



# Hermann Paus Maschinenfabrik

Extreme BEV durability

Electrification in UG Mining

# Content

- Company / Products and Solutions
- Electrification
- Development of a modular BEV-platform
  - Challenges
  - Machine durability
  - Overview
  - MinCa series
- What's next?



# Hermann Paus Maschinenfabrik GmbH

- **Family Business with tradition!**

- ✓ More than 50 years of experience in machine building
- ✓ Quality “Made in Germany”
- ✓ 300 Employees
- ✓ Specialist for Mining & Tunneling applications since 1974
- ✓ Solutions developed and designed for the underground
- ✓ Supplier of international format
- ✓ Strong customer focus, innovative strength, flexibility and reliability are our key assets

# Mining & Tunneling

## Extensive product range

Including mobile equipment such as working platforms, explosive transporters and chargers, scaler, grader, LHD loaders, dump trucks, personnel carrier, concrete mixers and spraying machines, rescue vehicles and many more

## Made for miners

All machines are designed to meet the challenging tasks at the underground

## Individual solutions

Besides a wide choice of standard equipment and configurations already available all machines can be customized to your needs or even newly-developed to meet your individual demands



# Electrification

## Expertise

Already starting in the early 1980s PAUS is developing electric solutions for the Mining & Tunneling

## Technology-driven

Since decades, our drive and operating concepts include tethered solutions like with a cable reel or for overhead contact lines but also hybrid configurations with combustion engine for drive of the machine and cable-electric operated superstructures

## Forward-looking

With the MinCa 5.1 E PAUS already released years ago the first mine made BEV with fully electric driveline concept





# Electrification @ Paus

## Battery electric concept

- Task: Development of a platform for battery electric mining vehicles
  - Top 3 challenges:



Safety & Health



Charging



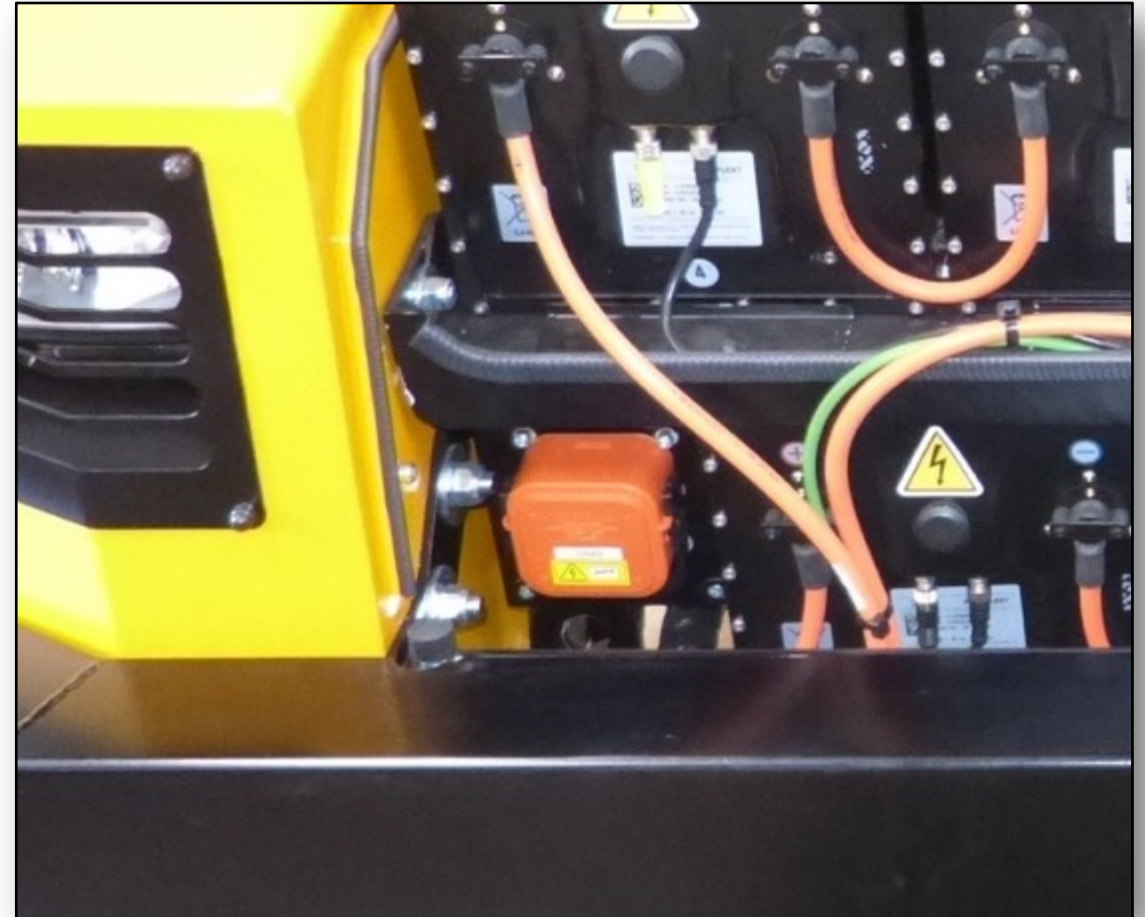
Lifecycle costs

# BEV-Plattform | Challenges



## Health & Safety

- Hundreds of times trusted MinCa chassis as basis
- Manual service disconnect
- Insulation monitoring
- Intrinsically safe battery system
- Tested and certified components
  - e.g. ECE-R100 Battery system
- No exhaust gases



# BEV-Plattform | Challenges



## Charging

- Modular battery design
  - Capacity depending on customer's need
- CCS charging interface
  - Type 1 and 2 available
  - Fast charging (up to 150 kW)
  - AC charging (optional)
- Battery swapping
  - Only for heavy machinery





# BEV-Plattform | Challenges

\$

## Lifecycle costs

- Acquisition costs
  - Battery (main cost driver)
  - Charging infrastructure\*

\* If not already available



# BEV-Plattform | Challenges



## Lifecycle costs

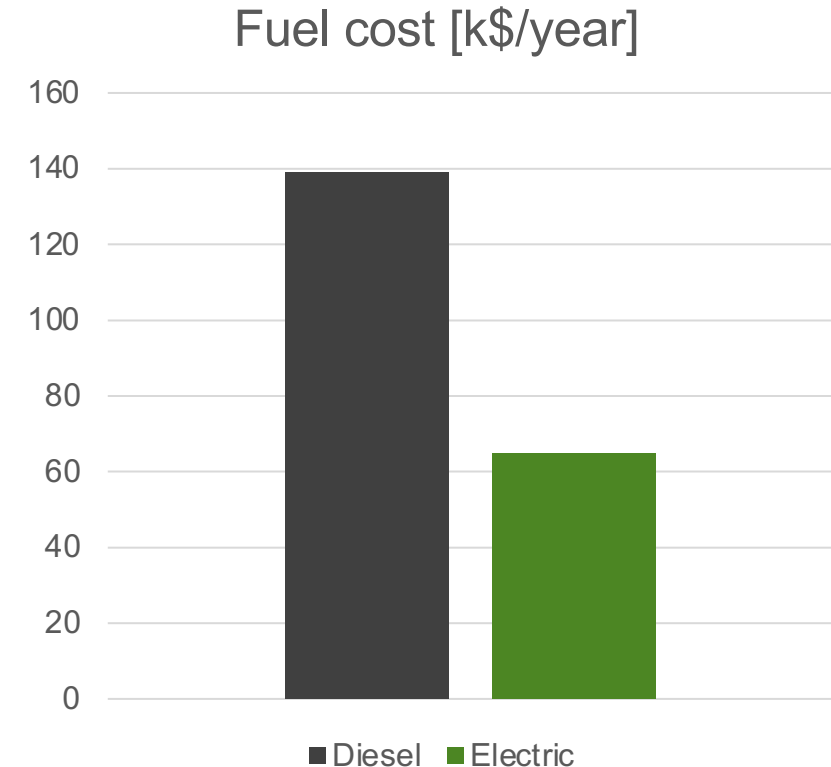
- Availability/ Maintenance costs
  - Applicable for proven long-life MinCa carriers
  - Component selection
    - Robust and maintenance-friendly
    - Proven and certified
  - Maintenance-friendly machine design
    - Modular concept
    - Plugable modules
    - Smart component layout

# BEV-Plattform | Challenges



## Lifecycle costs

- Energy efficiency
  - Fully electric driveline
  - Optimized mechanics
  - High voltage, low currents, less heat
  - Less “Fuel” costs



Source:

[http://minewiki.engineering.queensu.ca/mediawiki/index.php/Electric\\_equipment](http://minewiki.engineering.queensu.ca/mediawiki/index.php/Electric_equipment)

# BEV-Plattform | Challenges



## Lifecycle costs

- Ventilation costs
  - High machine efficiency, less heat
  - No exhaust gases

# BEV-Plattform | Challenges



## Lifecycle costs

- Acquisition costs
- Availability / Maintenance costs
- Energy efficiency
- Ventilation costs



- Higher initial costs
- Much lower operating costs



**Durability**  
pays off  
significantly



# BEV-Plattform | Durability

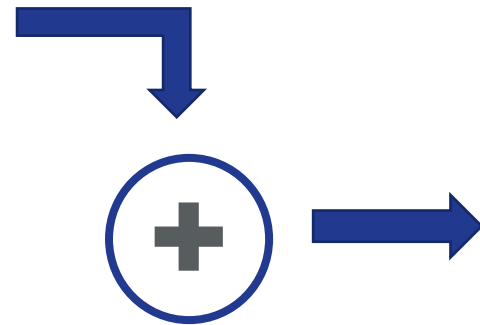
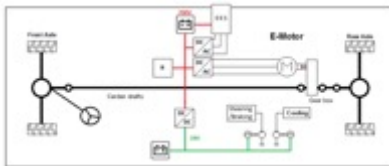
Durability = Key factor for profitable battery-electric mining!

- BEV-Plattform must be extremely durable
- Combine ultra-robust vehicles of Paus with the new BEV-Plattform

Paus' proven



BEV-platform



# BEV-Plattform | Durability

## Mechanics

- Ultra-rugged and proven design for the most adverse environments
- Smart component layout for easy maintenance
- Drive train performance designed for excessive hill climbing



MinCa 18 (Diesel)

# BEV-Plattform | Durability

## Environmental conditions

- Operating temperatures from  $-50^{\circ}\text{C}$  to  $50^{\circ}\text{C}$
- Waterproof system
- Proven under real conditions



MinCa 5.1 E (Battery-electric)






MinCa 5.1 E (Battery-electric)

# BEV-Platform | Durability

## Electric system

- Long lasting, rugged, tested components and wiring
  - >10,000 battery cycles
  - IP67, ECE-R100, ...
- Rapid troubleshooting through onboard diagnostics
  - Operating states
  - Active and previous alarms
  - State of each In- and Output
  - Data logging
  - Many more...

<b>PIN 251</b>	<i>LS Digital Input</i>	FALSE
Low beam		
<b>PIN 252</b>	<i>LS Digital Input</i>	FALSE
Windscreen wiper		
<b>PIN 253</b>	<i>LS Digital Input</i>	FALSE
build-in start engine (50a)		
<b>PIN 254</b>	<i>LS Digital Input</i>	FALSE
Alarm beeper (info)		
 1	 page up - - page down	 25.09.2019 13:55:06

IO-Diagnosis

# BEV-Plattform | Overview

- Battery system
  - ☑ Lithium-ion
  - ☑ 700 VDC
  - ☑ Scalable (in 50 kWh-steps)
  - ☑ ECE-R100 tested
  - ☑ Cycle life > 10,000 cycles
- Charging
  - ☑ CCS interface
    - ☑ DC charging (standard)
    - ⊕ AC charging (optional)
  - ⊕ Battery swapping
    - ⊕ Only for heavy machinery
- Drive train
  - ☑ PMSM traction motor
  - ☑ Scalable
  - ⊕ Braking resistor (optional)
  - ⊕ Cable bound mode
    - ⊕ For (quasi-)stationary work



# BEV-Plattform | MinCa

## General information:

### Proven MinCa series:

- ✔ Ultra-robust MinCa BEV
- ✔ Heavy duty structure and drive unit
- ✔ Specially designed for mining
- ✔ ROPS/FOPS driver's cab
- ✔ Compact dimensions
- ✔ Excellent maneuverability



# BEV-Plattform | MinCa

Possible configurations MinCa 5.1 E:

- + Personnel carrier (5 seats)
- + Pickup truck (2 seats)



# BEV-Plattform | MinCa

## Possible configurations MinCa 18 E:

- + Personnel carrier (up to 18 seats)
- + Transporter with loading platform (single or dual cab)
- + Rescue vehicles (fire truck, ambulance, „MRV 9000“)
- + Tank trucks (water, fuel, lubricants)
- + Crane trucks
- + Mobile workshops
- + Explosive charging and transport
- + Working platforms





# BEV-Plattform | MinCa

## Drive train:

### PMSM traction drive:

- ✔ 90 kW MinCa 5.1 / 112 kW MinCa 18
- ✔ Excellent climbing performance
- ✔ Easy maintenance
- ✔ High energy efficiency

### All-wheel drive system:

- ✔ All-terrain capacities

### Regenerative braking:

- ✔ High energy efficiency
- ✔ Low-wear

### Braking resistor (optional):

- ⊕ Downhill braking @ 100% SoC without using friction brakes



# BEV-Plattform | MinCa

## Battery system:

### 50 kWh battery as standard capacity:

- ☑ Best fit for most use cases
- ☑ Opportunity charging

### 99 kWh battery (optional):

- ⊕ Allows for ultra-high availability
- ⊕ Whole shift without charging

### Battery details:

- ☑ Manual service disconnect and insulation monitoring
- ☑ Self-monitored battery system
- ☑ High lifetime (>10,000 cycles)
- ☑ ECE-R100 tested

### CCS Charging (CCS Combo 2):

- ☑ DC charging (80% SoC in 45 min.)
- ⊕ AC charging (22 kW, optional)





# BEV-Plattform | MinCa

Proven under toughest conditions:

- ☑ Dust, water and humidity
- ☑ Mechanical shock
- ☑ Extreme temperatures





# At a glance | MinCa

The PAUS MinCa are special and unique designed mining vehicles. Both variants impress with extraordinary payloads - of up to 1,5t along with the MinCa 5.1 and 4.0t with the MinCa 18 – and high performances.

The best all axle, spring and shock absorber suspension system in underground mining equipment market gives not only operator and passengers high safety and comfort, but also longer lifetime in rough terrain.

- Full shock absorber suspension system for higher safety and better performance
- High performance, fully electric driveline
- Ultra-durable design
- Low life cycle costs
- Spacious and comfortable driver´s cabin





# What's next? | Electric developments







*...the people who care*

**“Coming together is the beginning. Keeping together is progress. Working together is success.”**

**-Henry Ford-**