Ivent Solutions Market Trend Update
June 2018

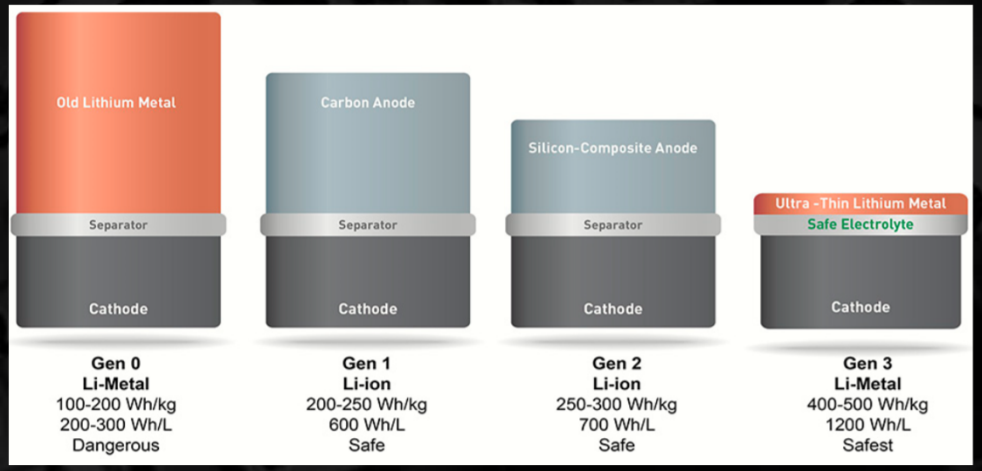
Lithium Battery Technology Update

If you ask people for their number one concern about making the jump to an electric vehicle, driving range will pretty much always be the answer. No matter how many press releases are made touting incremental improvements, people still worry about being left stranded without the instant replenish of fossil fuel energy. The reason is simple: Even with Level 2 equipment, it takes several hours to charge up an electric vehicle (EV). Even a DC Fast Charger (if your car supports it) takes the most part of an hour if you want more than 80% charge. There are two ways to increase the range of an existing EV. You can put in more batteries or you can improve the energy storage capacity of the batteries. Adding more batteries means more weight and more expense, which makes increased capacity the "holy grail" of battery development. This is what researchers at the University of Waterloo in Canada have been pursuing — and may have found in **lithium metal**.

What is a lithium metal battery? Lithium metal batteries are not new. You can find them at any grocery store checkout line. Typically, the difference between a lithium metal battery and a lithium-ion or lithium polymer battery is that you can recharge the ion and polymer versions, but not the lithium metal variety.

Lithium is considered the best available battery anode material because it carries the highest theoretical capacity and lowest electrochemical potential of all known candidate elements. But the material has several drawbacks. Repeated charge and discharge cycles can cause microscopic structural changes that lead to internal short circuits, or merely to reduced battery life.

However, researchers at Waterloo University have made significant progress using negative electrodes made of lithium metal, and their work has the potential to dramatically increase battery storage capacity.



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The increased storage capacity, which is also known as energy density, could boost battery performance by a factor of three compared to existing battery technologies. There is a problem with lithium batteries that stems from internal short circuits that can develop. The batteries can explode because the lithium in them reacts to water, or to the water vapor that's present in ordinary air. Lithium batteries are generally safe, but if a battery is damaged or has a manufacturing defect, it can explode or catch fire. So in order to make the new battery technology workable, The researchers had to overcome two critical safety issues.

The first danger was to minimize the risk of fires and explosions caused by the microscopic structural changes. The second challenge involved a chemical reaction that creates corrosion and limits both how well the batteries will work and how long they can last. Waterloo's researchers solved both problems by adding a chemical compound made of phosphorus and sulfur elements to the electrolyte liquid that carries the actual electrical charge within the batteries. The phosphorus-sulfur compound reacts with the lithium metal electrode inside the battery and creates a very thin coating over the lithium. That coating protects the lithium from exposure to water. The breakthrough specifically helps in the development of lithium metal battery technology for electric vehicles. The chemical compound makes batteries with greater storage capacity and therefore greater performance.

Old-fashioned batteries are going away! While electric cars, hybrids and industrial products are the main beneficiaries of battery research, the conventional car stands to benefit from advances in battery tech, too. The old-fashioned wet cell lead-acid battery hasn't changed much in the last 100 years, but now Mazda has partnered with ELIIY Power Company and Ube Industries to jointly develop lithium-ion batteries for use in gas-fueled automobiles. The three companies plan to work together to develop durable 12-volt lithium-ion batteries as a viable replacement for lead-acid starter batteries in motor vehicles by 2021. The benefits of this research include reduced weight in motor vehicles and reduced lead pollution in the manufacturing and disposal process of vehicle batteries. Yet Mazda and its partners still have problems to solve… Lithium-ion starter batteries will have to work for extended periods of time in hot, dirty engine bays and the new batteries must also be able to survive collisions without causing a secondary emergency.

With the lithium-ion battery market currently expected to be about $33 billion by 2019, research into improved battery and charging technology is not limited to just a few universities or corporations. Researchers at the Universities of Surrey and Bristol in the UK are working with Superdielectrics Ltd on new polymer conductor technology that has the potential for faster energy transfer and greater storage capacity in the future.

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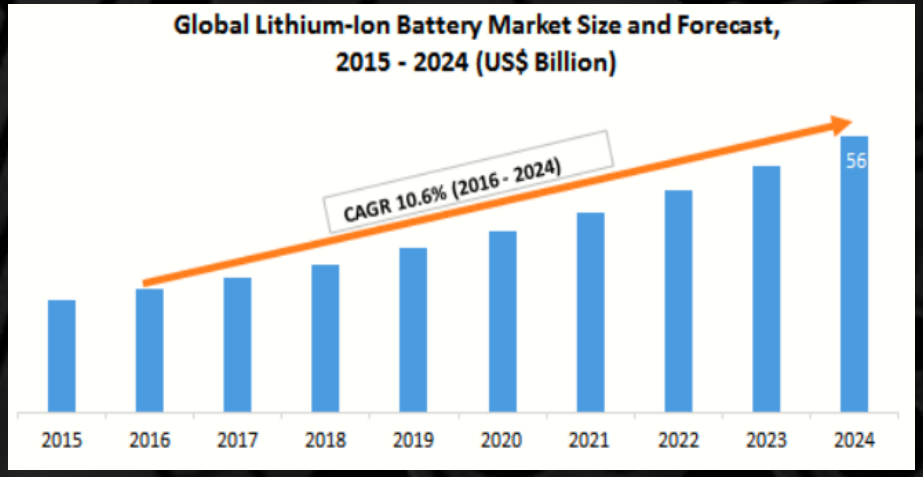
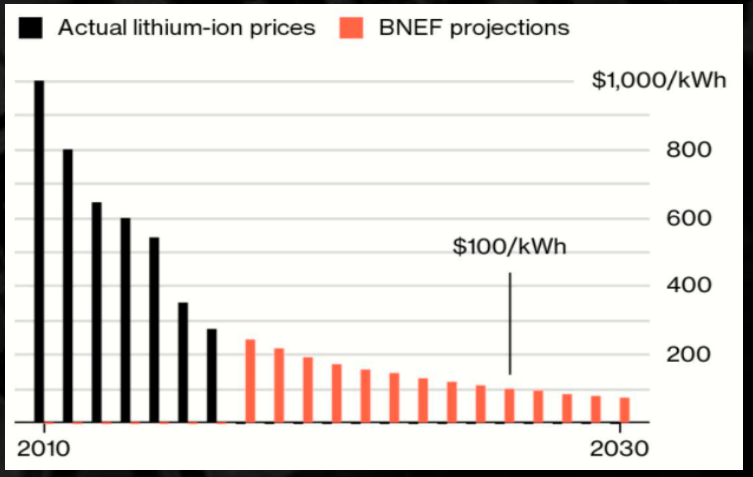
"The present work, if it can be translated into production, promises to make rapid charging possible for electric vehicles, as well as offering a much-needed low-cost method of storing the transient output from renewable energy systems," said Dr. Donald Highgate, Director of Research for Superdielectrics. "Wind, wave and solar energy is available but it is intermittent and, without storage, cannot be relied upon to meet our energy needs. This new work would transform the energy system which underpins our entire way of life – it is the necessary development before we and our children can have a genuinely sustainable, environmentally safe energy supply."

According to New Scientist Magazine, German company BASF is also working on improved cobalt-nickel battery technology that will provide the sought-after experience of a charging station that works as quickly as a gas fill-up and which provides roughly **300 miles** of range in a standard EV. "You will be able to recharge your electric sports car in the time it takes to drink a coffee, then drive 500 kilometers before needing to top up," the magazine reported.

When an EV requires no more investment in time and planning than a gas-powered car, and costs far less to operate, it will become a true game-changer for the automobile industry. It's not here yet, but people all over the world are working on it — and making progress.





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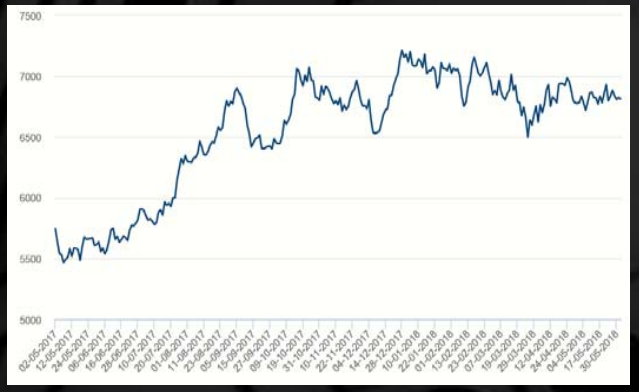
NZD versus AUD - AU$0.925 vs NZ$1.00

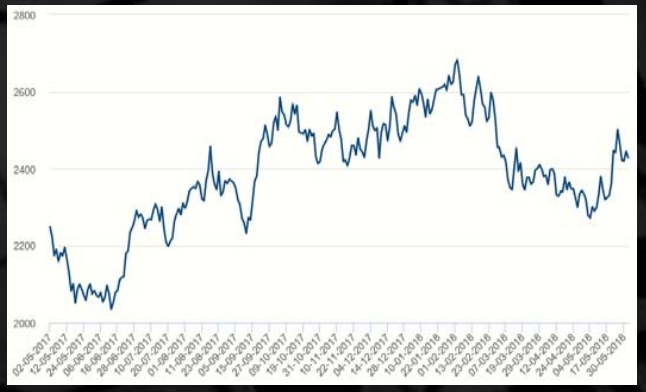
NZD versus USD - US$0.695 vs NZ$1.00

NZD versus EUR - EU$0.595 vs. NZ$1.00

Copper - USD6800 / tonne



Lead - USD2450 / tonne



Nickel - USD15150 / tonne