

# Battery technology - the drive power of the future in track construction

Battery-based electric drives are not only an environmentally friendly alternative but bring about major advances in ergonomics and work quality.

**THOMAS HÖLZLWIMMER**

In the era of climate change the traditional combustion engines will sooner or later need to be a thing of the past in order to achieve the ambitious targets for climate protection. Like the automotive sector, where the race in the development towards purely electric or hybrid drives is gathering ever more pace, the railway construction sector is working on new, economically efficient and zero-emission drive technologies. This article shows how batteries already play an important role in hand-guided track construction machines and looks at their future potential.

## Why battery power?

For decades, the drive technology based on petrol and diesel engines was undisputed and the generally accepted solution in the automotive sector as well as in the areas of machines and equipment. However, the recent politically initiated turnaround in energy policy and the global climate protection targets of the international community have given rise to criticism of combustion engines with their harmful emissions. The call for alternative, environmentally friendly technologies determines the political debate. Time is running out - in Norway new fossil fuelled cars will be banned from 2025, in Denmark and Sweden from 2030.



The railway as an environmentally friendly means of transport plays a significant role in this scenario. The rolling stock sector responds to the pressure for technological change with electrification, amongst others, and the railway construction sector is beginning to equip its vehicles and machines with new drives.

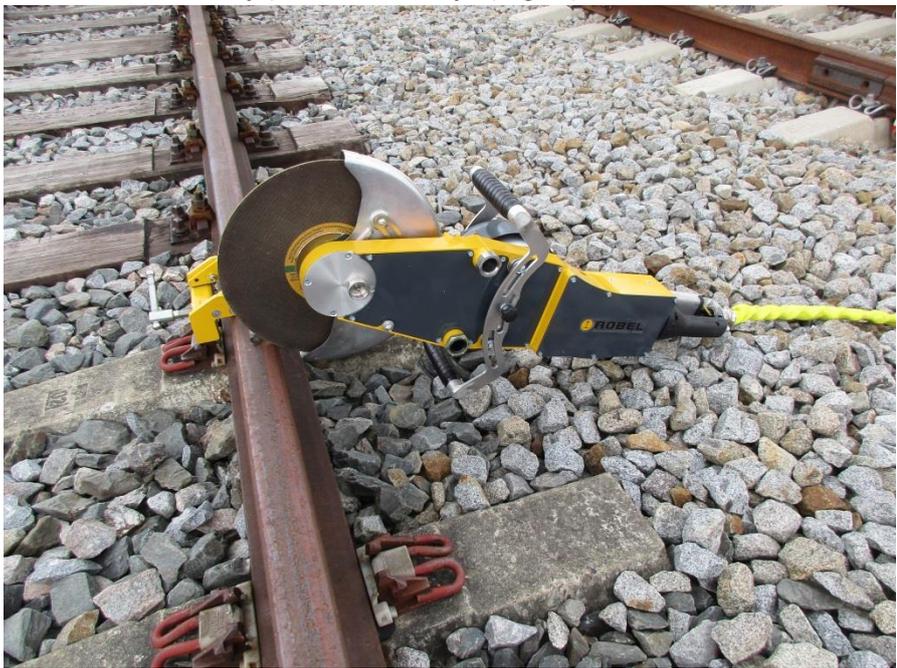
ROBEL has been working intensively on modernising the track construction site for years and is investing in the development of alternative drive and power supply technologies. As far back as 2013, at iaaf, the company from Freilassing presented a rail drilling machine and an impact wrench with modular rechargeable battery packs for ze-

**Fig. 1:** All four of the battery powered family of ROBEL machines are powered with the same lithium-ion battery.

ro-emission and ergonomic work on the track. The lithium batteries together with high-performance electric motors have since become a true alternative to the combustion engine, providing high performance and durability as well as comfortable working.

That the expansion of the battery powered fleet of machines has a top priority at ROBEL, can be seen from the considerable growth of ROBEL's "battery powered family" (Fig. 1). With the addition of the ROSAW B Rail Band Saw and the ROTAMP B Vertical Tamper, there are already four battery powered hand-guided machines available with a proven track record for a range of uses in track maintenance. A further member of the family, the ROCUT B Rail Cutter (Fig. 2), will be produced in series from the end of 2019.

International demand is high - the battery powered machines are already in use throughout Europe. A market survey carried out by ROBEL highlights the huge potential of the alternative drives: Distributors worldwide expect 40% of all track construction machines to be battery operated by 2020.



**Fig. 2:** Powerful lightweight: The new ROCUT B Rail Cutter performs 50 cuts with one battery charge.

## The benefits of battery technology

The replacement of combustion engines with battery powered electric motors opens up new opportunities with tangible improvements for the operator and the environment, especially for work in tunnels and in urban environments (underground, urban transport networks). The machines are light in weight, quiet, produce zero emissions and can be used in any working environment. There is no more need for time-consuming laying of power cables - in tunnels usually done by two additional people - and setting up generators, as is necessary for standard electric drives. And no more ventilation and the associated health hazards and costs. Track maintenance becomes faster and more efficient, with considerably less effort per work site and higher employee satisfaction.

## Sustainable track maintenance

Sustainability is a key argument in favour of alternative drives. The battery service life is approx. 500 charge cycles, the machines themselves are capable of operating fault-free for many years due to their sturdy design and low wear. Drilling and wrenching tools used for existing ROBEL machines as well as the multi-hole drilling templates and rail profile templates can continue to be used for the battery powered machines without any restrictions.

## Modular design - one battery for all models

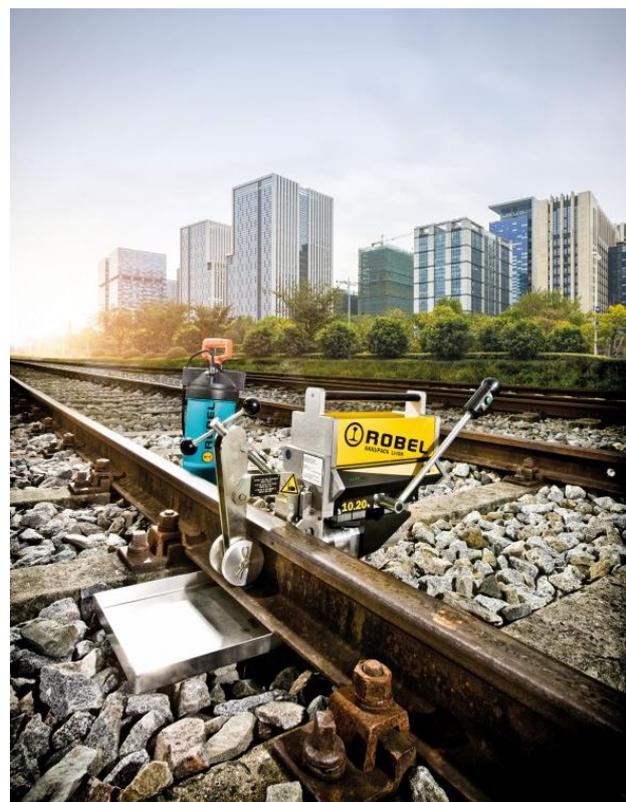
All the ROBEL family of battery powered machines work with the same battery pack, a lithium-ion based accumulator with a voltage level of 43 Volt and a capacity of approx. 13 Ah which has been tried and tested for many years. The battery is firmly secured to the machine through form-fit and position lock, yet it can be released with just two actions by hand. The

sturdy handle of the battery pack also serves, for instance on the RODRILL B Drilling Machine, as a carrying handle for the machine (Fig. 3). In addition to the modular design, the sturdy design of the components is a key factor: The battery pack is completely maintenance-free.

### Less weight - improved ergonomics and safety

The latest generation of electric motors with the same output is considerably smaller and lighter than their predecessors. This has multiple benefits for the design of the machine. The compact motor opens up new possibilities for its positioning on the machine, e.g. to optimise its centre of gravity. Thus, operation and transport of the machine require considerably less effort. The lack of a heavy and high-vibration combustion engine on the machine allows for a still sturdy but light aluminium construction: The ROMPACT B Impact Wrench, for instance, weighs 20 per cent less than the same model with a 4-stroke engine.

The view of the workplace remains clear, the operator's posture is ergonomically perfect. There are no fuel tanks or handling of fuel, no hot exhaust or engine parts during operation. Furthermore, the machine operators are no longer exposed to engine fumes or a high level of noise and hand-arm vibration. This not only promotes the health of the construction crew but also increases their motivation and thus their availability for work.



**Fig. 3:** The handle of the battery pack also serves as the carrying handle of the RODRILL B Drilling Machine.

### Used everywhere - quiet and clean

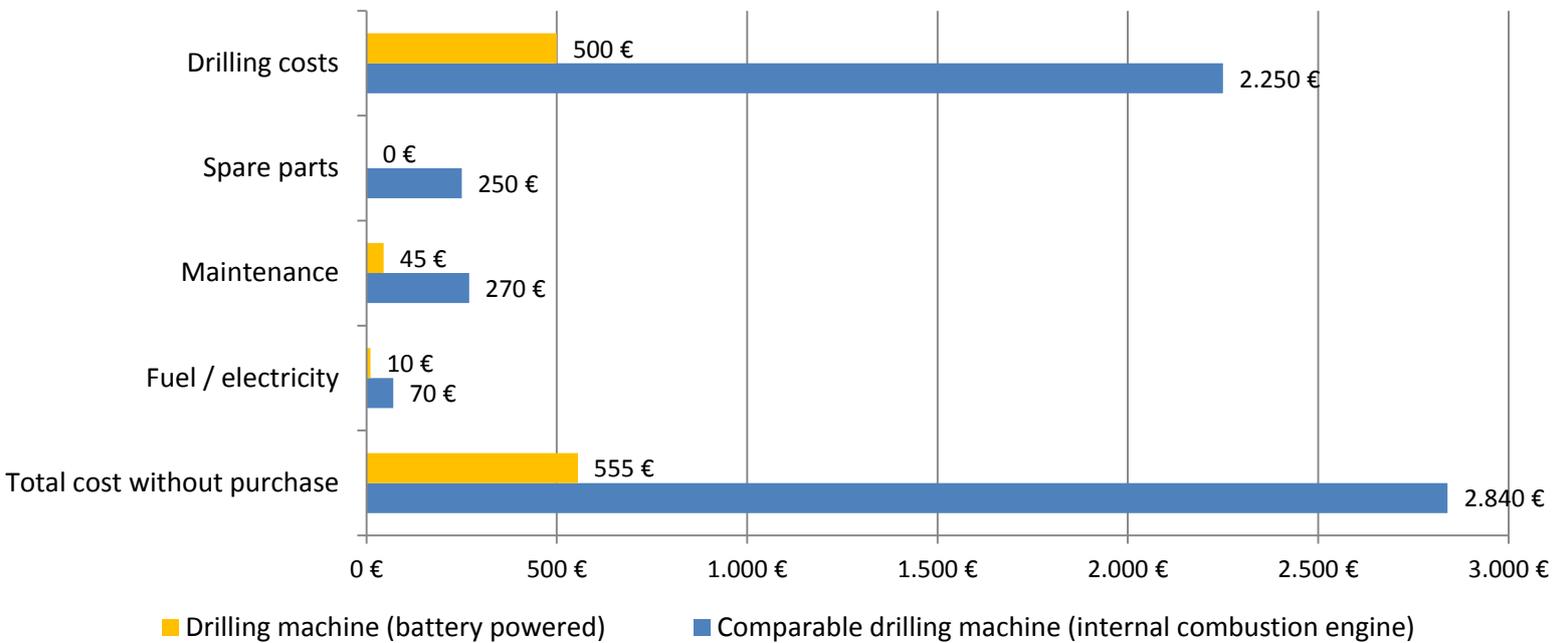
It has become increasingly difficult for track construction sites in noise-sensitive areas, such as those close to clinics, care homes and schools, to be accepted by local residents and local authorities due to the intolerable noise levels, especially at night. In the worst case, protests can result in the construction site to be shut down. The use of battery powered machines and tools reduces the on-site noise levels considerably: The ROSAW B Rail Band Saw is verifiably 10 times quieter than a comparable cutting device with combustion engine. In some other cases, maintenance only becomes possible with alternative drives, for instance, where the use of fuel is forbidden by law, such as in certain tunnels.

In terrain that is difficult to access it can be a huge benefit for operators if the machines to be used can be transported easily by hand over longer distances with little effort. Here, the battery powered machines come into their own due to their lightweight design and the immediate and consistent availability of power. A lot less material is moved to the work site as the replacement batteries are the same for all machines.

### Consistent power supply - at least for the duration of one shift

The insufficient reach of vehicles with alternative drives on the road is at the centre of the current public debate. Currently, a standard electric car has a maximum reach of 400 kilometres, which is reduced considerably in cold weather. On the track, neither the reach nor the ambient temperatures pose a problem. Independent of the type of activity - drilling, cutting or wrenching - the battery lasts for at least a shift, without the need for any maintenance, even at temperatures below zero. Unprompted extensions of the work assignment are backed up

## Cost comparison in operation over 3 years / 3000 holes



**Fig. 4:** Cost comparison of operating a battery powered drilling machine and a drilling machine with combustion engine over 3 years and 3,000 drilling operations.

by additional batteries, the battery pack is recharged within three to four hours and ready to use again.

### The question of cost - why battery technology pays off

For the maintenance company the total cost of ownership (TCO), made up of procurement, service life and maintenance costs, is a key consideration. The TCO of battery powered machines and tools always comes up trumps.

A 2- or 4-stroke engine has around 200 parts, many of which are moving. The brushless electric motor essentially consists of the stator, rotor and the bearing, making it completely maintenance-free. Furthermore, a battery powered drilling machine or impact wrench will not require a gearbox for right-left rotation, which increases the availability of the machine even further. Monitoring and routine activities, such as filling up with fuel, oil change and filter-cleaning as well as the considerable spare parts logistics, including storage, in the case of combustion engines are a thing of the past.



**Fig.5:** Electronically supported work: The LED display of the battery powered rail drilling machine shows the manual feed rate.

Add to this the cost savings during operation (Fig. 4): Machines powered by electric motors are, unlike combustion engines, ready to be operated on site straight away, at full speed and performance, without the need for a warm-up phase. No more cold start attempts, which are often required for petrol engines in cold weather. Faster drilling and wrenching cycles increase the work output per shift. Intelligent design and technical solutions, e.g. electronically supported work processes (Fig. 5), LED lighting of the work area and the positioning of the switches and handles, deliver a better work result in shorter time.

Despite their considerable capacity, battery powered machines and tools can reach their limits in track maintenance work where there is a requirement for very high outputs. ROBEL's answer to this is a new generation of considerably bigger battery powered machines.

### Even more output at lower machine weight

Up until now it has not been possible to operate powerful machines, such as the ones required for grinding, economically with a battery. Having developed a new, considerably more powerful battery pack, ROBEL is now in a position to provide all the power required on a work site without a combustion engine for the first time. The new battery is designed for the supply of all machines that are used for replacing a closure rail, for instance: cutting, trimming, grinding, tamping, wrenching. The company will showcase the first prototypes of its new battery concept at its In-House Exhibition in September 2019.

This much power can be heavy - depending on its output (2 to 13 kWh) the battery weighs between 20 and 100 kg. In order to maintain the benefits of the battery powered machines, i.e. lightweight design, easy handling, working comfort, ROBEL separates the new battery pack from the machine. The essential benefits of the system make up for the nuisance of the cable connection: up to 20 times longer operating times, high potential output and machines that are another approximately 6 kg (weight of the battery pack) lighter. Separating the power from the machine also brings the benefit that the machine can be operated alternatively with a hybrid drive unit or from the mains via an inverter: Just plug in and go.

The cells used in the battery pack are non-combustible, making them suitable for highly sensitive areas such as mines. In addition to safety and power, the service life is second to none: In over more than 3,000 charge cycles the new battery concept loses hardly any capacity, and retains 80% of its nominal capacity at 5,000 and more charge cycles. Based on an estimated 200 charge cycles per year, this adds up to a service life of at least 10 years for the new battery.

### How do you get the battery to the track?

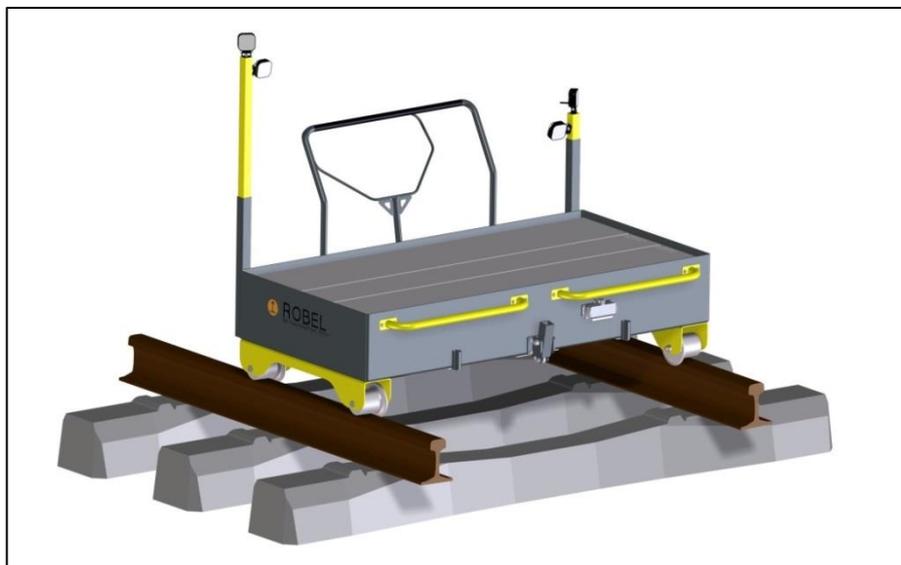
ROBEL has developed three solutions for the safe and ergonomic transport of the battery to the work site:

1. On the rail-road trolley (Fig. 6), the battery pack, which weighs about 50 kg, is built into a housing that is equipped with a rail guide in the centre and rollers on the rear for transport in the field. In addition, the trolley has a storage area for machines, tools, personal protective equipment and consumables.



**Fig. 6:** The rail-road trolley enables the transport of the battery and additional material on the rail and in the field.

- The track trolley (Fig. 7) fulfills all standard functions, on top of that it carries a cumulative power supply of up to 13 kWh: The battery pack weighs approx. 100 kg and is housed inside the trolley, well protected and compact.
- The portable battery pack with its approx. 20 kg is carried to the work site by the operator like a comfortable rucksack or a bag with a belt and then put down on the track for work.



**Fig. 7:** Track trolley with additional function: The high-performance battery is housed inside and thus well protected.

### Hybrid technology as an alternative to the battery

In addition to the development of the battery technology, ROBEL also drives forward the development of hybrid machines. Here, too, we are working on new drive solutions, always with the aim of improving ergonomics, making transport and operation easier as well as saving cost and time.

With the ROGRIND HF Head Rail Head Grinding Machine, a new generation of grinding machines went into production in 2018; its modular drive concept sets a new technological standard in hand-guided track construction machines. On the machine works a small, powerful BLDC motor. The second module is positioned at a



**Fig.8:** Portable solution: A separate Powerpack supplies the ROGRIND HF Head high-frequency grinding machine.

| Machine Type                 | Output                                  | Work/ Battery Charge                            | Comparison to conventional machine                    | Weight incl. battery  |
|------------------------------|---|---|---|-----------------------|
| <b>Rail Drilling Machine</b> | 1600 W                                  | 100 drillings at 14 mm<br>35 drillings at 32 mm | 20% less drill wear                                   | 21,8 kg               |
| <b>Rail Band Saw</b>         | 1600 W                                  | 20 cuts   | 25 cuts with 1 band<br>no flying sparks               | 60,6 kg               |
| <b>Impact Wrench</b>         | 1600 W adjustable<br>to 50 / 75 / 100 % | 500 tightening cycles                           | 1800 Nm torque, height and<br>angle adjustable handle | 18,3 kg               |
| <b>Vertical Tamper</b>       | 1600 W                                  | up to 40 mins of tamping<br>performance         | minimum hand-arm vibration                            | 24,9 kg               |
| <b>Rail Cutter</b>           | 6000W                                   | 50 cuts (at 13 kWh battery<br>pack)             | 75 sec. for cutting a S49 rail                        | Without battery: 18kg |

**Tab 1:** Performance overview of ROBEL battery powered machines

distance from the grinder, at the other end of the non-sparking connection cable: a portable unit consisting of a petrol engine, generator and super capacitors. (Fig. 8)

The patented hybrid power chain halves the weight of the grinding machine, protects the operator from emissions and noise and the combustion engine from abrasive dust. A cooling system developed by ROBEL adds to the improvement in working conditions: The air flow required for cooling the electric motor is dissipated via the grindstone and carries the abrasive dust and sparks down with it.

The electric motor of the ROGRIND HF Head reduces not only the weight of the machine but also vibrations to a minimum. Together with the logic-controlled cup wheel feed and a patented fine grinding program this ensures even grinding patterns, independent of the operator's experience, and a reduction in the number of abrasives used by approx. 30%. The grinder not only works more accurately, but also faster: Measurements in real operations have shown a gain of 5 minutes per grinding spot or 55% more abrasion in grams/minute compared to conventional grinding methods.

## Conclusion

The current debate in society about the impact of alternative drives in vehicles to achieve the climate protection targets is ever-present. The subject was taken up much earlier in the railway sector. ROBEL is a European pioneer when it comes to battery-powered hand-guided machines. The technical challenge for the company is to make track construction with new drive solutions not only cleaner and quieter but also generate added value. Relieving operators with ergonomic machine concepts and at the same time focusing on quality, safety and return on investment. With the battery powered family of machines and the new hybrid grinding machine, tried and tested models with alternative drive concepts are already in use. At its In-House Exhibition this September, ROBEL will showcase what the future of battery and hybrid drives will look like.

## The author:

Dipl.-Ing. Thomas Hölzlwimmer, Deputy Head of Development of Machinery & Tools, ROBEL Bahnbaumaschinen GmbH, Freilassing

[Thomas.hoelzwimmer@robел.com](mailto:Thomas.hoelzwimmer@robел.com)

## Image credits:

All images © ROBEL Bahnbaumaschinen GmbH