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TECHNOLOGY WATCH

How are batteries going to evolve while respecting sustainable development ?

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AGENDA

INTRODUCTION

- The discovery of electricity leading to the need and creation of batteries
- History of batteries

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- The problem of global warming
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- How are batteries going to evolve while respecting sustainable development ?
- The opening of our technology watch

INTRODUCTION

To begin with, I think it is important to remember where batteries come from, why they were created and by whom also why we chose this topic.

Natural phenomena, such as lightning, were already observed in ancient times, but for a very long time electricity terrified people who saw it as a manifestation of divine anger or supernatural power.

It was not until the end of the 16th century that scientists began to study electricity in order to understand its mechanisms and establish laws. Their successive works allowed the artificial creation of electricity by transforming various energy sources.

Many give credit to Benjamin Franklin who would have demonstrated electricity with his famous kite experiment. Even if it goes back to the 18th century, traces of ancient batteries have been found by excavating Egyptian ruins with the "Baghdad Battery".

Today, this electricity is produced by power plants, transported and distributed to consumers. Like fire in prehistoric times, electricity has changed the life of humanity. It has become essential to everything that makes up our daily lives: food, heating, lighting, washing, health care, communication, transportation, manufacturing...

A little history

Already 2600 years ago, Thales (625-547 BC), the Greek philosopher, knew how to attract strands of straw with a piece of yellow amber rubbed on wool. It is the electrostatic properties of this fossilized resin (amber is said in Greek "elektron") that gave birth to the word electricity.

It took a long time for scientists to unravel the mysteries of this phenomenon. For more than 20 centuries, men have only noted the existence of magnets, lightning and static electricity without knowing how to use this energy.

As early as 1600, sparks could be produced by cranking the handle of a curious device: the Ramsden machine.

Luigi Galvani, born on September 9, 1737 (1737-1798), was a professor of anatomy at the University of Bologna, Italy, who tested the effects of the small discharges provided by Ramsden's machine on the cadaver of frogs. Galvani concluded that animal electricity existed when he discovered that the muscles of amphibians twitched on contact with the shocks.

In 1800, Count Alessandro Volta (1745-1827), an Italian physicist, took a close interest in Galvani's experiments. Volta believed that the contact of two different metals produced electricity. To prove this, he made machines composed of plates of various metals...

Thus, he piled up more than 60 copper and zinc discs between which he inserted felt soaked in salt water. He attached wire to the ends of his pile and succeeded in making a spark by bringing the two ends together. The word "battery" comes from this stacking!

This battery produced electricity without the need to turn a crank. This principle is still the same as our current batteries: two different metals (the electrodes), and a conductive liquid: the electrolyte.

In 1802, Dr. William Cruickshank, from Great Britain, designed the first mass-produced electric battery. Much simpler to manufacture than the Volta battery, it worked with copper and zinc plates placed in a diluted acid solution. The whole thing was placed in a sealed box. This battery was not rechargeable.

In 1859, the French physicist Gaston Planté invented the first rechargeable lead battery, according to a principle that is still used today.

In 1868, the Frenchman Georges Leclanché (1839-1882) created the first so-called "dry" battery: the electrolyte was gelled, which made it more manageable. The Leclanché battery is maintenance free. As the advertisement says: "It only wears out if you use it". In its modern form it is still the most used battery. It is the origin of the zinc-manganese dioxide salt battery.

In 1899, Waldmar Jungner, a Swede, invented the nickel-cadmium battery.

Almost 50 years later, Neumann succeeded in completely sealing the battery, which led to the modern sealed nickel-cadmium battery.

In 1959, the American Lewis Urry designed the first consumer alkaline battery. Its performance was far superior to that of salt batteries.

In 1970, the first lithium batteries, which replaced zinc with a more reducing metal, were developed. At the same time, nickel-cadmium and nickel-metal hydride batteries were developed for space technology and massively distributed on the market from 1992.

Today, research is still very active, particularly with the aim of increasing the capacity or power of batteries.

New electrochemical couples are regularly tested such as sodium-lithium or plastic-lithium. New ways of using them are also studied: miniaturization to the extreme, solar

recharge included, flexible batteries, sugar-based, biodegradable or even unmanageable ...

All this is very nice, however a problem arises: the ecology, that’s why we chose this topic. Its because batteries are essential and many things could not work without them, that's why it is important to find a way to continue to use them without polluting, because indeed the materials used are very polluting and for many reasons such as the extraction of ores, their manufacture and also the fact that we can not recycle them.

DEVELOPMENT

I- Different types of batteries

There are several types of batteries. The most common batteries are lead-acid (open lead, AGM and Gel) and lithium-ion. Lead-acid batteries are the oldest and most common. They are used in cars, motorcycles and boats. Lithium-ion batteries are lighter and have a longer life than lead-acid batteries. They are used in cell phones, laptops and electric cars. There are also other types of batteries such as nickel-cadmium (NiCd), nickel-metal-hydride (NiMH), lithium-polymer (LiPo) and lithium-iron-phosphate (LiFePO4).

Quels sont les différents types de batteries solaires ? - Libow
19 différents types de Batteries (classification détaillée des batteries) | Be Able (agencebeable2.com)

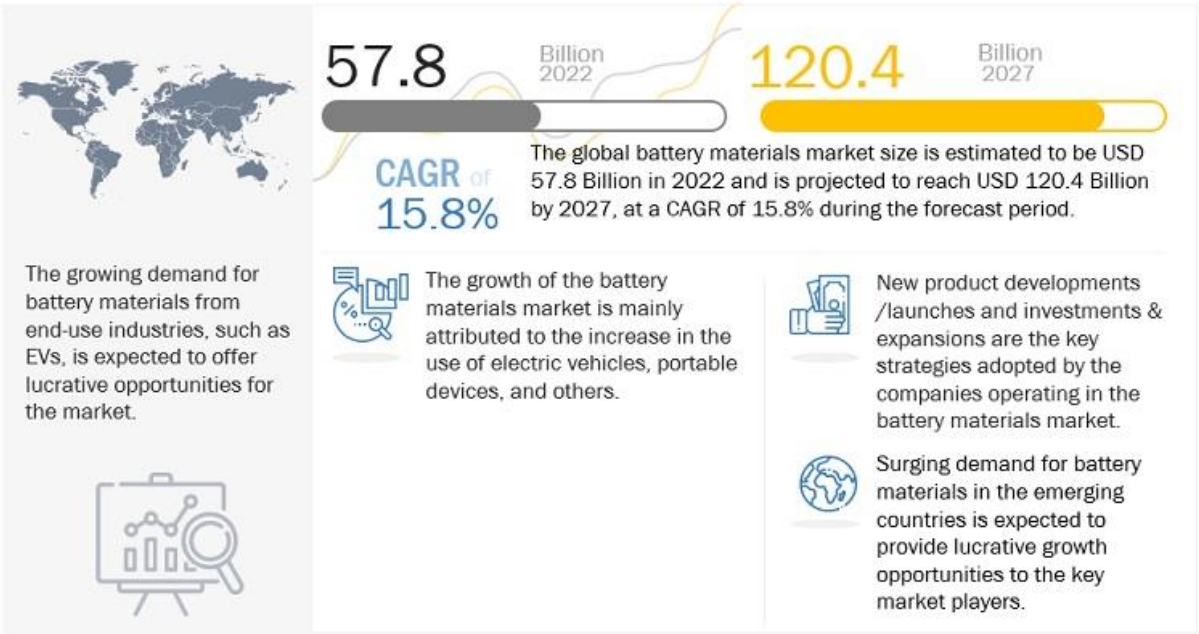
II- The increasing use of batteries in daily life and growing demand (electric cars)

When batteries were invented, they were not often used due to a lack of research and development in the field of electrical components. In fact, they were used for scientific experiments or demonstration purposes, to move objects, to turn cranks, etc. The first great invention which used a means of storing electricity was invented in 1840, it is the electric telegraph (field of communication) that allows a more reliable communication over longer distances.

From that point, innovations followed at great speed. In the decades that followed, were invented: the electric clock (invented by Alexander Bain in 1840), the battery-powered electric motor (invented by Thomas Davenport in 1834), the microphone (invented by David Edward Hughes in 1876), the phonograph (invented by Thomas Edison in 1877), the electric motor boat (invented by Gustave in 1881), the electric fan (invented by Schuyler Skaats Wheeler in 1882), etc.

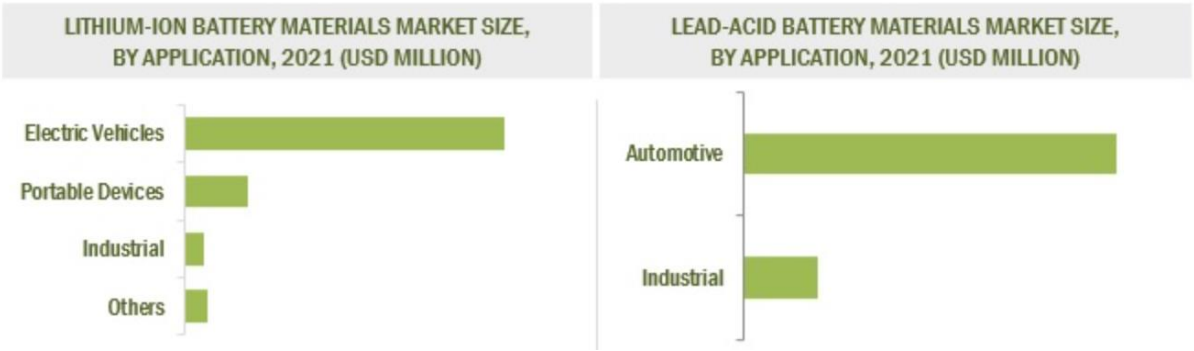
This increase in the use of batteries continues, as batteries have become ubiquitous in our daily lives, powering everything from smartphones, electric cars, to household appliances and energy storage facilities. Indeed, according to a report published by Fortune Business Insights, the global battery market will reach USD 57.8 billion in 2022 and is expected to double to reach USD 120.4 billion by 2027. This

corresponds to an annual increase of 15.8% which is considerable and will continue since this future increase was estimated at 7.9% in 2020.



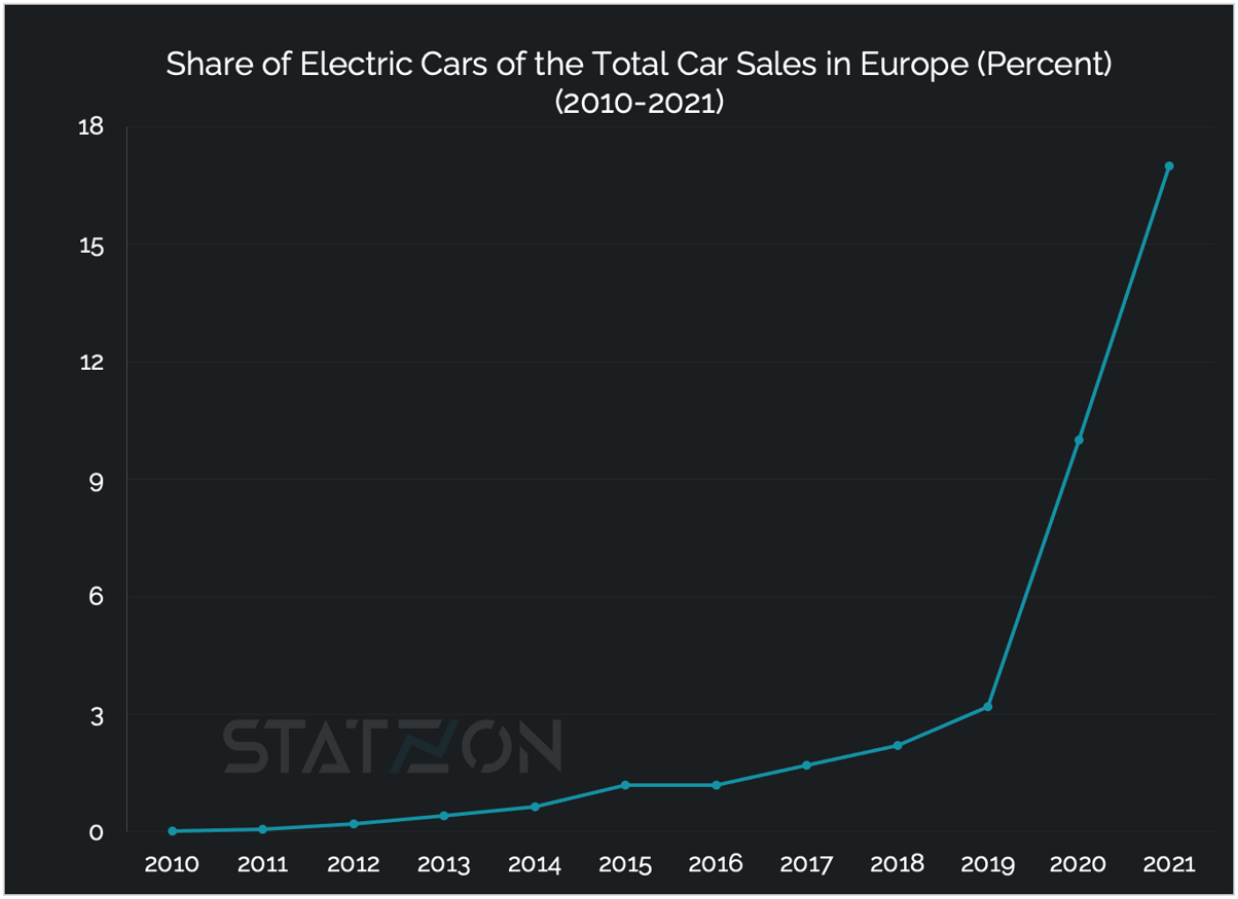
([Global Battery Materials Market Size & Forecast [Latest]])

Current investments in this sector also show a significant fact: electric cars, although a minority and still in development today, account for 48% of the world's battery needs. In Asia, these numbers are much more worrying, reaching 80% as we can see in this graph below.



([Global Battery Materials Market Size & Forecast [Latest]])

So we can conclude that electric cars will become the main players pushing limits, needs and battery production in the coming decades. In addition, according to a report by BloombergNEF, EEA Global EV Outlook 2022 registered 6.6M of electric cars sold in 2021, a huge number since it represents the double of the previous year, knowing that there are only 16.5M of electric cars currently in circulation.



(https://statzon.com/)

With such demand, the amount of lithium used in batteries increased from 5,160 tonnes in 2007 to over 100,000 tonnes in 2022. This inevitably leads to problems in the production and extraction of rare metals such as cobalt, lithium and nickel, which are needed to produce batteries, and this also contributes to the pollution (toxic waste) caused by batteries. In addition to the environmental aspect, the increasing use of batteries can also lead to social tensions caused by over-exploitation and increasingly scarce materials. For example, lithium mining in the Atacama Desert in Chile has led to conflicts between indigenous peoples and mining companies, which have polluted rivers and agricultural lands in the region.

In addition to all these problems is the limited battery life. Batteries, especially lithium-ion batteries, need to be replaced regularly. The toxic waste they generate has become a major problem, especially with the increase in their use. According to a report by the Union of Concerned Scientists, the production of batteries to power an electric car generates about 15 tonnes of carbon dioxide, mainly due to the extraction and processing of the required materials. Moreover, progress in battery recycling is only in its infancy, as the majority of lithium-ion batteries currently in use are not recycled and therefore the precious metals and components are lost.

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The Rise of Energy Storage: How Batteries Will Revolutionize the Grid
https://www.energymonitor.ai/tech/energy-storage/why-we-need-to-build-batteries-better/

III - The problem of global warming

This growing need for batteries will cause significant environmental problems, particularly in the context of global warming. Indeed, the production of batteries generates greenhouse gas emissions at several stages of the process, from the extraction of raw materials to manufacturing and transport. According to a report by the Carbon Tracker Initiative, battery production could become a major source of carbon emissions by 2030, accounting for up to 17% of the automotive industry's emissions. We must therefore find alternatives, innovate and even change the way the energy industry operates in order to avoid future disasters (material shortages, environmental degradation, social and economic crises, pollution, etc.).

The battery value chain continues to face numerous environmental, social, and governance challenges.

McKinsey & Company

([Battery 2030: Resilient, sustainable, and circular](#)**)**

To limit the negative impact of batteries, the government, the private sector and the population must act together. As consumers, we need to adopt greener habits and technologies by reducing our consumption of electrical appliances. If not possible, we need to repair and recycle the technologies that we use. As private sectors, there must be room for innovation and green solutions for the whole production chain. And the government needs to adapt and rethink its objectives by putting in place laws that promote the ecological transition.

On the side of the industry, we can mention the program to adopt a circular value chain in which used materials are repaired, reused or recycled. Progress has already been made there. Indeed, the number of recycled batteries is increasing by 20% each year. Other companies are innovating to design batteries that are manufactured on a large scale and are 100% recyclable. We know that this is possible because North Volt has already managed to recycle 100% of an electric car battery.

Research into more sustainable and environmentally friendly alternatives is therefore essential to mitigate the environmental impacts of the increasing use of batteries. These include 100% recyclable redox flow batteries, which use non-toxic organic electrolytes and abundant metals such as iron or vanadium. Other alternatives under development are intended to be more ambitious. This is the case of the company Stora Enso, which offers a new type of battery made from a wood-based

material. Or a group of researchers from the University of Bristol who managed to create a lithium-free battery using natural algae.

The most urgent solution is therefore to replace lithium-ion and all other rare and polluting materials in current batteries. Although progress has shown that this problem is far from insurmountable, achieving a greener battery in the laboratory is much easier than developing and manufacturing it on a larger scale to replace all of the mondial production. Faced with the urgency of the situation, various batteries using a multitude of equally varied materials were created. Some choose wood, bio-algae, seawater or hemp that are 100% natural, others have opted for more feasible alternatives such as sodium, iron or silicon that have chemical properties close to lithium.

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IV - New technologies for batteries

Batteries are essential elements for the storage and conversion of electrical energy. They are used in many areas, such as electric vehicles, electronic devices or smart grids. However, they also have limitations, particularly in terms of durability, safety and performance. To address this, researchers around the world are working on innovations to improve the properties of batteries.

These innovations include more heat-resistant batteries. Current rechargeable lithium-ion cells and batteries tend to degrade and lose capacity when exposed to high temperatures. To avoid this problem, researchers have developed cells and batteries that can heat up to 60°C and then cool down again without damage. These cells and batteries also allow electric vehicles to be recharged more quickly in just 10 minutes.

Another innovation concerns automotive batteries with a range of 800 to 1000 km. This is an ambitious goal that aims to make electric vehicles more attractive and competitive with thermal vehicles. To achieve this, the energy density of batteries must be increased, i.e. the amount of energy they can store per unit of mass or volume. One possible solution is to use solid-state batteries, which replace the liquid electrolyte with a more stable, higher-performance solid material. These batteries are also safer and more durable than lithium-ion batteries.

Finally, a promising innovation is a revolutionary battery in 2024 that will be able to recharge 60 times faster than the lithium-ion units currently in use and will be less expensive. It is a battery based on graphene, a material consisting of an atomic layer of carbon with exceptional properties. Graphene increases the electrical and thermal conductivity of batteries, as well as their storage capacity. A graphene battery could thus offer a range of 1000 km and a charge from 0 to 80% in only 8 minutes. Moreover, it would be more ecological and economical than current batteries.

These innovations show that cells and batteries are evolving rapidly and that they offer interesting prospects for sustainable development and the energy transition.

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CONCLUSION

Today, batteries play a primary role in everyday life. They power our cell phones, electric cars, entire houses and even the appliances that serve our vital needs. However, their production can have harmful effects on the environment due to the various materials used and the amount of energy required to manufacture them. To address these environmental concerns, batteries will evolve in the future by adopting more sustainable and environmentally friendly technologies.

Batteries with more sustainable materials: Current batteries use materials such as lithium, cobalt and nickel which are expensive and have a significant and aggravating environmental impact. The batteries of the future will use more sustainable and abundant materials such as sodium, magnesium or zinc. All of which do not significantly impact the environment.

Reusable batteries at will: Manufacturers are currently working on batteries that can be easily disassembled and recycled or reused. This will reduce the amount of electronic waste and recover valuable materials for future use.

Batteries for storing renewable energy: Batteries will play an increasingly important role in storing renewable energy, such as solar, wind or other renewable sources. This will help to avoid the use of fossil fuels as much as possible.

Batteries with superior storage: The batteries of the future will be more efficient and able to store more energy. This will reduce the number of batteries needed to power electronic devices and thus extend their lifespan.

In conclusion, batteries will evolve in the future to become more sustainable and environmentally friendly, with technologies such as recycling, the use of sustainable materials and the storage of renewable energy are all trends that will develop in the years to respond to environmental concerns which in our time are, to say the least, frightening and totally disordered.