E-mobility for construction equipment

Making it easy to build and use electric-powered construction machinery
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 moves to develop E-mobility vehicles for the construction jobs.

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.
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 or retrofit construction vehicles – such as excavators, bulldozers, wheel loaders, dump trucks, backhoes, compactors and more – you are probably thinking about E-mobility and wondering what the best ways are to expand your electric product range. You may also be considering sustainability issues and the increasing demands from construction companies and operators for zero-emission machinery.

Identifying the winning strategy for successfully moving forward in this growing field 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 questions and concerns that we hear regarding E-mobility from manufacturers and retrofitters of construction vehicles, and then present our ideas and solutions that can support you in making E-mobility successful.
Where are you on your e-journey?

Total cost of ownership
- Can I be price competitive with an electric-powered vehicle?
- Can it offer a lower TCO, total cost of ownership, than diesel?
- Will it help meet both existing and future emissions rules?

Charging
- How is charging handled?
- If there is limited available electrical capacity, can we charge all units at the same time, like during a lunch break?

Powertrain
- What voltage level should I select?
- Will the solution fit in the vehicle?
- What is the best electric powertrain layout for my vehicle?

Performance
- Will my customers buy the electric solution I develop?
- Will it perform as well as the equivalent diesel version?
- Performance is very important, and no operator or fleet manager wants a vehicle that feels slow compared to what they are used to

Correct dimensioning
- How do I correctly size the right products to get the targeted performance, and not be oversized or overpriced?
- Needed motor size to meet the vehicle performance?
- What drive is best for the motor?
- What type of battery and capacity is needed?

Reliability
- How reliable and robust is electric compared to diesel?
- Our operators regularly push the construction machines to, and sometimes beyond, their limits.
- Can electric powertrains handle the wet, dusty, corrosive environments as well as diesel does?
- Will overheating at low speeds be a problem?

Safety and maintainability
- Is electrical safety complicated?
- Do I need a trained technician to connect the motor during assembly and service?

Support
- If I need support, is there someone nearby who both speaks my language and understands the technology?
After giving these questions serious thought, ABB has developed the 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 construction equipment 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 and need, to satisfy your customers

High torque capability for excellent productivity, performance and response
- High peak torque ensures good tractive efforts at low speeds, eg. when filling the bucket with gravel.
- 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*
\[\text{= Purchase cost + Installation cost + Cost of running + Cost of not running}\]
- 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 protect motor and drive against too high temperatures.
- Enclosure protection ratings to meet all application needs for moisture and dirt.

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.
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 construction equipment and vehicles makes perfect environmental sense – already now and of course for the future. Operators avoid noxious fumes in their workplace, CO\textsubscript{2} emissions are cut drastically, and the transport and handling of fossil fuels/diesel is eliminated.

Noise pollution, which is a serious concern especially in cities and especially at night, is also cut with E-mobility.

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 states may potentially require electric vehicles as a qualifier for operating in their areas.
Retrofitting existing diesel powertrains with electric is easy with ABB’s flexible solutions

In the construction equipment sector, many companies work with retrofitting different types of construction vehicles. An increasing number of E-mobility retrofits are now starting to move forward, resulting in real projects. We are ready to assist and support this transition with both our motors and drives, as well as our deep knowledge in this field.

Easy configurability and scalability are key enablers for retrofitting
ABB’s E-powertrains give you the key benefits of being easy to install and commission, in a safe way. Thus the retrofit can be done quickly with no requirement for long lead times.

Compact motor with high torque density to save space
One important factor in retrofitting is for the motor to be as compact as possible. Usually the space is limited, and a small motor with high torque density helps make more space for the batteries.

Our motors can be connected to axles, transmissions and pumps, thus requiring the least mechanical adjustment and customization. This is attractive for retrofitters, since very few extra adjustments saves both construction hours and costs.
Newton’s 2nd 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) × 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 2nd Law of Physics, \( F = ma \), meaning Force = mass of object × its acceleration. Here we can also mention that power \( (P) \) equals speed \( (v) \) times force \( (F) \), \( P = vF \).

Newton’s Second Law of Physics

\[ \text{Torque} = \text{Tractive effort (Force)} \times \text{Wheel radius} \]
Newton’s 2\textsuperscript{nd} 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. These points are represented in Figure 1.

1. Maximum torque at low speed or standstill, for example curb climbing, coming up from a pothole or starting/holding the vehicle on a slope or ramp
   - This point will decide the maximum peak torque for the motor and drive.
   - Peak torque is limited by the peak current of the drive, the size of the motor and magnetic saturation

2. Continuous torque at low speeds, like pulling a heavy load or continuous driving uphill
   - Continuous torque or continuous operation is limited by the thermal capacity of the motor and drive and they also need to be harmonized together. The continuous torque range can be tailored to your needs by changing the size of the motor or the cooling capacity

3. Points 1 to 3 describe the constant torque region, e.g. maximum acceleration at low speeds
   - Point 3 represents the nominal speed point and is related to where the optimum efficiency of the motor should be placed. This point can be modified, such as by changing the winding configuration of the motor

4. Maximum speed of the motor and vehicle. How fast should the vehicle be able to travel?
   - This point is important for mechanical durability, bearing lifetime and potential hysteresis losses that need to be considered, since they affect efficiency of the motor

5. Torque needed to drive at maximum speed in steady state operation, e.g. transporting with no load or moderate hill
   - This point affects the continuous torque of the motor and inverter, as in point 2, but at maximum speed instead

6. Torque needed to drive at maximum speed, with an increased load, during a short time, e.g. maintaining speed driving up a short steeper slope
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 construction equipment and vehicles, 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)

For more detailed information, click here.
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

Shaft and flange dimensions in wide range available
As a further advantage, the motor shaft and the flange can be selected to fit already existing interfaces.

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 construction equipment 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.

For more detailed information, click here.
Summary & more information

No matter where you are on your journey to increase E-mobility in construction vehicles, ABB can help make it a smoother ride. To learn more about how we can support you, get in touch with us at . . .