Alternative Drives

From the perspective of a Heavy Mining Equipment OEM

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Liebherr-Australia Pty Ltd

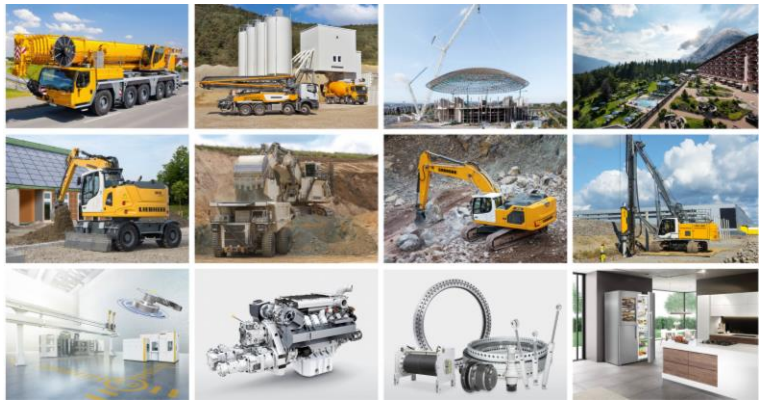
The Liebherr Group

History of the Liebherr Group

- Company founded in 1949 by Dr.-Ing. E.h. Hans Liebherr
- Independent, family-run company, which is managed jointly by the second and third generation of the Liebherr family
- Decentralized organisational structure and comprises 13 product segments

The year 2020 in numbers

- 10,341 € m turnover
- 605 € m investments
- 47,925 employees
- > 40 product companies
- > 140 companies



Diverse group of companies

- Mining
- Earthmoving
- Material Handling Technology
- Deep Foundation Machines
- Mobile and Crawler Cranes
- Tower Cranes
- Maritime Cranes
- Concrete Technology
- Aerospace and Transportation Systems
- Gear Technology and Automation Systems
- Refrigeration and Freezing
- Components

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Liebherr-Component factories

Liebherr-Components Colmar SAS

- Colmar, France
- Established: 2011
- Employees: 250

Products
- Diesel engines (1.250 – 4.250 kW)

Liebherr Machines Bulle SA

- Bulle, Switzerland
- Established: 1978
- Employees: 1,600

Products
- Diesel engines / gas engines
- Hydraulic pumps and motors
- Pump splitter gear boxes
- Competence center in alternative fuel

Liebherr-Components Deggendorf GmbH

- Deggendorf, Germany
- Established: 2015
- Employees: 340

Products
- Fuel injection systems

Liebherr-Components Biberach GmbH

- Biberach, Germany
- Established: 2012
- Employees: 1,670

Products
- Electrical drive
- Control technology
- Competence center in battery tech

Liebherr Mining Commitment

Offer by 2022 low carbon solutions for full range of Liebherr Mining Hydraulic Excavator and Off-Highway Trucks.

Offer by 2030 latest proven fossil fuel-free solutions for the majority of applications.

- Near Zero GHG (CO2-e) Emissions
- Focusing on Well to Wheel
- Considering Cradle to Grave

Proven low emissions solutions

Mining Trucks

- AC drive system
- Trolley Assist System
- Tier 4 Final certified engine
- HVO fuel compliant Liebherr engine

Mining Excavators

- E-drive for the full range
- Liebherr Power Efficiency
- Cable management systems
- Tier 4 Final certified engine
- HVO fuel compliant Liebherr engine

Mining Dozers

- Hydrostatic drive system
- Tier 4 Final certified engine
- HVO fuel compliant Liebherr engine

Hydrogenated Vegetable Oil (HVO)

Trolley Assist System benefits*

Increased productivity with reduced fleet size

- Less truck investment cost
- Less operating and maintenance cost

Reduced energy cost per tonne by 37%

- 53% reduction of diesel fuel consumption (total fleet#)

Reduced mine carbon footprint supported by a decrease of 74%* of the total fleet# CO2e emissions locally.

The well-to-wheel/global fleet# CO2e emissions are reduced by 71%*,**

Total fleet= standard diesel trucks + diesel excavator vs. reduced trolley trucks + electric excavator
* Diesel fuel local (tank-to-wheel) GHG emissions factor = 2,740g CO_2e/L,
Diesel fuel local (well-to-wheel) GHG emissions factor = 3,300g CO_2e/L
** Electrical energy Global (well-to-wheel) GHG emissions factor = 51g CO_2e/kWh

Liebherr trolley trucks in operation

GHG emissions reduction

Up to 80% today

World's largest 360t trolley truck fleet(s)

- Total of 39x T 284s on two mine sites
- 11 additional T 284s to join existing fleets
- Up to 1.8 time faster on trolley vs diesel
- Up to 21% improvement in production

World's longest truck trolley line

- 6x T 236s in operation at Erzberg in Austria
- 5 km trolley line with 180° switch back
- Project awards
  - Mining Magazine Award 2020
  - EL-MOTION Award 2021
  - ENERGY GLOBE STYRIA AWARD 2021

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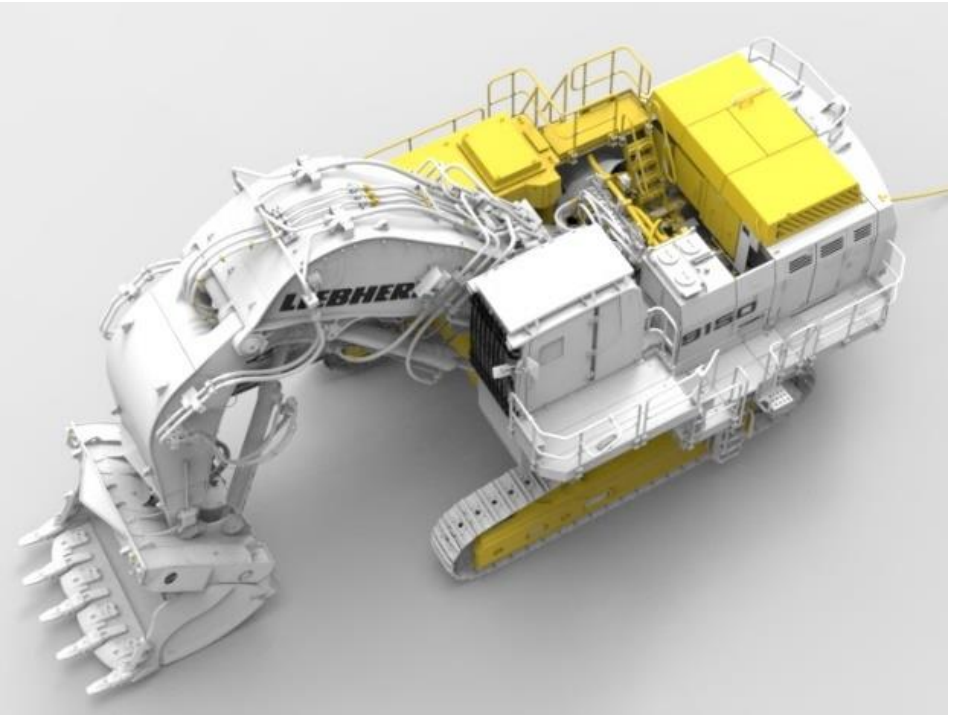


Electric drive system HEX

A well proven design

- Derivate from the diesel version
- Upgrade from diesel version to electric version possible
- 70% components commonality between diesel and electric version
- All fuel system, air intake, exhaust and engine cooling replaced by a high voltage electrical cabinet
- IEC or UL/CSA certifications

Liebherr Power Efficiency Control System

Innovative engine and hydraulic control system for mining excavators

Overall system integration and optimisation

- Electronic pilot control
- Electrohydraulic valve control
- New pump control
- Efficiency increase of the control valves and the new Liebherr pumps
- Fully integrated engine control system

29% less fuel consumption per tonne moved

R 9600 vs R 996B

Modular solutions, which can be upgraded or retrofitted

Design principles for future drivetrains

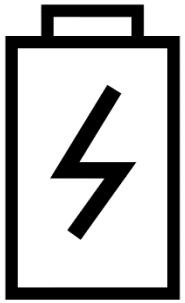
Liebherr will offer zero emission technology solutions that are modular, which can be upgraded or retrofitted, easing the transition to low or zero emissions for our customers.

- Zero emission design concepts will ensure that current and future equipment can be retrofitted with future technologies.
- Modular concept enables combination of different energy solutions and future technology adaptations
- The design principle enables energy type agnostic and machine application agnostic drive train technology
- We are committed to supporting our customers through this journey by enabling them to upgrade to zero emission drives for from now on delivered equipment

Liebherr can offer today a solution to their mining customers to start their zero-emission journey.

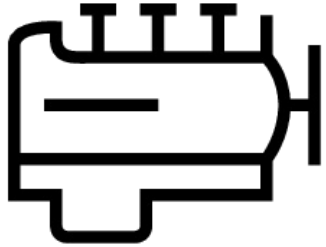
3 drivetrain core technology options

Electrification



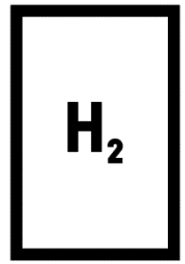
Battery truck & trolley
or dynamic
or stationary charging

Internal combustion engine



HVO / Ammonia /
Methanol / H2 / E-fuels

Electrification



Hydrogen fuel cell battery
truck & trolley
or other dynamic charging

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Mining truck zero emission / fossil fuel-free drivetrain options

Electrification
Battery truck & trolley assist
Dynamic or stationary charging

Internal combustion engine
HVO / Ammonia /
Methanol / H2 / Other E-fuels

Electrification
Hydrogen fuel cell battery truck
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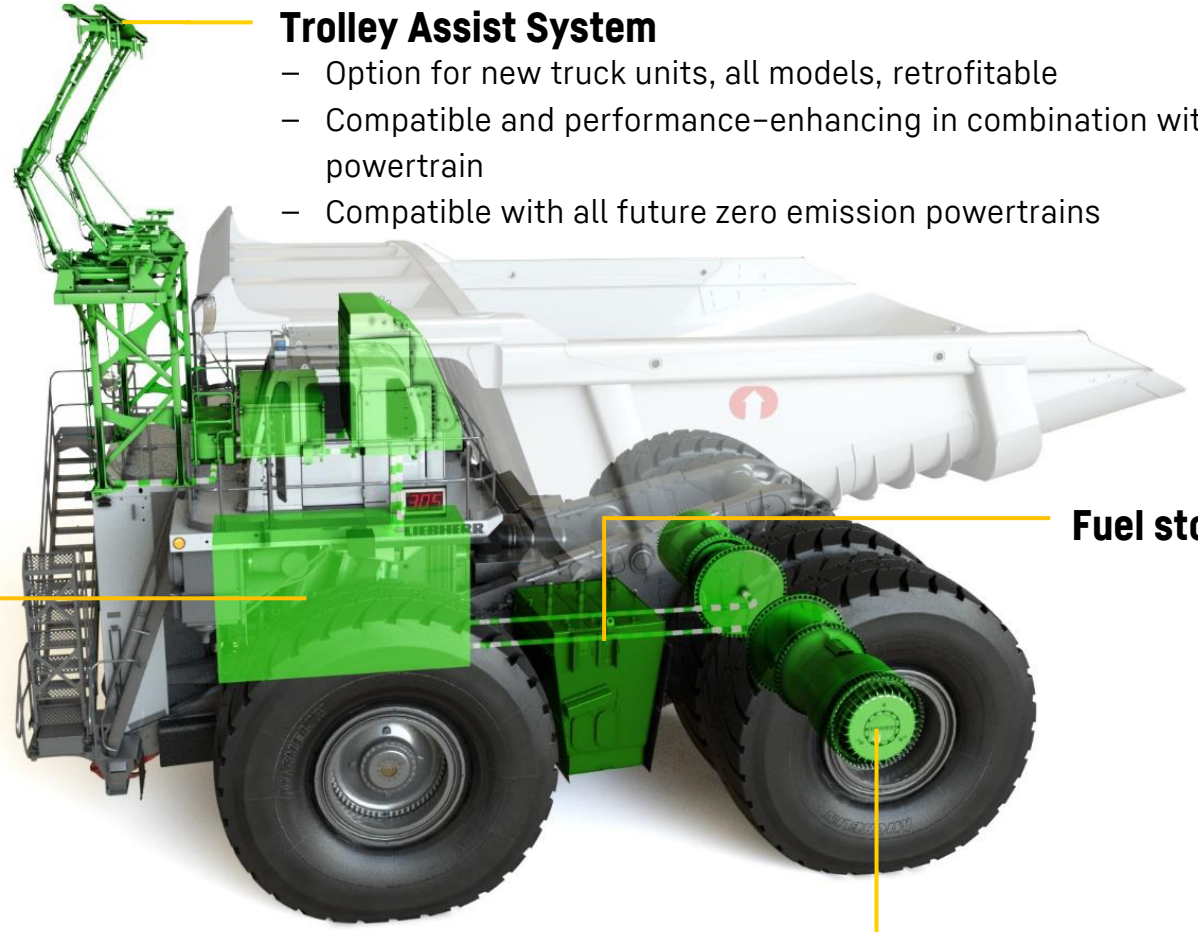

Trolley Assist System
- Option for new truck units, all models, retrofitable
- Compatible and performance-enhancing in combination with diesel powertrain
- Compatible with all future zero emission powertrains

Fuel storage

Liebherr AC Drive System
- Maximize electrical power conversion into mechanical torque
- Deliver high speed on grade and higher rim pull forces

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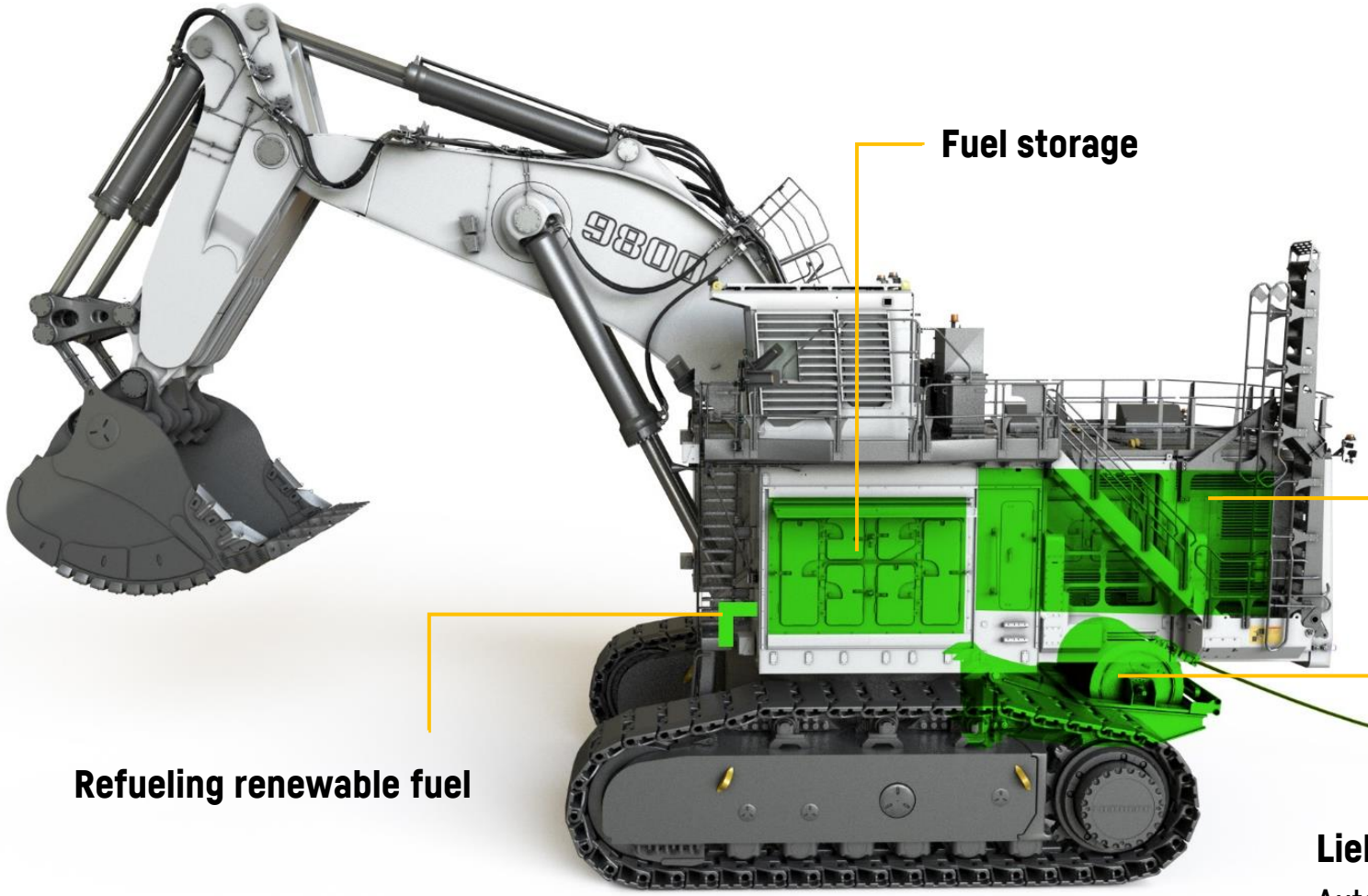
Mining excavator zero emission / fossil fuel-free drivetrain options



Fuel storage

Refueling renewable fuel

Electrification
Electric drivetrain

Internal combustion engine
HVO / Ammonia /
Methanol / Other E-fuels

Liebherr Cable Reeler
Automatic cable management

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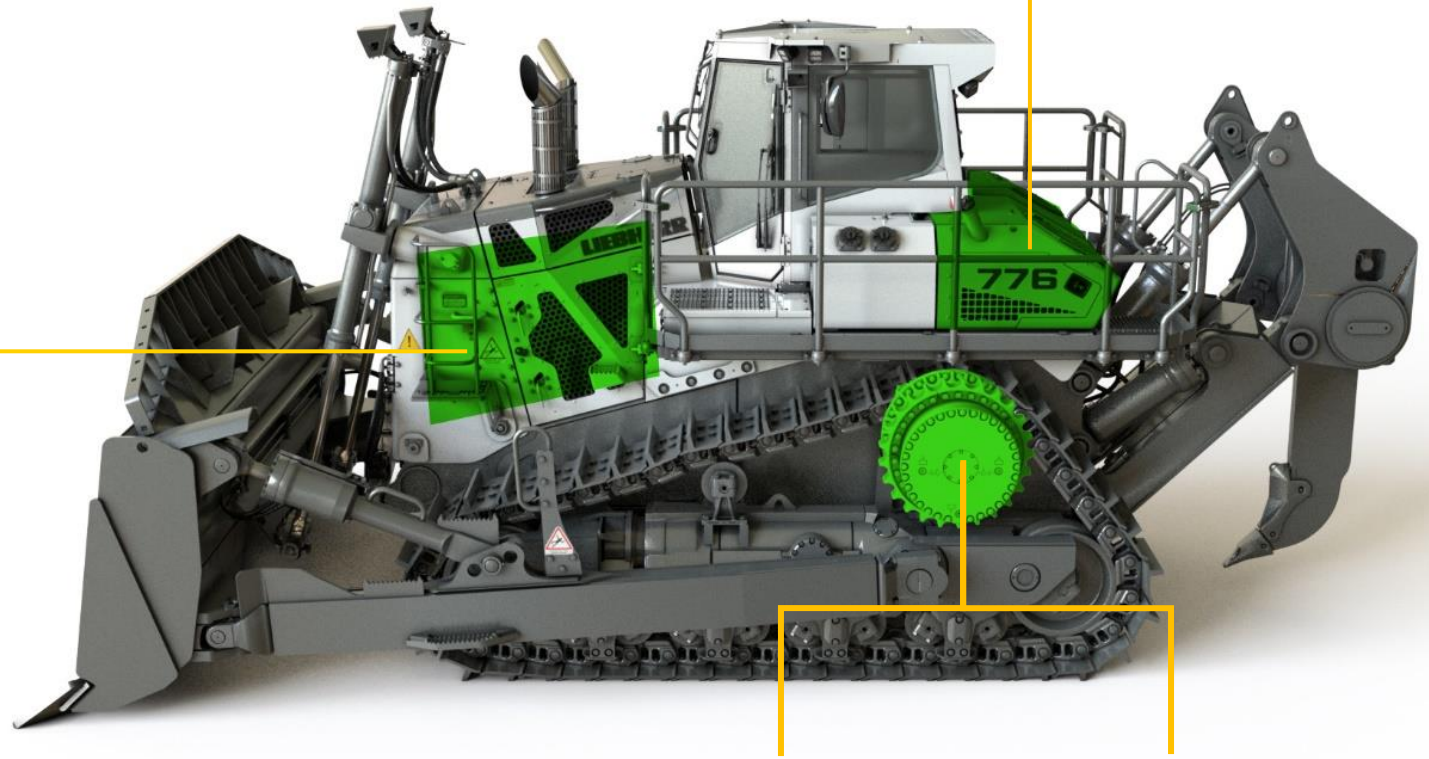
Mining dozer zero emission / fossil fuel-free drivetrain options

Internal combustion engine
HVO / Ammonia /
Methanol / Other E-fuels



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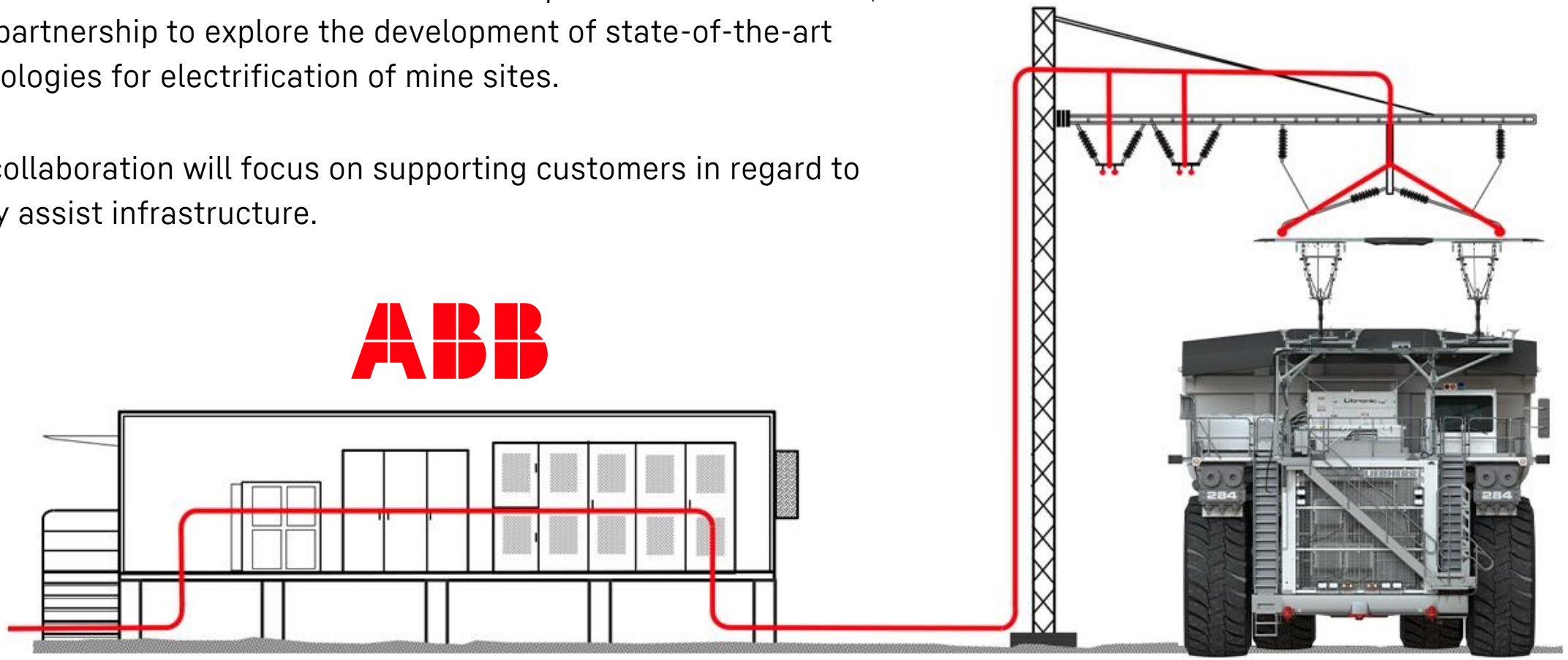
Collaboration with ABB

Liebherr and ABB have announced at MINExpo International® 2021, their partnership to explore the development of state-of-the-art technologies for electrification of mine sites.

This collaboration will focus on supporting customers in regard to trolley assist infrastructure.



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Strategic partnerships

Collaboration with ENGIE

Liebherr Mining and ENGIE have officially announced their partnership on zero-emission mining solutions for a sustainable future at MINExpo International® 2021.

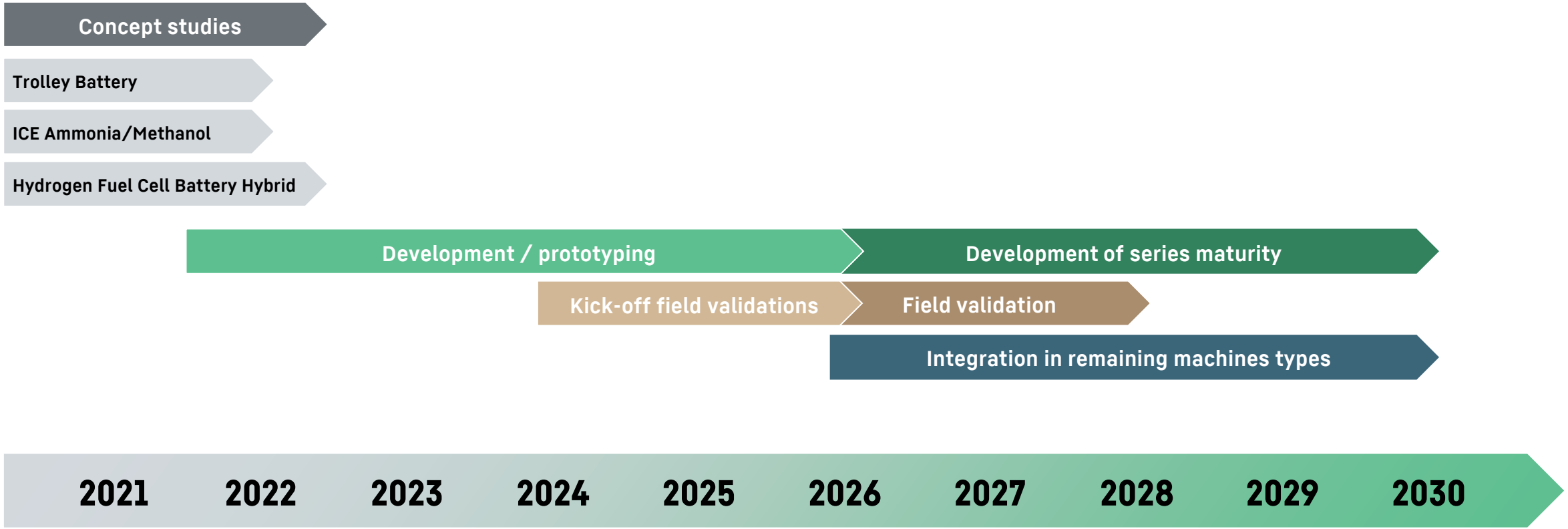
– Each company will bring its own expertise and knowledge to the table to develop an integrated well-to-wheel solution for the mining industry.

– The collaboration aims to evaluate different renewable energies, in particular renewable hydrogen, and hydrogen derived fuels.

– The joint feasibility study will determine the well-to-wheel new energy ecosystems for trucks, excavators, and dozers.

Roadmap to zero emission / fossil fuel-free

Provide solutions for hauling, digging and dozing machines



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Thank
you.
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