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## **Expanding e-mobility in cargo and material handling**

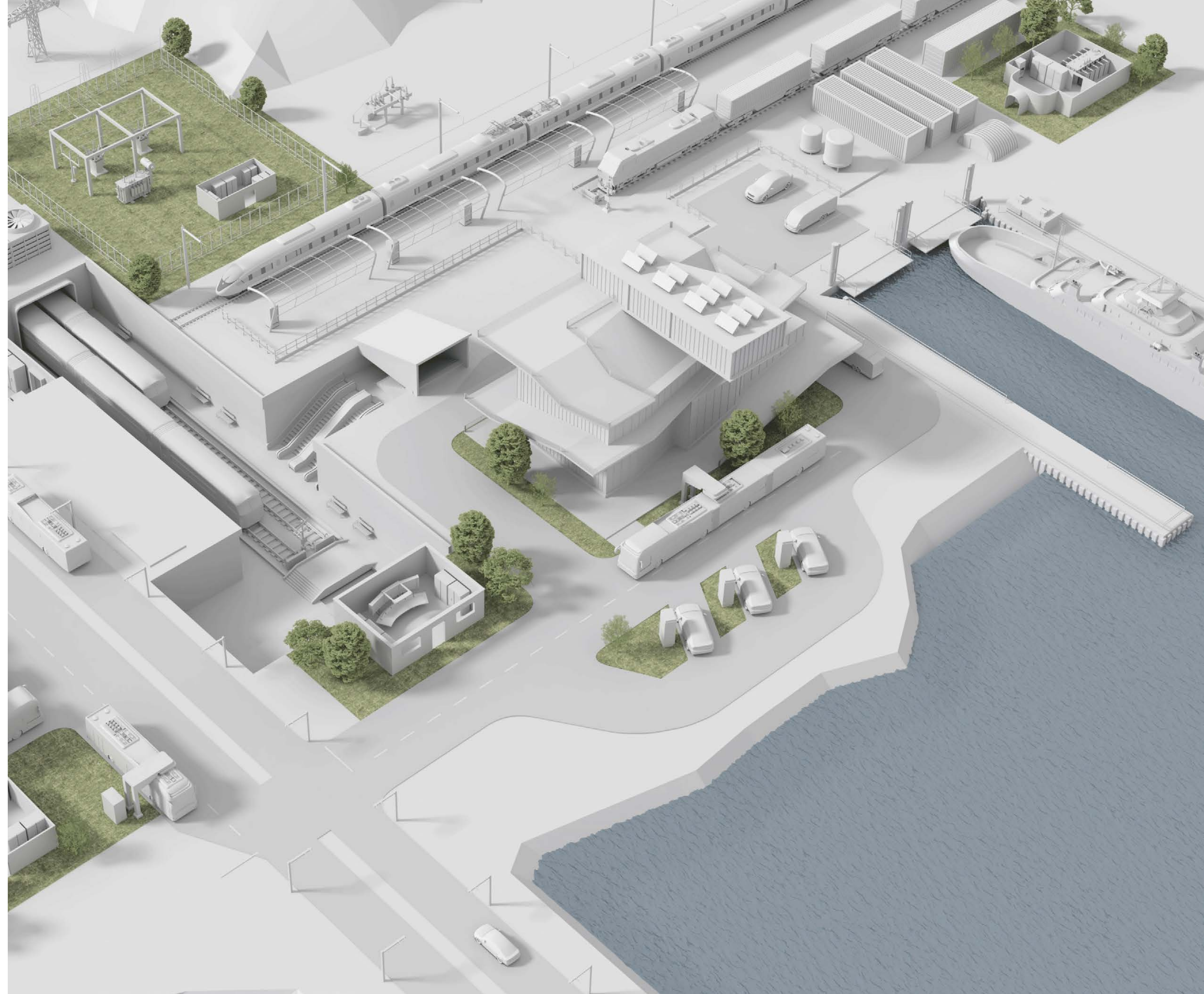
Designed to meet your targets  
and your customers' demands



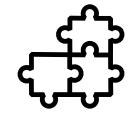
## A long history of electric mobility

With over 130 years of experience building electric motors and controls for hundreds of applications, including trains, busses, and vehicles used in harsh environments like mining, ABB is perfectly placed to support your expanding e-mobility offering.

As your partner, we can supply the tough motors and drives you need. In addition, we can work closely with you and share our deep knowledge about motor dimensioning and cyclical loads, inverters and batteries, charging and connectors, and other system-related topics.







### Where are we today

- Fossil fuels, CO<sub>2</sub> emissions, increasing governmental regulations
- Noisy work environment, with noxious fumes
- Low energy efficiency, much wasted heat
- Mechanical wear and tear, many moving parts



### Where are we going

- Cleaner electric vehicles, free of CO<sub>2</sub> emissions, green solution
- Cleaner air and quieter in operator's work zone
- Higher efficiency, reduced heat waste
- Few moving parts, reduced mechanical stresses



### What it brings

- Improved health for bystanders
- Less sick leave, better productivity
- Operating indoors, reduced need of ventilation and investments, less operating costs
- Easier service and maintenance, increased uptime and productivity

## Your concerns are both important and solvable

E-mobility brings many advantages in a wide range of areas, like environmental impact, working environment, operating cost, machine productivity and maintenance.

Like many companies that build cargo and material handling vehicles, you are probably thinking about e-mobility and assessing the best ways to expand your electric product range. You may also be considering sustainability issues and the increasing demands operators have for zero-emission machinery.

Identifying the winning strategy for moving forward can be tricky, since there are many challenges to be evaluated and solved as you transition further from traditional fossil fuels to clean electric propulsion.

We would like to share the most common issues that we hear about e-mobility from manufacturers of cargo handling vehicles – like forklifts, reach stackers, straddle carriers and AGVs (Automated Guided Vehicles) – and then present our ideas and solutions that can support you in making e-mobility successful.



# Where are you on your e-journey?

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INTRO



SOLUTIONS



NEWTON'S SECOND LAW



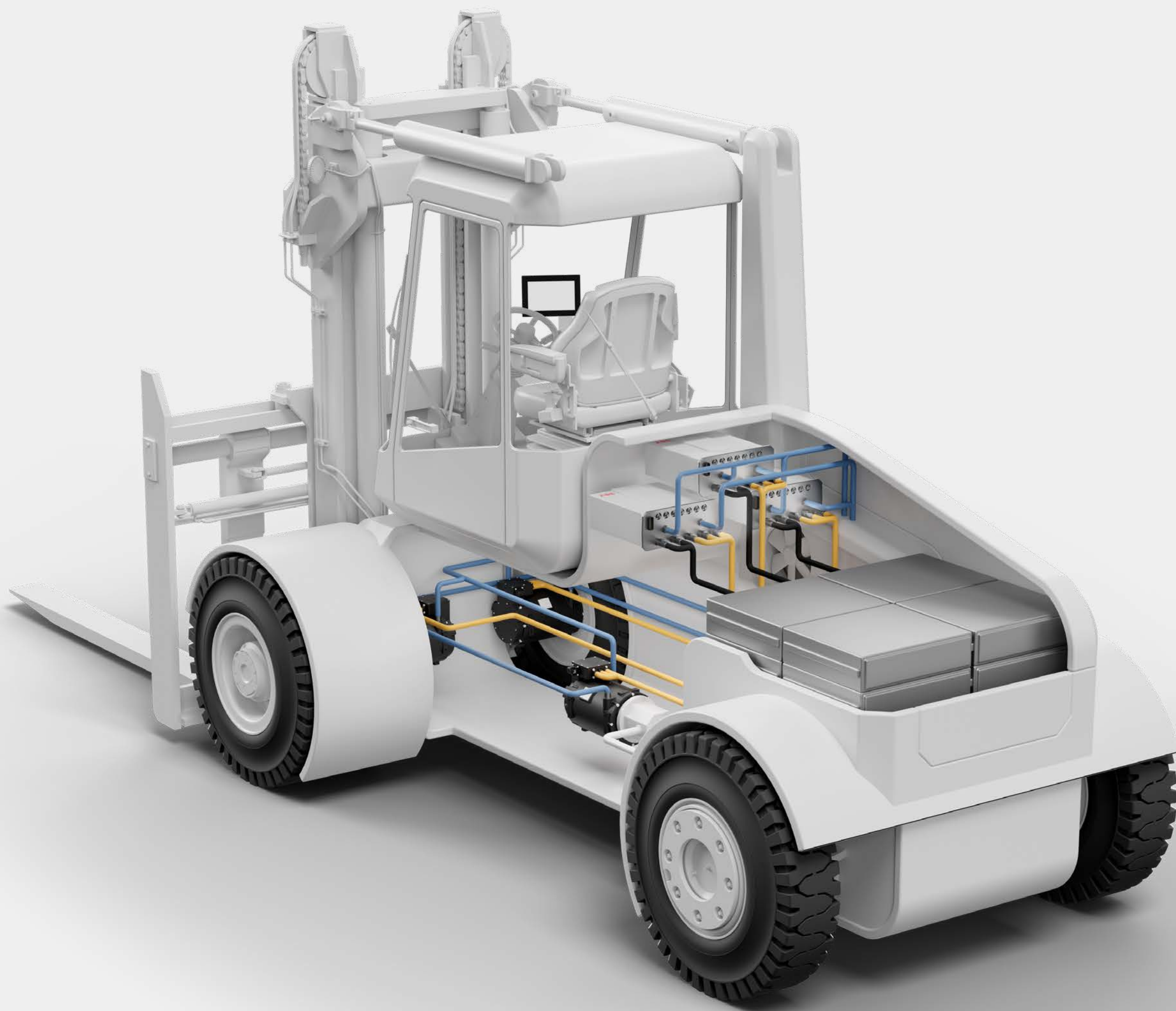
PRODUCTS

After giving these questions considerable thought, ABB has developed key solutions you may need

Our insight and products can make e-mobility much easier for you.

With ABB motors and drives at the heart of your e-powertrains, your electric cargo handling vehicles can give your customers everything they are asking for. Explore these benefits and features, which are designed to help you successfully deliver all the necessary requirements.

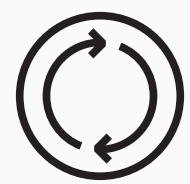
By working with ABB you will gain a trusted partner that offers proven e-powertrain products. This allows you to efficiently meet all the most important market demands, such as improved productivity, reduced TCO, increased uptime and operator environment.





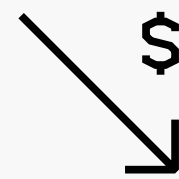


## The key features and benefits you want, to satisfy your customers



### Fast acceleration and response time, for top-level performance

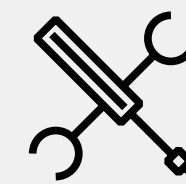
- Due low weight and inertia, ABB's e-powertrains respond better than the diesel engines you are used to
- The innovative water cooling design means the motor gets high torque density, giving the operator a powerful vehicle while maintaining a quieter working environment all day long
- Fast and accurate torque control provides excellent response to the operator commands



### Low Total Cost of Ownership\*

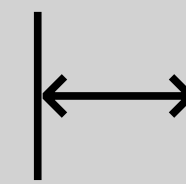
(= Purchase cost + Installation cost + Cost of running + Cost of not running)

- Highly-reliable powertrain performance, based on proven building blocks from similar e-mobility applications
- Maintenance-free mobile drive and robust bearings made to last for years
- Easy to install in the vehicle, to reduce integration and manufacturing costs



### Designed and manufactured for rough and tough work environments

- Tolerates high shock loads and vibration levels, and wide ambient temperature ranges, for long running times
- Supervision to control motor and drive temperatures and protect if too high
- Enclosure protection ratings to meet all application needs for moisture and dirt
- Manufacturing process improved with 130 years of experience and research



### Fit for your purposes and performance, with perfect sizing

- We help you precisely evaluate performance and dimensioning needs, to meet your applications and drive cycles
- Our wide e-mobility portfolio lets you choose and mix the equipment that's just right for you
- Wide and flexible operational range for any application, over broad speed and torque ranges





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## Additional advantages to help make your e-journey smooth and profitable

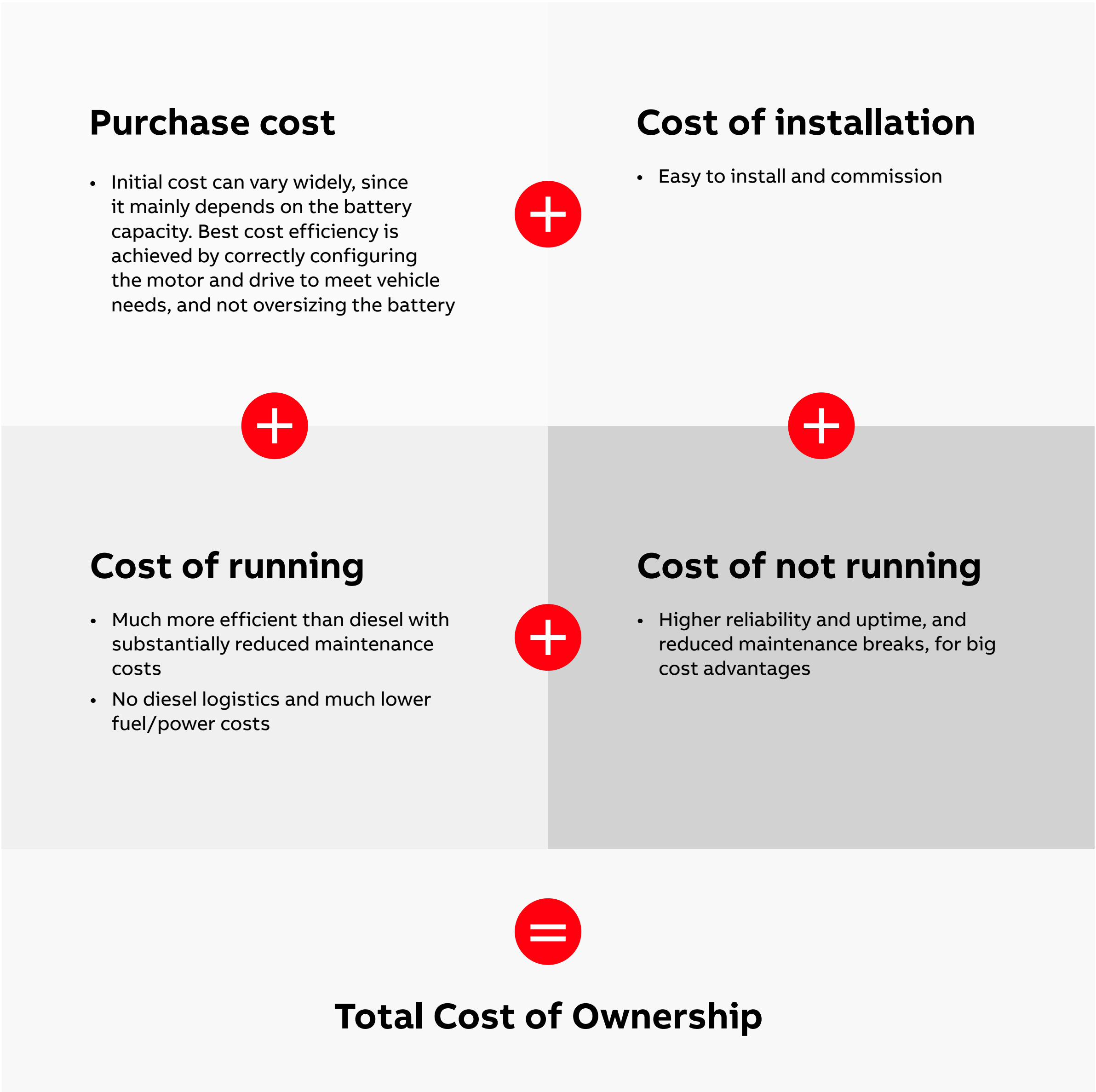
- Compatible with your battery via different voltage levels
- Global manufacturing footprint and reach, combined with local presence and support wherever you are
- Training for your personnel, e.g. in development, service, and assembly
- Low power consumption/energy losses
- Compact motor and drive module are easy to fit in any vehicle
- Safe and easy to install, with quick plug connectors and high voltage interlock
- Propulsion and auxiliary usage from same supplier





**Go electric. It makes good environmental and financial sense.**

Besides the advantages of reduced emissions, electric powertrains can also offer better overall cost efficiency compared with diesel versions. Although initial purchase cost may be somewhat higher, this is easily compensated by gains in the other three parts of the TCO equation.







## Major Sustainability benefits

Electric propulsion in cargo handling vehicles makes perfect environmental sense – already now and of course for the future. Operators avoid noxious fumes in their workplace, CO<sub>2</sub> emissions are cut drastically and the transport and handling of fossil fuels/diesel is eliminated.

In addition, topics such as sustainable corporate initiatives or regional diesel bans also come into the calculation. For example, it is foreseen that certain cities and ports will request electric vehicles as a qualifier for operating on their premises.



# Newton’s 2<sup>nd</sup> Law of Physics, applied to your vehicles

Understanding a little bit of the science behind e-powertrains can be very helpful.

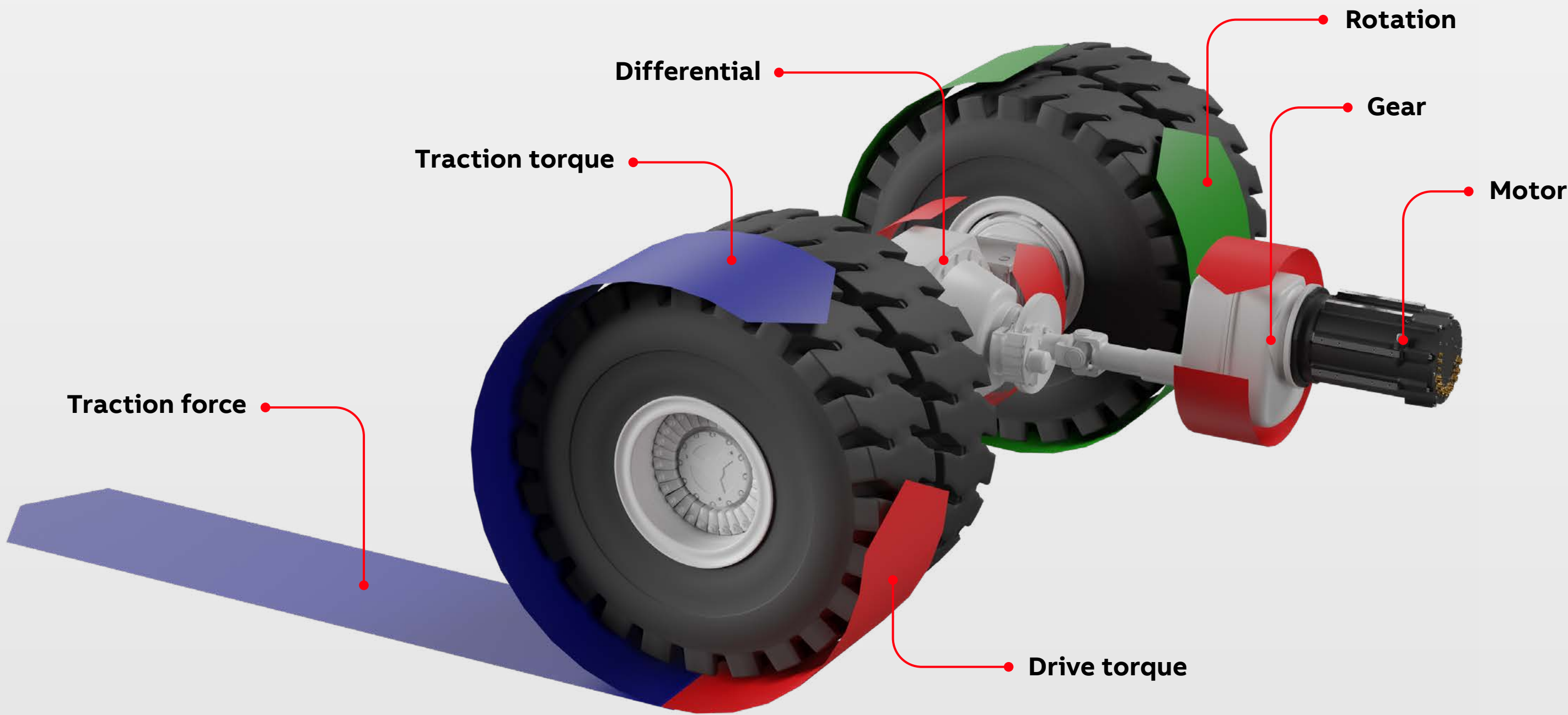
When choosing the correct powertrain, it is important to understand the different driving conditions your vehicle will need to manage, since this impacts the motor and inverter dimensioning and selection.

The vehicle’s tractive effort and speed are translated to electric motor requirements by the equation: Torque = Tractive effort (Force) x Wheel radius. The actual formula may need further modification based on the specific driveline design, taking gear ratios and efficiency losses into the equation.

The tractive effort needed can be obtained from Newton’s 2<sup>nd</sup> Law of Physics,  $F = ma$ , meaning Force = mass of object x its acceleration. Here we can also mention that power (P) equals speed (v) times force (F),  $P=v \times F$ .

Newton’s Second Law of Physics

**Torque =  
Tractive effort (Force)  
x Wheel radius**





**Torque =**  
Tractive effort (Force)  
x Wheel radius



# Newton's 2<sup>nd</sup> Law of Physics, applied to your vehicles

To accurately assess your motor and inverter needs, it is good to map up six different driving scenarios to get a diagram describing the tractive effort and vehicle speed. This includes peak conditions for short times, and continuous over longer times.



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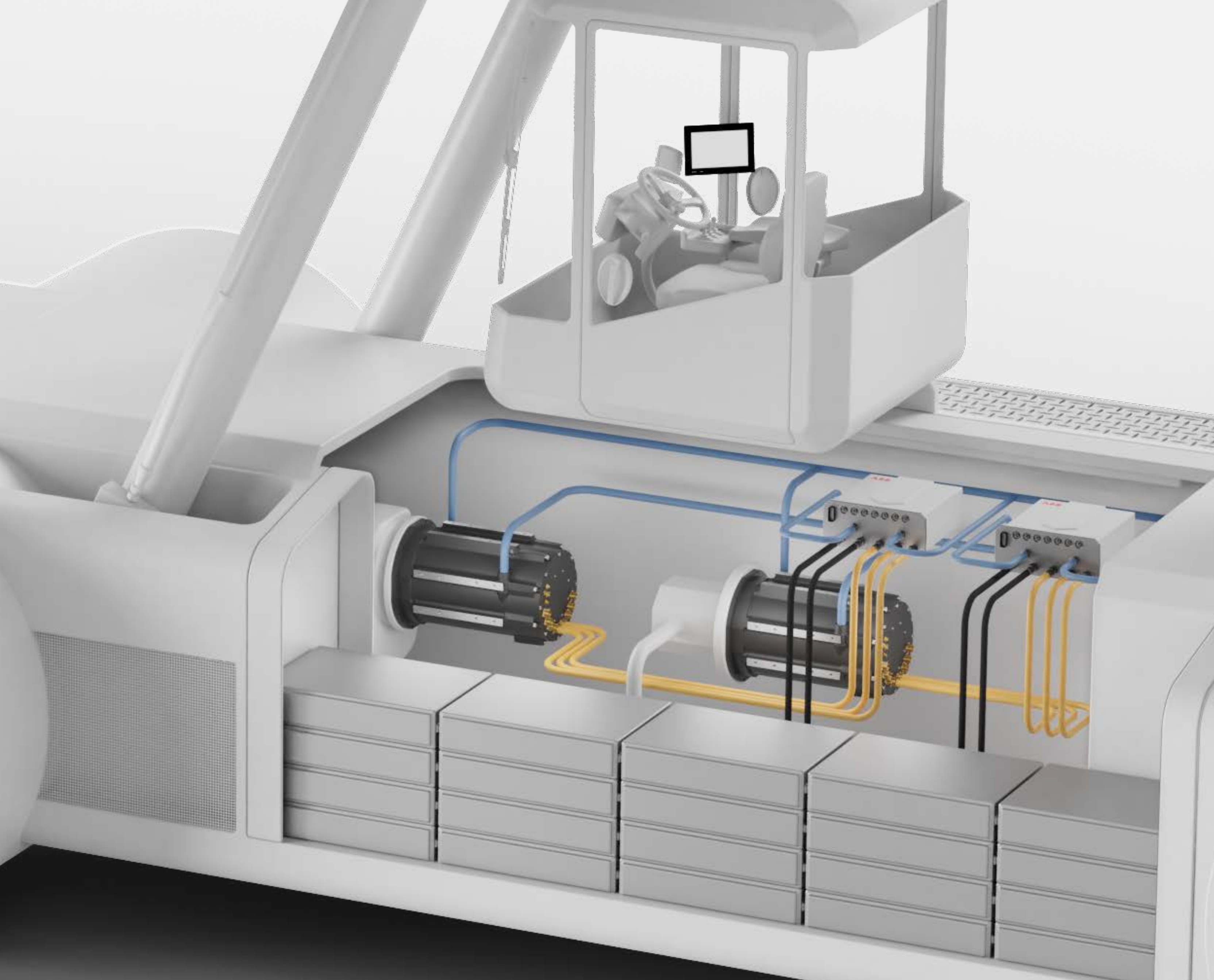
## Complicated? We are here to help.

At ABB, we are pleased to share our knowledge – to help you solve challenges.

- If you have any questions or thoughts about E-mobility solutions for cargo handling machines, we would be pleased to discuss them with you
- If the above scenarios about motor and inverter dimensioning are obvious to you, that's great. You can just jump to the technical data sheets to check out our products and how they can fit in your vehicle
- If you feel it's a bit complicated, we are happy to talk with you to understand your challenges and how we can solve them together. We are confident that we won't need to call on Mr. Newton







## ABB's product offering and technical specifications for e-mobility motors and drives

Common features in all our e-mobility motors and drives.

- High enclosure protection class, IP67
- Withstand heavy vibration and shocks
- Wide ambient temperature range, -40 to +85 °C (-40 to +185 °F)
- Liquid cooling with high liquid input temperature, up to +70 °C (+158 °F)



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## AMXE motors

Compact, permanent magnet synchronous motors for high efficiency propulsion and auxiliary usage. Configure your motor with specific lengths, windings and voltages to get your needed performance.

- Power levels from 20 to 520 kW
- Speed range up to 8000 rpm
- Four different frame sizes

**1 AMXE132 - up to 600 Nm**

**2 AMXE160 - up to 1000 Nm**

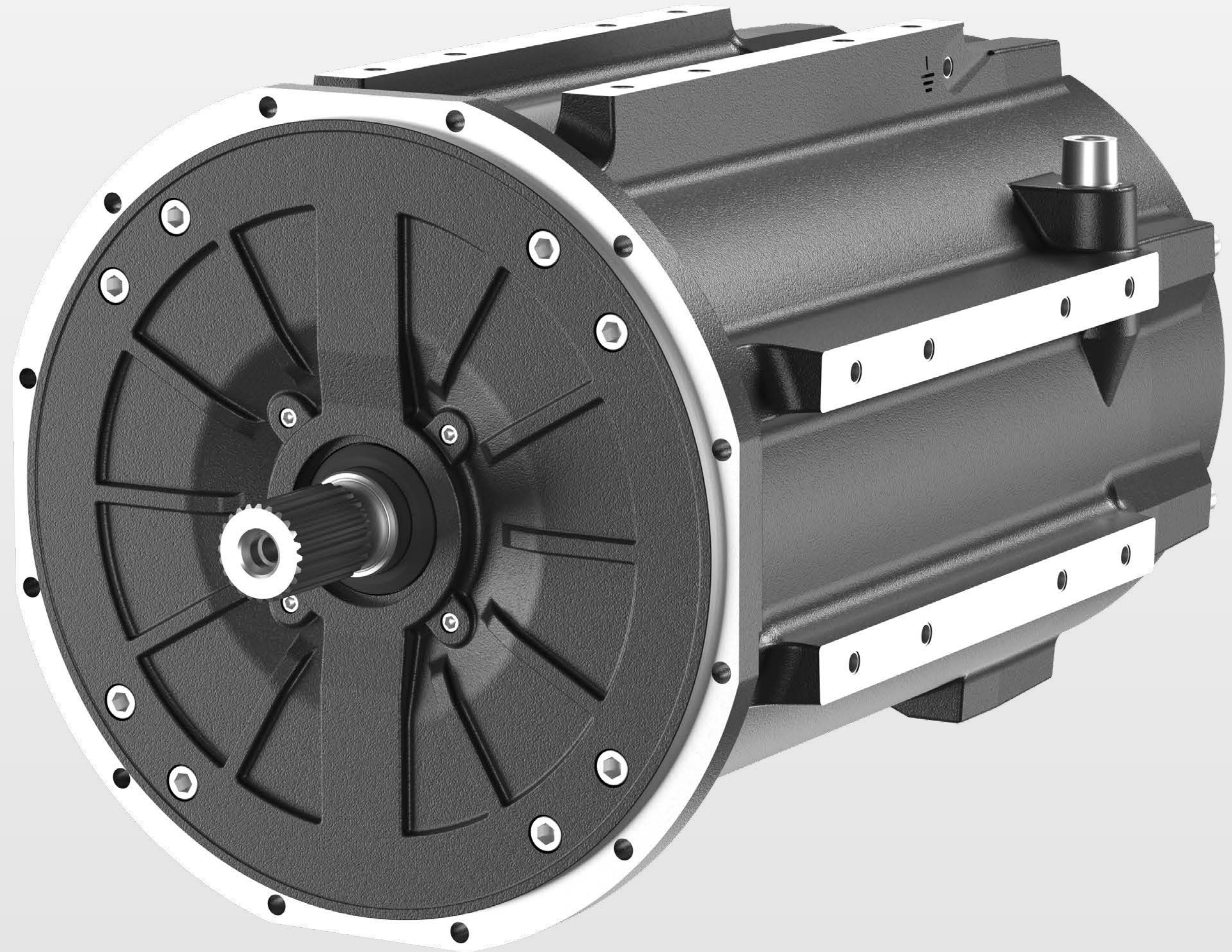
**3 AMXE200 - up to 1900 Nm**

**4 AMXE250 - up to 3300 Nm**

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### Don't find the motor you are looking for?

We have long experience with unique customer projects and solutions and are happy to help you.







## HES880 mobile drive

Compact and rugged, the HES880 drive has been designed specifically to work in electric powertrains in applications like cargo handling vehicles. Features and benefits include:

- Inverter for traction motor and generator up to 510 kW continuous and up to 760 kW peak electrical power
- Three different frame sizes with voltage from 320 to 750 VDC – 350, 600 and 900 A as maximum currents
- Bi-directional line converter for grid connectivity
- DC/DC converter for battery, super capacitor or fuel cell, up to 620 kW
- The same module can be used as a line converter, motor inverter or DC/DC converter
- Easy to install, only plug connectors
- Safe torque off (STO) as standard, integrated braking chopper as option



**AIDB**