E-Mobility

„Pure Play“

Voltabox electrifies – Advanced modern lithium ion technology and its applications

November 21st 2018

VOLTABOX®

Corporate Development

1988
- Mother company paragon founded by Klaus Dieter Frers (as private ownership)

1994
- Certification as automotive Tier 1 for electronics

2000
- IPO of paragon AG (now paragon GmbH & Co. KGaA) at Frankfurt Stock Exchange (now: Prime Standard)

2011
- Market entry into Lithium-Ion Batteries: E-Mobility launched as a new business segment of paragon AG

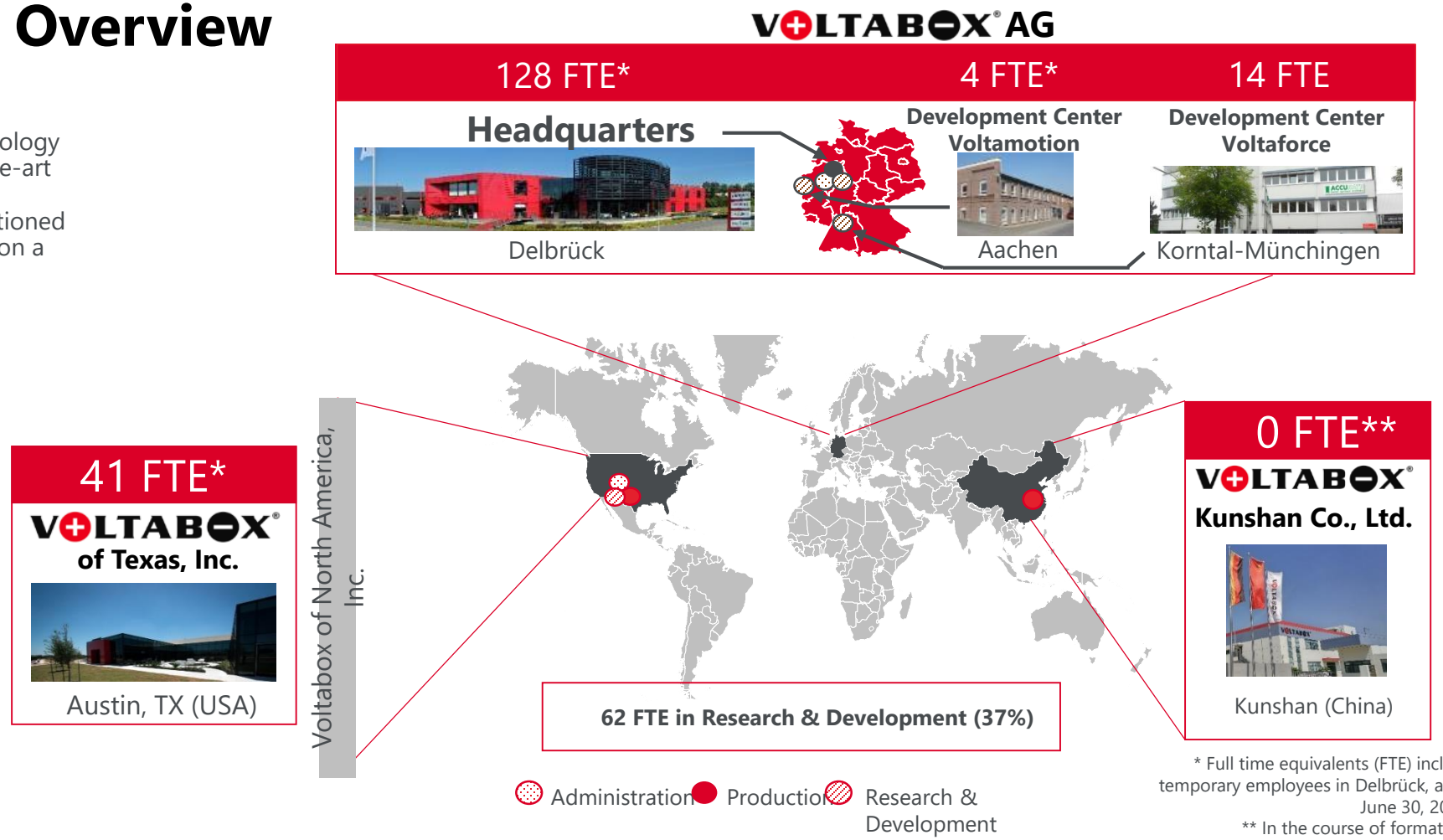
2014
- Foundation of Voltabox as legal entities in Germany and the US (100% subsidiaries of paragon AG)

2017
- Voltabox IPO

2018
- Acquisitions of Concurrent Design, Inc. and Accurate Smart Battery Systems GmbH marking key milestones in M&A growth strategy
- Rearrangement of intralogistics partner agreement required for targeted market leadership / Start of direct sales activities in the intralogistics market

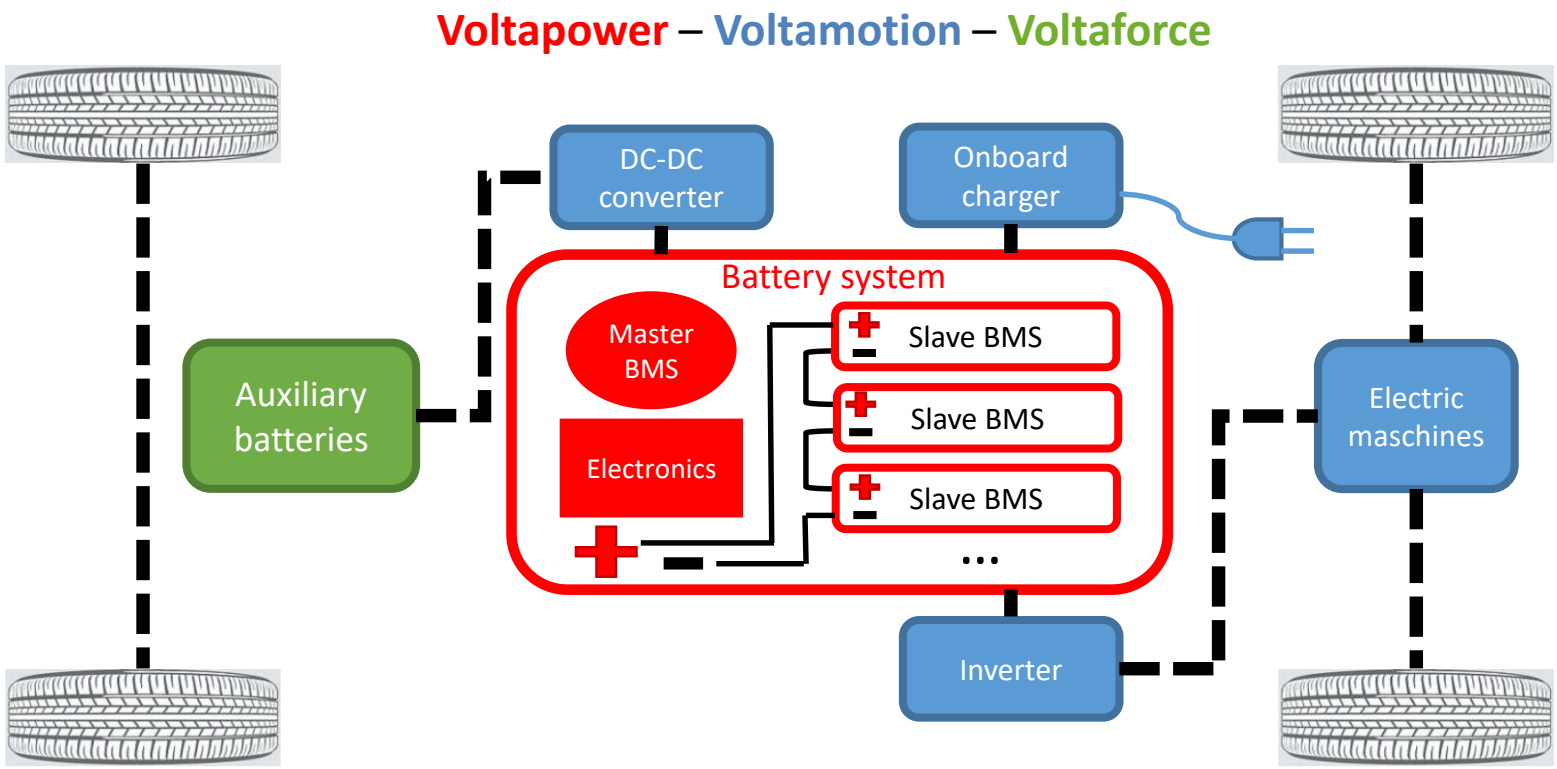
Location Overview

With 169 FTE*, technology hubs and state-of-the-art production facilities, Voltabox is well positioned to grow its business on a global scale.



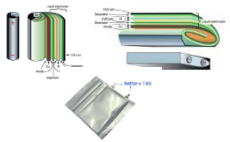
* Full time equivalents (FTE) incl. 25 temporary employees in Delbrück, as of June 30, 2018.
** In the course of formation.

Business Units



E-Mobility Pure Play

Structural composition of a battery system

Base Components	Battery Cells	Battery Modules	Battery System
			
▪ Separator ▪ Anode ▪ Cathode ▪ Electrolyte ▪ Cell Housing ▪ Insulation Strips	▪ Cylindrical cells ▪ Prismatical cells ▪ Pouch cells in different Li-Ion chemistries • LFP • NMC • LTO • (NCA)	▪ Module cases with integrated • Cooling Devices • BMS Slave Circuit Board • Sensors • Wiring Loom • Lids • Sealings • Rupture Discs in various low and high voltage versions	▪ Robust housing with integrated fixing points ▪ Master ECU ▪ Data interfaces ▪ Power switchers ▪ DC/DC converters ▪ Compensators ▪ Fuses / Resistors ▪ Climate systems ▪ (Chargers, cable rewinds)

E-Mobility Value Chain

VOLTAMOTION
VOLTAPOWER
VOLTAFORCE

- Recycling
- Electric Vehicle
- **Drivetrain components**
- **Battery system**
- Cell
- Raw and processed materials

The sweet spot of E-Mobility

Modular Kits – Overview

	Modules	Chemistry	Cell Type	Suppliers	Application
Modular Kit I		**LFP* Chemistry**	**Cylindrical Cells** 	A123 SYSTEMS, valence, K2 Energy	
Modular Kit II		**NMC* Chemistry**	**Prismatic Cells** 	CATL, SAMSUNG	
Modular Kit III		**LTO* Chemistry**	**Prismatic Cells** 	TOSHIBA	
Modular Kit IV		**NMC* Chemistry**	**Pouch Cells** 	XALT Energy, Kokam Great Power for Everyone	

*LFP= Lithium Iron Phosphate; NMC= Nickel Manganese Cobalt; LTO= Lithium Titanium Oxide

Market Penetration by Voltabox

- Q2 2014: First major US-contract for battery systems in trolleybuses
- Q2 2016: Exclusive strategic partnership with leading mining equipment provider
- Q4 2016: Expansion of intralogistics market with batteries for Automated Guided Vehicles
- Q3 2017: First selected mass market entry with starter batteries for motorbikes
- Q4 2017: First strategic partnership in the area of agriculture and construction
- Q1 2018: Acquisition of the engineering services provider Concurrent Design
- Q2 2018: Strategically important rearrangement of intralogistics partner agreement
- Q3 2018: Expansion of Voltaforce segment aiming at applications in high-margin mass markets

Today: ***Significant future growth prospects backed by strong total 60-month order backlog of more than € 1 bn* (weighted)***

** As of June 30, 2018*

Customers & Products – Overview









Customers – Trolley busses

Focus:

Replacement of combustion engines with lithium ion technology on trolley busses to bridge track sections without catenary.
Busses equipped so far: Esslingen, Linz, Genf, Luzern, Cagliari, Seattle, Dayton and San Francisco.

Technical data:

- Cell chemistry: LFP and LTO
- Voltage: 320V – 720V
- Capacity: 25 kWh – 70 kWh
- Weight: 470kg – 1450kg

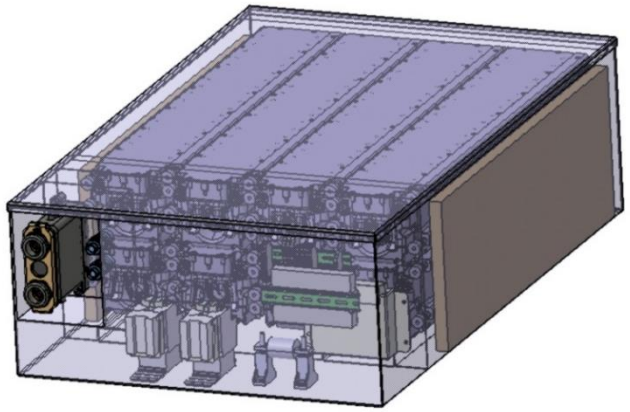
Validation:

UN38.3, shaker and climatic test, EMC, FEA
ECE R100 rev.2, internal simulation

Next generation of trolley bus battery systems

With taking individual modules to the next level, the newest VOLTABOX battery system for trolley busses delivers the following advantages :

- Easy and fast serial and parallel connection of multiple system units.
- Highly intelligent software functions to automatically control multiple standardized system units.
- Automatic voltage monitoring and supervision of individual units with different voltage levels.
- Hot Swap capability.
- Much lower investment cost required for validation processes like ECE-R 100.
- LTO based to allow for the expansion of existing route networks ➔ highest cycle life and superior performance.



Example: System based on 8 LTO Modules

BOB Solingen

Second Life Use Case for former Trolley bus battery systems

Project Scope

- Development of processes to certify already used traction batteries from trolley busses for stationary second life applications.
- Exploit new business cases.
- Gather additional knowledge about the cell chemistries and cells in general traditionally used in trolley busses.
- Detailed testing of cells and previous used modules at their EoL; ambitious climatic and electric tests like Impedance Spectroscopy.
- Building of two ~530 V ESS with 63 kWh and min. ~100 kWh.

Gefördert durch:

Bundesministerium für Verkehr und digitale Infrastruktur

Koordiniert durch:

NOW Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

Summary – Key Highlights

1. E-Mobility "Pure Play" benefitting from attractive megatrends around the vehicle electrification
2. Leading in specialized industrial markets characterized by low competition & high margins
3. "First-mover-advantage" in superior Lithium-Ion technology disrupting current battery standards
4. Immediately available and industry proven modular kits meet application-specific demands and highest safety requirements
5. Comprehensive order backlog with leading market players offer high visibility and underpin growth momentum
6. Experienced management benefitting from outstanding expertise in the field of automotive electronics and Li-Ion battery technology

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