✓ Complete solution of converting originally *diesel midibuses to pure battery;*

- ✓ **IVECO** frame based busses by renowned Slovak chassis builder **ROŠERO P** or Serbo-Slovenian **FENIKSBUS**



- ✓ **Tailor Made Solution By EVC:**

- ✓ > 40 pcs of EVC e-drives (**666V**) and different cell type based traction batteries

- ✓ **Two battery layouts** depending on door distribution

- ✓ On-board three-phase 18kW (AC) or CCS DC charging



Electric Drives – Reference Projects

- ✓ **2018-2019: Full Electrification of a Roller**

- ✓ World-established producer of construction machinery
- ✓ First step to a **fully battery & electric driveline line-up exchange** of a formerly diesel & hydraulic systems

- ✓ **Tailor Made Solution By EVC:**

- ✓ 2 PoC electrification sets providing:
 - ✓ Locomotion and vibration by e-motors only
 - ✓ EVC fully sizeable 18650 battery pack design



Electric Drives – Reference Projects

- ✓ **2019-Today: ENVIEL full electrification**

- ✓ Czech based company
- ✓ New Utility Vehicle in N1/N2 Category
- ✓ Moving from PoC1 to PoC2

- ✓ **Tailor Made Solution By EVC:**

- ✓ Turn-key electrification using EVC IVECO eDRIVE
- ✓ 18650 NMC battery format providing different capacity solutions
- ✓ On-board three-phase 18kW (AC) or CCS DC charging



Electric Drives – Reference Projects

✓ 2019: Elbee electrification

- ✓ Small-series wheel chair czech built vehicle
- ✓ Originally propelled by a motorcycle combustion engine 300cc



✓ Tailor Made Solution By EVC:

- ✓ turn-key electrification of a vehicle that was originally conceived to be fully electric
- ✓ PoC1 prototype using up to 20 kWh 18650 NMC battery and 15-30kW e-motor



Electric Drives – Reference Projects

RIGA (LT) – EVC FIRST/ROSERO P e-midibus in City trim and baltic region weather conditioning

CENTRAL SWEDEN – 12x EVC FIRST/ROSERO P e-midibuses in Shuttle & School trim

THE NETHERLANDS – 7x EVC FIRST/ROSERO P e-midibuses in Shuttle & City trim

PRAGUE (CZ) – 3 x EVC R3 / ŠKODA ROOMSTER
Converted cars for the Prague Magistrate

VOLTIA/GREENWAY – 20 x EVC J10 e-vans for Slovak-Austrian freight company, inspired by the Israel *Better Place* project

DAGMERSELLEN (CH) – 2x EVC FIRST / ROSERO P e-midibuses in School trim

MARIBOR (SL)– Feniksbus FB-E e-midibus



Energy Storage Systems (ESS)

**EVC Scalable Solutions Based On E-Mobility
Experience**



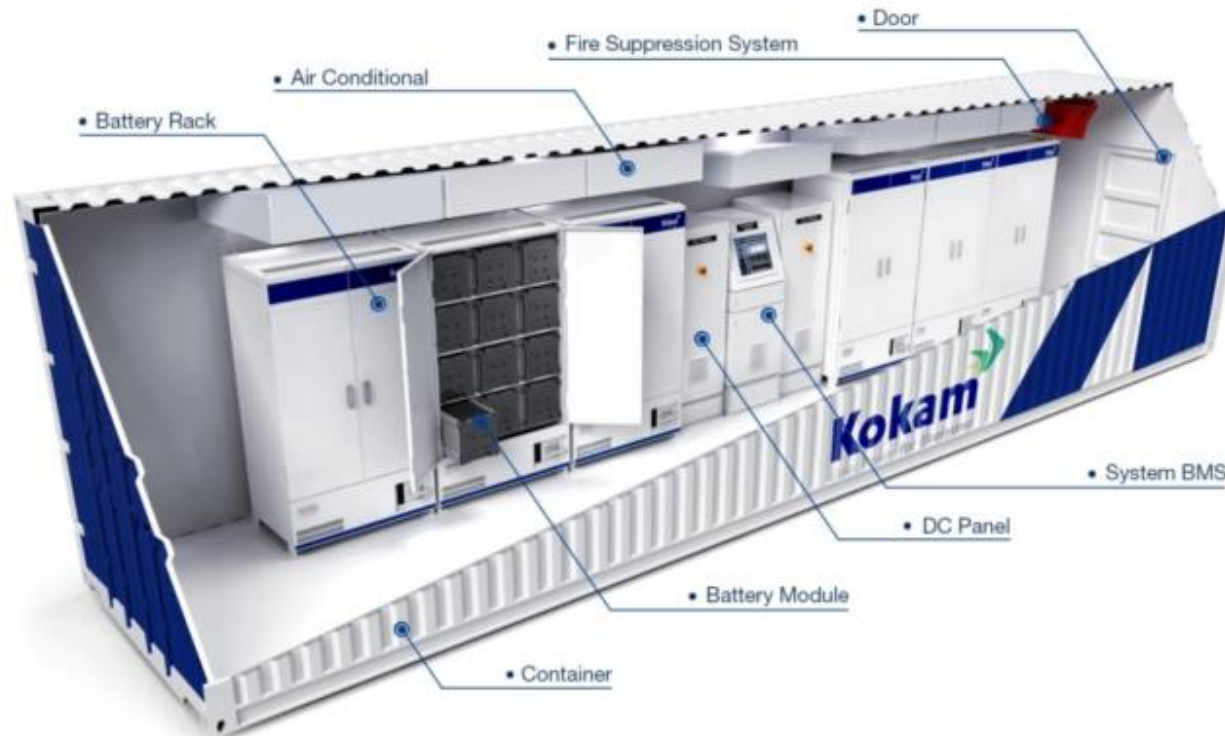
Energy Storage Systems

- ✓ **EVC Batteries (new & 2nd life) & OEM Power Inverters**
 - ✓ Use of new cells accordingly to customer's technical specification
 - ✓ Pouch & cylindrical NMC cells – KOKAM, LG, EVC brand, other
 - ✓ Possible use of 2nd Life cells/complete battery packs for extra ecology
 - ✓ Compatibility with leading player's inverter systems (Siemens, Kokam, etc.)



Energy Storage Systems

- ✓ EVC Long Term Partnership With KOKAM (now part of SolarEdge)
 - ✓ Capacity of providing & servicing official KOKAM ESS



Energy Storage Systems

Reference Projects



Energy Storage Systems

- ✓ **Small Size ESS / System Battery for Ecocapsule**
 - ✓ Under-bed Integrated Battery Unit
 - ✓ Variable Battery Size from 7-12 kWh
 - ✓ Including complete switchboard unit & CAN interface for various Power Inverters



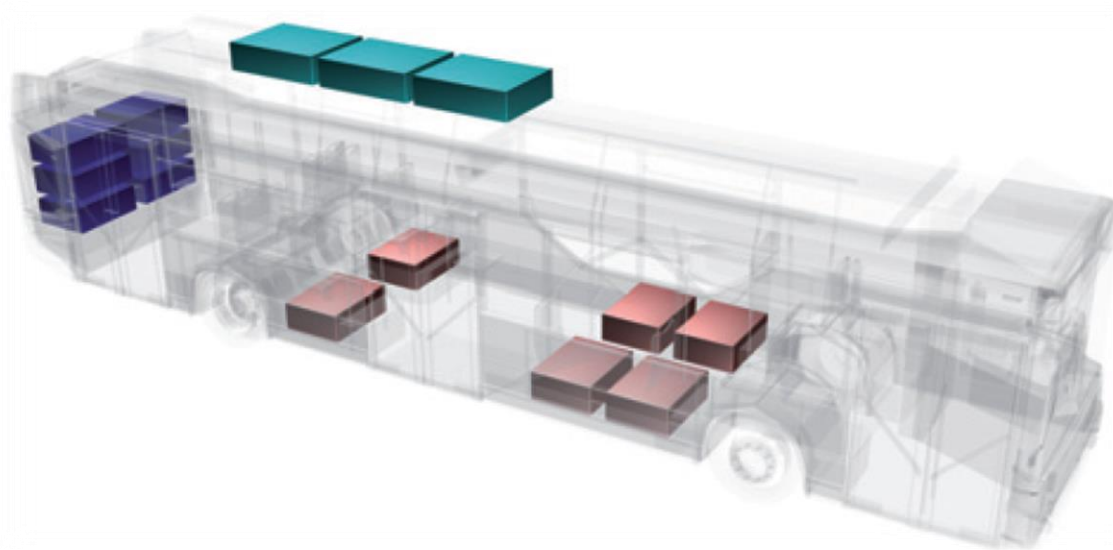
Energy Storage Systems

- ✓ **Middle Size ESS / System Battery For Converter Station**
 - ✓ Power Storage & Supply In Peaks Of Vehicle Braking & Acceleration
 - ✓ Variable Battery Size (up to 60 %) @ Voltage
 - ✓ Including complete switchboard unit & CAN interface for various Power Inverters



Energy Storage Systems

- ✓ **Large Industrial ESS & 2nd Life Battery Systems**
 - ✓ Availability of high voltage (>600/750 V) high capacity traction batteries
 - ✓ High Flexibility and Scalability (vehicle batteries in parallel)
 - ✓ High political/marketing & ekology potential
 - ✓ Over 2 MWh of batteries availbale in the next year & more in 5 years



New Fields Of Activity

EVC Growth & Inspiring Projects



New Fields Of Activity

- ✓ **EVC Group Growth**

- ✓ New production hall ready (2022)
- ✓ Aiming at new battery related fields (2nd Life, Battery recycling)
- ✓ Next quality level set: ISO TS

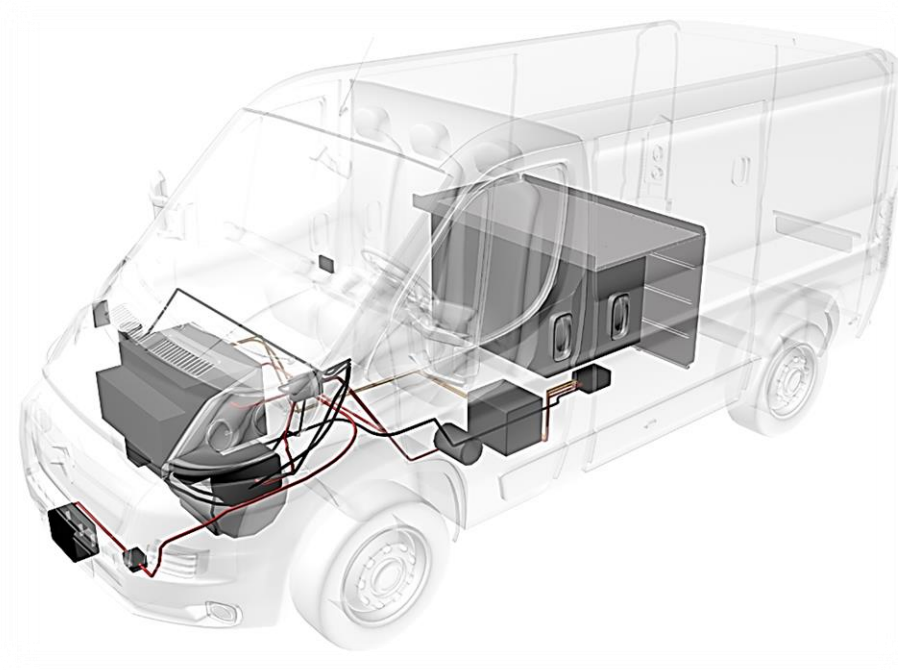


New Fields Of Activity

- ✓ In cooperation with world players the EVC team is working on these new projects:

- ✓ **ESS 2nd Life** from world market BEVs (>600kWh)
- ✓ ESS for **transformation substations** (150kWh)
- ✓ Hybrid **locomotive battery** (> 300 kWh)
- ✓ 24 V / 48 V / 80V modular lithium batteries for **material handling equipment**
- ✓ Complete e-drive for **wheel-chair car**
- ✓ Complete e-drive and battery for **construction building vehicles**





Thank You For Your Attention

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