Lithium Royalty Corp

Third Quarter 2019 Letter to Investors

Dear LRC Investor,

Last month the Royal Swedish Academy of Sciences awarded the 2019 Nobel Prize in Chemistry to John B. Goodenough, M. Stanley Wittingham and Akira Yoshino for their contributions to the development of the lithium-ion battery. In their release they stated *"the rechargeable battery laid the foundation of wireless electronics such as mobile phones and laptops. It also makes a fossil fuel-free world possible, as it is used for everything from powering electric cars to storing energy from renewable resources."* The full release is enclosed at the end of this letter.

During the third quarter of 2019 we negotiated terms for our fifth royalty acquisition on a hard rock lithium project in North America. We expect to enter into a formal Letter of Intent before the end of November and close the investment within the next three months subject to successful due diligence. Consistent with prior royalties, this project is high grade, low capex and has a relatively short timeline for development as it is very near final approvals and permits. Expected returns are equal to or greater than current royalty investments in the portfolio.

Looking back over the past year the primary components of LRC's investment thesis remain intact:

1. Electrification of Transportation is happening
2. Lithium is a key element in current and future battery chemistries and,
3. The supply response will be less than expected, take longer and cost more

While we remain highly convicted on points 1 and 2, they remain future expectations, whereas for the third proposition we now have actual evidence. Difficulties ramping new supply, whether greenfield projects (Mt. Cattlin and Olaroz) or expansion of existing projects (La Negra and SQM's Atacama) has been a well-established trend and continues with subsequent new project ramps (Tawana, Altura, Nemaska, Pilbara, Mineral Resources).

Chilean lithium producer, SQM, 16% of world lithium production reported 47,000 tonnes of estimated 2019 year end production as compared to their prior target of 65,000 tonnes.

The nascency of the sector is limiting capital availability and technical experience is scarce, both of which are negatively influencing new supply ramps which is generally to be expected in extractive resources. What we did not expect which is currently exaggerating the inadequate supply ramp is a sharp reversal in sentiment for Lithium stocks caused by China's economic slowdown and relative importance in the global auto and electric vehicle sector. The net impact has been weakening spot Lithium prices ($17,000 to $9,000) further curtailing capital availability and delaying new projects. Interesting to note is that during this period of spot price decline contract Lithium prices have been tremendously resilient ($13,000 to $11,000). Nonetheless, Abermarle, among the top three Lithium producers globally and approximately 20% of global supply has seen its share price halved while earnings, mostly based on contract Lithium prices have remained unchanged. As you might have guessed while China is currently 50% of the global consumption of Lithium (for EV batteries) they are predominantly spot price oriented and Abermarle does not sell to China in any meaningful volume. Unfortunately new producers without a history of product qualification and production reliability have been left to sell into China and experience the inferior economics of spot pricing.

LRC, along with Goldman Sachs (10.22.2019), Roskill and Benchmark Intelligence are expecting the current market to be a bottom for spot pricing as China inflects back to EV growth in 2020, China's relative importance diminishes as Korea, Europe and the United States (California) grow EV volumes (Goldman Sachs expects sustained 15% - 20% annual demand growth), new conversion plants (chemical refineries used to convert raw concentrate into Lithium chemicals) come on-line in 2020 and delays in new supply continue due to limited funding sources and/or high cost of capital.

Benchmark Minerals recently published "Lithium Price Paradox" where it states lower prices have led to a decline in new supply growth while at the same time the EV Revolution accelerates leading to a future scenario where supply will not meet tomorrow's EV demand.

While temporary periods of under and over-supply are to be expected in nascent industries – the disproportionate influence of China here and the global disruption of trade have conspired to exaggerate current conditions which will likely lead to repeated occurrences of dramatic spot price declines and price spikes until the market normalizes. The price declines are now to the point where the cost of marginal supply is at or above current prices. This is the basis for the bottoming thesis being shared by industry participants. While everyone has been transfixed on price, two other changes have occurred setting up for an even sharper snap back:

1. Battery sizes have increased materially beyond expectations, and in turn Lithium content per battery, as extended or greater than 500km range has been emphasized and,

2. New projects are coming on-line at greater than expected operating costs per unit, thus steepening the global cost curve.

> **China Inflecting Back to EV Growth in 2020**
> In addition to a general economic slowdown caused by a trade war with the United States, China also continues to revise down New Energy Vehicle (NEV) subsidies for both consumers and manufacturers. Smaller manufacturers and lower range vehicles are no longer eligible for subsidies causing total sales volumes to decline as the industry adapts to the changes. At the start of 2019 the expectation was for 1.5 to 1.6 million NEVs but was then revised down to 1.3 million NEVs, or flat volumes year-over-year. Recently the government revealed new 2019 NEV targets (which typically lines up very close to actuals) of 1.4 million NEVs, which is +12% year-over-year. LRC president, Ernie Ortiz , was recently on a research trip to China and Korea and learned that China's 2020 NEV target is rumored to remain 2.0 million units, +43% from 2019. China recently released their 2021 – 2035 NEV Plan which sets out policy goals of 20% EVs by 2025 (5 – 6 million NEVs per year) and 40% by 2030 (over 10 million NEVs per year).

The sentiment reversal in public equities is not shared by corporates who continue to see the forest through the trees and remain active in the sector.

- Hyundai Motor and Delphi auto parts spin-out Aptiv announce a $4 billion joint venture to pursue Autonomous Vehicles, with Hyundai and Kia investing $1.6 billion in cash.
- VW seeks to expand on its €1 billion investment into battery manufacturing citing risk that third party supply will be inadequate to meet their demands by 2023.
- Amazon vows to go carbon neutral and orders 100,000 electric delivery trucks from Michigan based electric vehicle company Rivian after investing $440 million into the company.
- Continental, Europe's largest auto parts company, flicks switch to electric vehicle focus.
- Daimler chief development officer commented that they will no longer work on the development of new combustion engines.
- SK Innovation, major Korean conglomerate, to divest two Peruvian gas fields for $1 billion in order to support investments in the electric vehicle battery space. SK Innovation currently supplies VW batteries.
- CATL increases its investment in Germany to €1.8 billion in what is expected to be 100 GWH of battery capacity in Erfurt, Germany.
- CATL invests A$61.8 million into lithium-spodumene producer Pilbara Minerals in order to improve its mineral security.
- ShanShan, major Chinese cathode producer, invests A$22.4 million into lithium-spodumene producer Altura Mining and is now its top shareholder with a stake just under 20%.
- Wesfarmers, A$46 billion market cap Australian chemical conglomerate, completes its acquisition of lithium developer Kidman Resources for A$776 million.
- Ganfeng closes its $160 million investment into Lithium America's Cauchari-Olaroz lithium brine project.
- Albemarle pays $820 million in cash for a 60% JV interest in Wodgina and provides for a 40% interest in its converting plants in Kemerton in a total transaction value of $1.3 billion.
- Rio Tinto, long rumored to be looking for an entry into the Lithium sector, announces a test pilot project in the United States to extract Lithium from Boron tailings

While the transition to EVs may not be observable as yet on the roads or in your public equity holdings – it is unfortunately painfully evident to the Auto OEMs. In addition to being globally levered to the overall slowdown in China which is 28% of the global auto market and has been 80% of global auto year-over-year growth, global auto manufacturers difficulties are being exacerbated by the rapid and costly shift towards electric vehicles and the introduction of tough emission requirements in Europe and China. Part suppliers are also being impacted. Continental AG, one of the world's top auto parts suppliers, announced a $2.8 billion write down and a spinoff of their traditional power train business as part of a companywide re-organization and pivot towards Electric Vehicles.

Tesla reports record unit volumes in Q3, announced their Shanghai plant is operational in only 10 months from first shovel and planning to break ground on a European Giga-Factory in 2020.

While market enthusiasm for battery materials has subsided, we continue to remain highly convicted and perhaps will look back at this period and wish we were more aggressive and less conservative in our underwriting assumptions. According to a recent report by Bloomberg, Electric vehicles within the next decade will match or exceed the performance of gasoline-fueled vehicles on almost every metric. By 2040, Bloomberg predicts that six out of every 10 vehicles sold globally will be electric.

When we first set out in mid-2018 to capitalize on the Electrification of Transportation investment opportunity, we thought we would have a short window of twelve months to execute, after which lower cost capital would arrive and reduce the available investment opportunities which meet our expected returns. The current conditions have combined to extend our investment window by another twelve months at which time we expect demand will outstrip supply leading to higher prices and a balance or undersupplied market.

Regards,

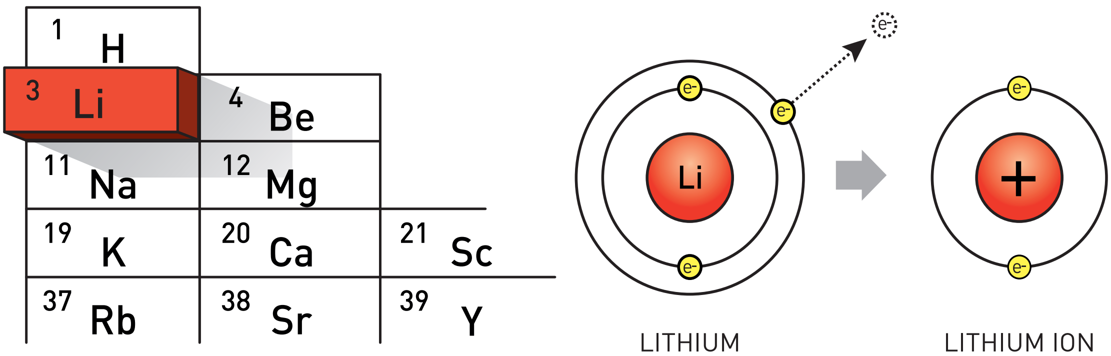
Lithium Royalty Corp

They developed the world's most powerful battery

The Nobel Prize in Chemistry 2019 is awarded to John B. Goodenough, M. Stanley Whittingham and Akira Yoshino for their contributions to the development of the lithium-ion battery. This rechargeable battery laid the foundation of wireless electronics such as mobile phones and laptops. It also makes a fossil fuel-free world possible, as it is used for everything from powering electric cars to storing energy from renewable sources.

An element rarely gets to play a central role in a drama, but the story of 2019's Nobel Prize in Chemistry has a clear protagonist: lithium, an ancient element that was created during the first minutes of the Big Bang. Humankind became aware of it in 1817, when Swedish chemists Johan August Arfwedson and Jöns Jacob Berzelius purified it out of a mineral sample from Utö Mine, in the Stockholm archipelago.

Berzelius named the new element after the Greek word for stone, lithos. Despite its heavy name, it is the lightest solid element, which is why we hardly notice the mobile phones we now carry around.



Lithium is a metal. It has just one electron in its outer electron shell, and this has a strong drive to leave lithium for another atom. When this happens, a positively charged – and more stable – lithium ion is formed.

To be completely correct – the Swedish chemists did not actually find pure metallic lithium, but lithium ions in the form of a salt. Pure lithium has set off many fire alarms, not least in the story we will tell here; it is an unstable element that must be stored in oil so it does not react with air.

Lithium's weakness – its reactivity – is also its strength. In the early 1970s, **Stanley Whittingham** used lithium's enormous drive to release its outer electron when he developed the first functional lithium battery. In 1980, **John Goodenough** doubled the battery's potential, creating the right conditions for a vastly more powerful and useful battery. In 1985, **Akira Yoshino** succeeded in eliminating pure lithium from the battery, instead basing it wholly on lithium ions, which are safer than pure lithium. This made the battery workable in practice. Lithium-ion batteries have brought the greatest benefit to humankind, as they have enabled the development of laptop computers, mobile phones, electric vehicles and the storage of energy generated by solar and wind power.

We will now step fifty years back in time, to the beginning of the lithium-ion battery's highly charged story.

Petrol haze revitalises battery research

In the mid-20th century, the number of petrol-driven cars in the world increased significantly, and their exhaust fumes worsened the harmful smog found in big cities. This, combined with the growing realisation that oil is a finite resource, sounded an alarm for both vehicle manufacturers and oil companies. They needed to invest in electric vehicles and alternative sources of energy if their businesses were to survive.

Electric vehicles and alternative sources of energy both require powerful batteries that can store large amounts of energy. There were really only two types of rechargeable batteries on the market at this time: the heavy lead battery that had been in invented back in 1859 (and which is still used as a starter battery in petrol-driven cars) and the nickel-cadmium battery that was developed in the first half of the 20th century.

Oil companies invest in new technology

The threat of oil running out resulted in an oil giant, Exxon, deciding to diversify its activities. In a major investment in basic research they recruited some of that time's foremost researchers in the field of energy, giving them the freedom to do pretty much what they wanted as long as it did not involve petroleum.

Stanley Whittingham was among those who moved to Exxon in 1972. He came from Stanford University, where his research had included solid materials with atom-sized spaces in which charged ions can attach. This phenomenon is called intercalation. The materials' properties change when ions are caught inside them. At Exxon, Stanley Whittingham and his colleagues started to investigate superconducting materials, including tantalum disulphide, which can intercalate ions. They added ions to tantalum disulphide and studied how its conductivity was affected.

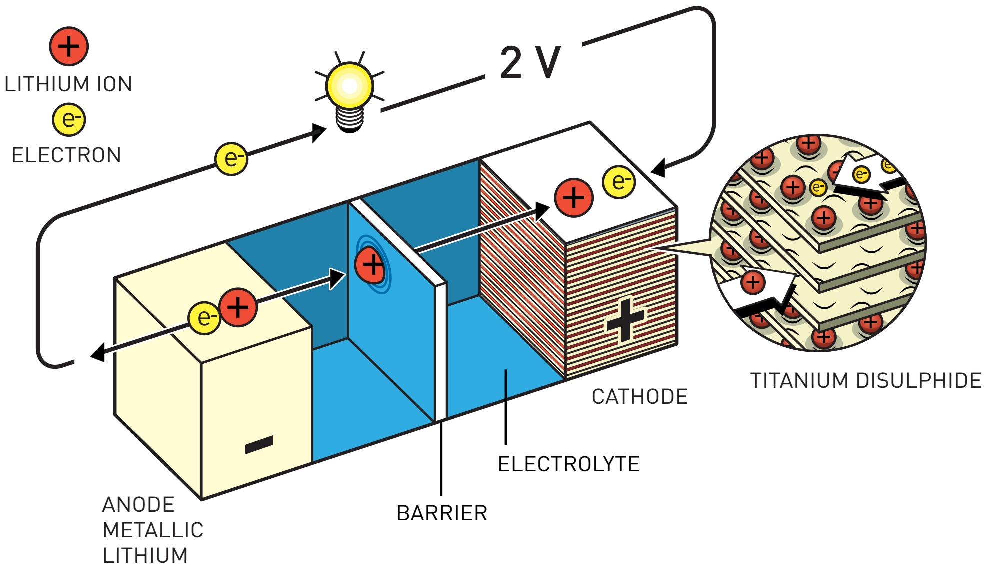
Whittingham discovers an extremely energy-dense material

As is so often the case in science, this experiment led to an unexpected and valuable discovery. It turned out that potassium ions affected the conductivity of tantalum disulphide, and when Stanley Whittingham started to study the material in detail he observed that it had a very high energy density. The interactions that arose between the potassium ions and the tantalum disulphide were surprisingly energy rich and, when he measured the material's voltage, it was a couple of volts. This was better than many of that time's batteries. Stanley Whittingham quickly realised that it was time to change track, moving to the development of new technology that could store energy for the electric vehicles of the future. However, tantalum is one of the heavier elements and the market did not need to be laden with more heavy batteries – so he replaced tantalum with titanium, an element which has similar properties but is much lighter.

Lithium in the negative electrode

Isn't lithium supposed to have pride of place in this story? Well, this is where lithium enters the narrative – as the negative electrode on Stanley Whittingham's innovative battery. Lithium was not a random choice; in a battery, electrons should flow from the negative electrode – the anode – to the positive one – the cathode. Therefore, the anode should contain a material that easily gives up its electrons and, of all the elements, lithium is the one that most willingly releases electrons.

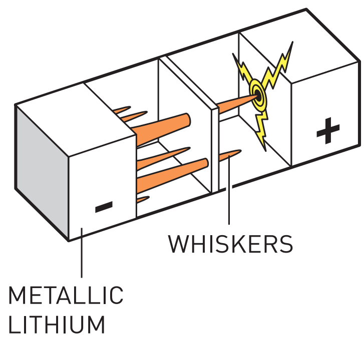
The result was a rechargeable lithium battery that worked at room temperature and – literally – had great potential. Stanley Whittingham travelled to Exxon's headquarters in New York to talk about the project. The meeting lasted about fifteen minutes, with the management group subsequently making a rapid decision: they would develop a commercially viable battery using Whittingham's discovery.



The first rechargeable batteries had solid materials in the electrodes, which broke down when they reacted chemically with the electrolyte. This destroyed the batteries. The advantage of Whittingham's lithium battery was that lithium ions were stored in spaces in the titanium disulphide in the cathode. When the battery was used, lithium ions flowed from the lithium in the anode to the titanium disulphide in the cathode. When the battery was charged, the lithium ions flowed back again.

The battery explodes and the oil price falls

Unfortunately, the group that was to start producing the battery suffered some setbacks. As the new lithium battery was repeatedly charged, thin whiskers of lithium grew from the lithium electrode. When they reached the other electrode, the battery short-circuited which could lead to an explosion. The fire brigade had to put out a number of fires and finally threatened to make the laboratory pay for the special chemicals used to extinguish lithium fires.



Whiskers of lithium form when a battery with pure lithium in the anode is charged. These can short-circuit the battery and cause fires and even explosions.

To make the battery safer, aluminium was added to the metallic lithium electrode and the electrolyte between the electrodes was changed. Stanley Whittingham announced his discovery in 1976 and the battery began to be produced on a small scale for a Swiss clockmaker that wanted to use it in solar-powered timepieces.

The next objective was to scale up the rechargeable lithium battery so it could power a car. However, the price of oil fell dramatically in the early 1980s and Exxon needed to make cutbacks. The development work was discontinued and Whittingham's battery technology was licenced to three different companies in three different parts of the world.

However, this did not mean that development stopped. When Exxon gave up, John Goodenough took over.

The oil crisis makes Goodenough interested in batteries

As a child, John Goodenough had significant problems learning to read, which was one reason why he was drawn to mathematics and eventually – after World War Two – also physics. He worked for many years at the Lincoln Laboratory at the Massachusetts Institute of Technology, MIT. While there, he contributed to the development of random access memory (RAM) which is still a fundamental component of computing.

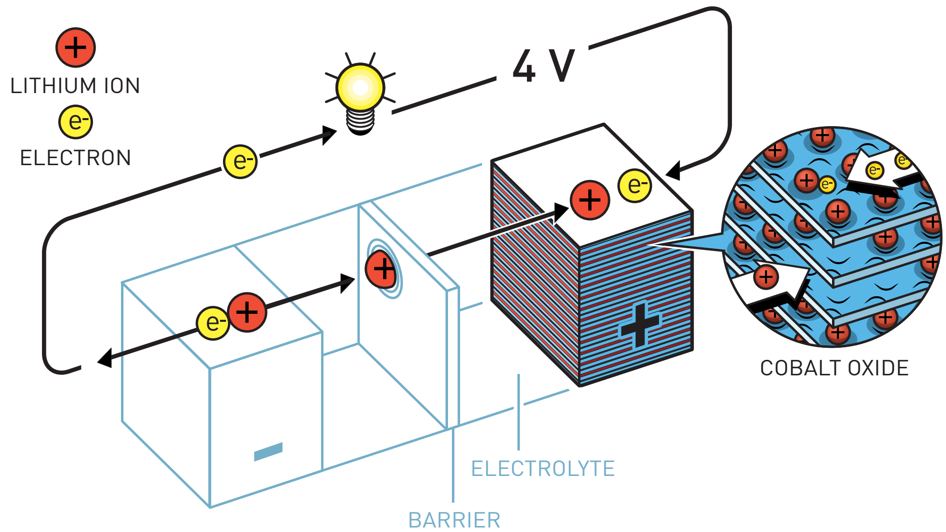
John Goodenough, like so many other people in the 1970s, was affected by the oil crisis and wanted to contribute to the development of alternative sources of energy. However, the Lincoln Laboratory was funded by the US Air Force and did not permit all kinds of research, so when he was offered a position as professor of inorganic chemistry at Oxford University in Great Britain, he took the chance and entered the important world of energy research.

High voltages when lithium ions hide in cobalt oxide

John Goodenough knew about Whittingham's revolutionary battery, but his specialised knowledge of matter's interior told him that its cathode could have a higher potential if it was built using a metal oxide instead of a metal sulphide. A few people in his research group were then tasked with finding a metal oxide that produced a high voltage when it intercalated lithium ions, but which did not collapse when the ions were removed.

This systematic search was more successful than John Goodenough had dared to hope. Whittingham's battery generated more than two volts, but Goodenough discovered that the battery with lithium-cobalt oxide in the cathode was almost twice as powerful, at four volts.

One key to this success was John Goodenough's realisation that batteries did not have to be manufactured in their charged state, as had been done previously. Instead, they could be charged afterwards. In 1980, he published the discovery of this new, energy-dense cathode material which, despite its low weight, resulted in powerful, high-capacity batteries. This was a decisive step towards the wireless revolution.



Goodenough started to use cobalt oxide in the lithium battery's cathode. This almost doubled the battery's potential and made it much more powerful.

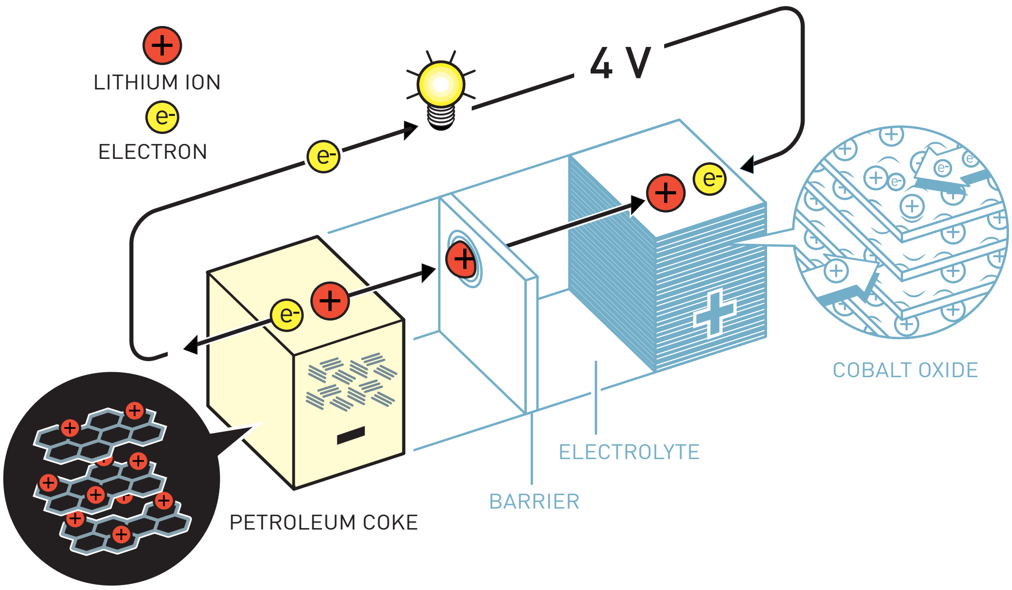
Japanese companies want lightweight batteries for new electronics

However, in the West, as oil became cheaper, interest paled in investments in alternative energy technology and the development of electric vehicles. Things were different in Japan; electronics companies were desperate for lightweight, rechargeable batteries that could power innovative electronics, such as video cameras, cordless telephones and computers. One person who saw this need was Akira Yoshino from the Asahi Kasei Corporation. Or as he put it: "I just sort of sniffed out the direction that trends were moving. You could say I had a good sense of smell."

Yoshino builds the first commercially viable lithium-ion battery

When Akira Yoshino decided to develop a functional rechargeable battery, he had Goodenough's lithium-cobalt oxide as the cathode and tried using various carbon-based materials as the anode. Researchers had previously shown that lithium ions could be intercalated in the molecular layers in graphite, but the graphite was broken down by the battery's electrolyte. Akira Yoshino's eureka moment came when he instead tried using petroleum coke, a by-product of the oil industry. When he charged the petroleum coke with electrons, the lithium ions were drawn into the material. Then, when he turned on the battery, the electrons and lithium ions flowed towards the cobalt oxide in the cathode, which has a much higher potential.

The battery developed by Akira Yoshino is stable, lightweight, has a high capacity and produces a remarkable four volts. The greatest advantage of the lithium-ion battery is that the ions are intercalated in the electrodes. Most other batteries are based on chemical reactions in which the electrodes are slowly but surely changed. When a lithium-ion battery is charged or used, the ions flow between the electrodes without reacting with their surroundings. This means the battery has a long life and can be charged hundreds of times before its performance deteriorates.



Akira Yoshino developed the first commercially viable lithium-ion battery. He used Goodenough's lithium-cobalt oxide in the cathode and in the anode he used a carbon material, petroleum coke, which can also intercalate lithium ions. The battery's functionality is not based upon any damaging chemical reactions. Instead, the lithium ions flow back and forth between the electrodes, which gives the battery a long life.

Another big advantage is that the battery has no pure lithium. In 1986, when Akira Yoshino was testing the battery's safety, he exercised caution and used a facility designed for testing explosive devices. He dropped a large piece of iron on the battery, but nothing happened. However, on repeating the experiment with a battery that contained pure lithium, there was a violent explosion.

Passing safety testing was fundamental to the future of the battery. Akira Yoshino says that this was "the moment when the lithium-ion battery was born".

The lithium-ion battery – necessary for a fossil fuel-free society

In 1991, a major Japanese electronics company started selling the first lithium-ion batteries, leading to a revolution in electronics. Mobile phones shrank, computers became portable and MP3 players and tablets were developed.

Subsequently, researchers around the world have searched through the periodic table on the hunt for even better batteries, but no one has yet succeeded in inventing something that beats the lithium-ion battery's high capacity and voltage. However, the lithium-ion battery has been changed and improved; among other things, John Goodenough has replaced the cobalt oxide with iron phosphate, which makes the battery more environmentally friendly.

Like almost everything else, the production of lithium-ion batteries has an impact on the environment, but there are also huge environmental benefits. The battery has enabled the development of cleaner energy technologies and electric vehicles, thus contributing to reduced emissions of greenhouse gases and particulates.

Through their work, John Goodenough, Stanley Whittingham and Akira Yoshino have created the right conditions for a wireless and fossil fuel-free society, and so brought the greatest benefit to humankind.

FURTHER READING

Additional information on this year's prizes, including a scientific background in English, is available on the website of the Royal Swedish Academy of Sciences, *www.kva.se*, and at *www.nobelprize.org*, where you can watch video footage of the press conferences, the Nobel Lectures and more. Information on exhibitions and activities related to the Nobel Prizes and the Prize in Economic Sciences is available at *www.nobelprizemuseum.se*

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2019 to

JOHN B. GOODENOUGH

Born 1922 in Jena, Germany. Ph.D. 1952 from the University of Chicago, USA. Virginia H. Cockrell Chair in Engineering at The University of Texas at Austin, USA.

M. STANLEY WHITTINGHAM

Born 1941 in the UK. Ph.D. 1968 from Oxford University, UK. Distinguished Professor at Binghamton University, State University of New York, USA.

AKIRA YOSHINO

Born 1948 in Suita, Japan. Ph.D. 2005 from Osaka University, Japan. Honorary Fellow at Asahi Kasei Corporation, Tokyo, Japan and Professor at Meijo University, Nagoya, Japan.

"for the development of lithium-ion batteries"

Science Editors: Claes Gustafsson, Gunnar von Heijne, Olof Ramström, the Nobel Committee for Chemistry
Text: Ann Fernholm
Translator: Clare Barnes
Illustrations: ©Johan Jarnestad/The Royal Swedish Academy of Sciences
Editor: Sara Gustafsson