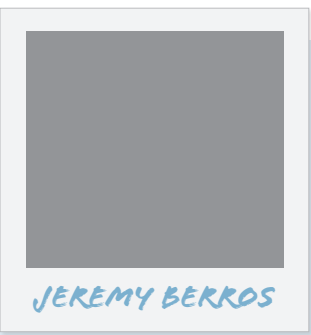




# BATTERY BREAKDOWN

UNDERSTANDING LITHIUM ION BATTERIES  
AND HOW THEY CAN IMPROVE BUSINESS



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## HISTORY OF RECHARGEABLE BATTERIES

The first use of rechargeable battery technology was about 30 years ago. At the time, rechargeable batteries had some disadvantages, such as weight, low power and low charging cycles. The memory effect mostly damaged the cells and led to a significantly shorter battery life. At the end of the '90s, the lithium ion technology became widespread, mainly in digital cameras and laptops. However, this was not an easy task for larger tools. The interconnection between cells required to form a powerful rechargeable battery was a challenge for manufacturers.

Lithium ion batteries require extremely precise cell management. In order for a lithium ion battery pack to work for a long time, its cells must be finely balanced. The

difference between the maximum voltage of the highest cell and the minimum voltage of the lowest cell from professional manufacturers must be less than 0.01 volts.

In 2004, these problems were solved with the "LiXion" pruning shears by Pellenc. That was the first tool in the world to be powered by a portable lithium ion battery. For landscapers, municipalities and construction, the technology was introduced for the first time in 2008. The solution gained momentum, especially from health-conscious users who no longer wanted to



inhale exhaust fumes from gas tools. This was particularly true for hedge trimmers due to the short distance between the exhaust and the face of the user.

## ADVANTAGES OF BATTERY TOOLS

Many gardeners who have been used to working with gas tools were initially skeptical about the battery solutions, with preconceived ideas on power, runtime or work in the rain. Users asked at that time about the main

reasons why they decided to buy rechargeable devices said it was "because of complaints from residents about the noise." The health factor plays a role, too. Often, users are no longer willing to breathe in the exhaust fumes from combustion engines 15 inches from their noses. Quieter, battery-powered tools also allow users to work earlier in the day than their gas counterparts. Today, all manufacturers present calculations on how economical accumulator devices are compared to 2-stroke—even those who have their core business with combustion engines.

In the professional sector, two basic systems have prevailed: one with an integrated battery in the tool and one with a separate battery on the back. Both have their justifications and advantages in different fields of application. Plug-in systems are designed for shorter operating times, less setup time and lower performance. Backpack systems are designed for long runtimes and intensive power-demanding work. But even within this backpack solution, there are major differences that can be difficult to recognize at first glance.

## THE BASICS OF THE LITHIUM ION BATTERY

**Lithium ion cell and batteries**  
The main advantage of lithium ion cells is that they can be charged without memory effect. There are countless lithium ion cells with different properties and major differences between the number of charge cycles and the power that a cell can deliver. A rechargeable battery consists of several cells—usually 18650—that are interconnected. Cells connected in series increase voltage, while cells connected in parallel create a higher current output.

**Operating voltage**  
The voltage of the battery is given in volts. The operating voltage is not the output power of the battery, which depends on the current that a battery can deliver. Higher voltages use less current flow, meaning they can deliver the same power with less heat generation. This is a benefit because heat takes energy. Even a cooling system takes energy storage, reducing the runtime of the tools.

**Capacity**  
This is specified in watt-hours (Wh). The higher

this value, the longer a tool can be used. As a rule of thumb, a hedge trimmer consumes 500 Wh to cut for one day. The indication of the capacity of the battery in ampere-hour (Ah) is less meaningful. It depends on the operating voltage of the battery.

**Maximum output power**  
For all tools with combustion engines, the power is specified in kilowatts (kW), previously in horsepower. In battery tools, this power specification is typically missing. There are a wide range of power outputs in rechargeable batteries, which also influences the power of the tools. The higher the value, the more powerful tools can be operated by one battery.

**Charge cycle**  
The number of charge cycles indicates how many times a battery can be fully charged before it has less than 80 percent of its original storage capacity. However, a charge does not necessarily correspond to a charging cycle. For example, if a battery is only charged up to 50 percent, this corresponds to only half a charge cycle. Only after a second charge of 50 percent, a full charge is reached and thus one cycle is consumed. Charging cycles for lithium ion batteries vary greatly. The standard lithium-magnesium batteries have about 500 charging cycles. There are professional manufacturers that specify "at least 1,300 charging cycles." A serious difference!

## USABLE ENERGY

The usable energy of a rechargeable battery is the amount that a lithium ion battery can provide over the course of its life. All charges are added together, and it is assumed that they are also fully used for work. This is calculated from two factors: the storage capacity of the battery and the number of charging cycles. For example, a battery with a storage capacity of 1,527 Wh and is specified with 1,300 charge cycles has a usable energy value of about 2,000,000 Wh.

**Economy of the battery**  
As already mentioned above, a battery hedge trimmer consumes approximately 500 Wh of energy in one day. Consequently, this means that a back battery with a capacity of 1,000 Wh can do this job with a full charge for two days. For the same task, a combustion engine would

certainly consume 0.8 gallon of fuel. With an average price per gallon of \$4, this gives \$8 of gas cost equivalent to 1,000 Wh. Considering 1,000 charging cycles, this would be the equivalent of \$8,000. If the same battery had only 500 charging cycles, this would correspond to a fuel savings of only \$4,000. The economy would be halved. Not to forget of course the electricity costs per charge. At about \$0.11/kWh on average and considering 1,000 charging cycles, this corresponds to approximately \$110 charging cost over the lifetime of the battery.

**Work in any weather conditions**  
The IP classification determines if a battery can be used in the rain, and manufacturers explain what tools work in the rain. The specification of the rechargeable battery does not automatically transfer to the tool.

**Charging infrastructure**  
Each charger requires a certain amount of power from the network. Plug-in battery systems are generally equipped with chargers that can supply the battery with a lot of energy in a short time. They pull a lot of current from the network. The situation is different with backpacks, where batteries slowly charge. Charging cabinets hold up to 10 batteries to allow time-controlled charge management.

## LOOKING TO THE FUTURE

The energy density of lithium ion cells will continue to increase, making batteries smaller and even more powerful. This will lead to a greater variety of tools that will, in turn, become more and more powerful. Newly developed charging concepts will allow batteries to be charged more efficiently, and diagnostic systems will help to better plan the service life of the tools.

With new regulations, bans from cities and battery solution democratization, the lithium ion battery is a technology that will mark the end of the 2-stroke for landscapers and cities for portable tools.

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