Making lithium ion battery components more durable and efficient to improve battery capacity

written by InvestorNews | November 24, 2021

NEO Battery Materials' Progressing on the Development and Commercialization of Longer Lasting Higher Energy Density Lithium Ion Battery Components

Investors looking for a cutting edge technology company in the electric vehicle (EV) battery components sector need look no further than NEO Battery Materials Ltd. (TSXV: NBM | OTCQB: NBMFF). NEO is a North American battery materials company with a current focus on developing silicon anode (the negative electrode in a battery) materials through its "ion-and electronic-conductive polymer nanocoating technology." Or, in simpler language, a 'silicon material' for batteries, used to make the anode last longer in service (make it capable of being charged and recharged more times without losing integrity or efficiency) and be capable of holding more energy, thus making the battery more durable and efficient

NEO states: "NEO has a focus on producing silicon anode materials through its proprietary single-step nanocoating process, which provides improvements in capacity and efficiency over that of lithium-ion batteries using graphite in their anode materials."

NEO's stock price has been on a tear in 2021; however, the recent pullback potentially gives a better entry point for investors.

NEO Battery Materials (TSXV: NBM) 1 year stock price chart

Source: Yahoo Finance

Another thing that investors love is active management that can rapidly progress a company and produce lots of good news. We'll take a look at the news flow summary below, just for November 2021.

- Nov. 23, 2021 – NEO Battery Materials appoints lithium-ion battery electrode binder and polymer technology expert, Dr. Byeong-Su Kim, to Scientific Advisory Board. The news states: "Utilizing robust binder technologies with characteristics such as a high elastic modulus can **help contain and control the volume expansion of silicon**, resulting in lower probabilities of particle pulverization and a cracking anode."
- Nov. 18, 2021 – NEO Battery Materials receives approval for a core patent from the Korean Intellectual Property Office.
- Nov. 16, 2021 – NEO Battery Materials announces research consortium LOI with both the University of Toronto **and with an undisclosed global OEM for R&D and scale-up of EV Battery Materials**. The preliminary project will involve the full electrode fabrication of silicon-carbon composite anodes through NEO's silicon particle nanocoating process…..With the active material (silicon and/or graphite), binders and conductive additives as core components….
- Nov. 10, 2021 – NEO Battery Materials appoints Dr. Dongmok

Whang, expert in low-dimensional nanomaterials and graphene, to Scientific Advisory Board. His research expertise lies in the field of fabrication and manufacturing of low-dimensional nanomaterials, especially **graphene**, **semiconductor nanowires**, and **porous nanostructures** for applications in electric vehicle lithium-ion batteries, fuel cells, and various energy storage solutions.

- Nov. 4, 2021 – NEO Battery Materials accomplishes **anode production capacity upscaling Project** over the past three months. The news states: "From the initial production rate of several grams per hour for manufacturing silicon anode materials at the lab-scale, **NEO's engineering team has accomplished to expand the rate to a level of several kilograms per hour.** This is a result of improving productivity by more than 1,000-fold, and the success of the Project at this level has given stronger validation for **the 120-ton semi-commercial plant that is scheduled to be commissioned by the end of next year.**" President & CEO Spencer Huh, added: "As NEO understands the need to fast-track into mass production, we are pleased to announce the accomplishment of the Upscaling Project. The Company is at the forefront of developing unique Si anode lines through the low-cost manufacturing process, and we are customizing solutions for various downstream users to optimize the products for high-power electric vehicle lithium-ion battery applications."

The above 5 news items, when added together' show the rapid pace and progress NEO is achieving. Looking back on the previous two months there were even more great achievements by NEO. The standout news came on October 26 when NEO announced: "**Completion of semi-commercial plant conceptual design** and initiates engineering EPC stage for construction." The facility will be in South Korea. President & CEO, Spencer Huh, stated: "NEO is now another step towards commercializing our silicon anode materials for EV lithium-ion batteries and is actively expediting our timelines and milestones."

As shown below the problem with silicon in anodes can be that as the silicon absorbs the electrons it expands then cracks the anode, leading to a low cycle life (low longevity). NEO has managed to improve this by using its cost-effective and efficient one-pot, single-step, nanocoating process.

NEO Battery Materials state that their silicon anode materials are already achieving much higher cycles than competitors

Source: NEO Battery Materials company website

Closing remarks

A lot of the details surrounding NEO Battery Materials' achievements are not very well understood by investors. This is only natural as most investors are not battery material scientists.

The key to understanding NEO's work is that its silicon anodes or composite silicon graphite anodes can significantly improve battery capacity, which relates to greater energy density, and hence longer range for the same size battery. What EV manufacturers and customers all want is better performing batteries that result in longer driving range for a given size battery. Silicon anodes today present many challenges, especially cracking leading to poor cycle life. NEO is making great strides in solving this problem by producing silicon anode materials with a much longer cycle life.

If NEO can succeed in meeting commercial standards it will have Tesla and other EV and battery/anode OEMs knocking on its door.

For now it appears there is plenty of promise, especially given the longer cycling results (1,000 cycles) and recent production scaling progress, as well as the interest from an OEM in joining NEO's research consortium.

NEO Battery Materials trades on a market cap of C$39 million. It's one to watch.

What's this about Johnson-Matthey exiting the EV battery cathode business?

written by Jack Lifton | November 24, 2021

The legacy carmakers and their supply base both face bankruptcy if they make the wrong decisions on entering the "transition to EVs" markets. This is because the OEM automotive industry is, along with semiconductor manufacturing, one of the most capital-intensive industries in the world. Just like with a 200,000 ton DWT ship, inertia being the problem on the one hand and prior deployment of massive amounts of capital being the issue on the other, the OEM automotive industry cannot change course in a short time, and so must be careful to choose the right path (allocation of capital) before starting the voyage.

The battery materials' *processing* markets were surprised yesterday by an unexpected announcement from the UK's most prominent technology metals' processor, Johnson-Matthey Ltd. (JM), that it was withdrawing from the battery materials' processing market due to its estimation that the return on capital from manufacturing lithium-ion battery cathodes would be too low to justify the allocation of capital required to do so. JM's stated reason for this decision was that the battery materials' business is becoming "commoditized," so that JM's hoped for competitive advantage based on its specialized cathode manufacturing technology would either not materialize or not be good enough to be competitive.

But, even if so, It is the timing of this announcement that seems puzzling.

Both CATL, China's largest integrated battery manufacturer and Umicore, Europe's largest battery materials *processor* have poor returns on capital in their respective battery business sectors, and this has been going on since both entered the battery business, so JM cannot have been surprised by this factor, and, in fact, should have taken it into account on day one of its foray into the battery materials' business.

So, what's it all about?

Large companies with either diversified products or vertical integration can distribute costs. Legacy OEM automotive EV makers, for example, like Germany's Volkswagen, which had a 5 billion Euro profit last year, can afford to lose some money introducing its EVs to the market at a loss per vehicle, while it tests both market acceptance and the lowering of manufacturing costs due to scaling up production.

Let's set aside my continuing accounting of battery raw materials' resources as woefully insufficient to support a transition to EVs, and concentrate on the OEM automotive industry's costs of bringing a new vehicle with any type of power train to market.

It is always multi-faceted crap shoot, and the history of government intervention in the car market is not one to inspire confidence.

Designing a new car and preparing to produce it costs billions of dollars and takes 3 to 6 years.

Government intervention in this market is always a compendium of what you can’t do, not what you can. The U.S. and EU government’s favorite regulatory intervention in the OEM automotive industry is the required “average miles-per-gallon” range for an OEM’s output. This “standard” was first introduced to reduce the emissions of hazardous gases and then added the reduction of the emission of particulates to its mandate. The current EV craze was actually the result of California’s 1990’s experimental legislation requiring the slow phase in of zero-emission vehicles. General Motors brought out a battery electric vehicle, the EV in the late 1990s, and Toyota introduced its “hybrid” Prius into the US (mainly California) market in 1997 to meet that mandate. The Prius, a hybrid, using, at first, a nickel-metal-hydride (the metal being a mix of rare earths) battery prospered. The EV with its lead-acid batteries and short range, 90 miles before needing a recharge, did not (It helped that GM lobbyists got California to suspend enforcement of the zero emissions mandate). GM had only leased its EVs; they were recalled and scrapped.

BEVs as a type went into hibernation until 2005 when Elon Musk decided that lithium-ion batteries were ready for prime time. Global Cooling became Global Warming and then Climate Change, and Musk’s struggling, capital devouring, OEM automotive venture, Tesla, kickstarted a revival of a serious EV industry, something last seen by the great grandfathers of Detroit’s, Wolfsburg’s, Paris’, and Tokyo’s car industry leaders when they decided that Thomas Edison’s Nickel-iron batteries were not practical for even their then short range motor cars. They knew that Rockefeller’s gasoline and kerosene distribution system in “filling stations” was far more practical than Edison’s expensive and hard to maintain DC generating stations except for trolley cars.

So, what’s this got to do with JM’s decision to pull out of the battery cathode business?

The answer is that JM has (correctly) concluded that the market, though large, is limited, and that very large profitable multi-product and/or vertically integrated or (whisper) state-supported companies are already driving prices down by competition to get market share.

JM has concluded, again correctly, that most of the cars and trucks manufactured for the next generation will use internal combustion engines and that its core automotive exhaust emission catalytic converter business based on its dominance in the processing and use of platinum group metals is where it has the best competitive advantage and sunk costs.

The reputed costs to JM associated with building a Poland sited cathode plant were twice the industry average.

JM was once also in the rare earth processing business, and it exited that in the 1980s when the first Molycorp was losing its dominance to Chinese low-cost competitors. That was a wise decision then, and getting out of the lithium-ion battery cathode business before getting into massive non-recoverable debt is also a wise decision.

Finally, I would like to repeat my prediction that since the OEM automotive assemblers do not understand or want to understand that the manufacturing of EVs using lithium-ion batteries is limited by the availability of lithium, there will be a cull. The survivors will be those OEMs that can balance the production of their allocation of (raw materials' supply limited) EVs with ICE production profitably. BMW is my choice for the most likely survivor, because it has already announced that it will continue to produce a mix of powertrain choices in its vehicles. The rest, so far, are either going "all-electric" or eliminating ICE production and development. They chose poorly.

TechMet's Brian Menell with Jack Lifton on the "extreme supply-demand dislocation" in technology metals due to EV market demand

written by InvestorNews | November 24, 2021

In this episode of the **Critical Minerals Corner** with Jack Lifton, Jack speaks with Brian Menell, Chairman and CEO of TechMet Ltd., about the "extreme supply-demand dislocation" in technology metals as the electric vehicles and energy storage industries accelerate.

In this InvestorIntel interview, which may also be viewed on YouTube (click here to subscribe to the InvestorIntel Channel), Brian went on to say that TechMet is an investment company that invests in projects across the technology metal supply chain adhering to the highest level of ESG standards. With focus on cobalt, lithium, nickel, tin, tungsten, vanadium, and rare earths projects, Brian told InvestorIntel that TechMet is "only metals and mining company with significant direct U.S. government equity participation." Brian also provided an update on some of the projects that TechMet has invested in which includes the largest lithium-ion battery recycling company in North America and the cheapest producer in the world of electrolytes used in vanadium redox flow batteries.

To watch the full interview, [click here]

About TechMet Ltd.

TechMet is a private industrial company that is building controlling or significant minority positions in world-class projects across the technology metal supply chain.

To learn more about TechMet Ltd., [click here]

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If you have any questions surrounding the content of this interview, please email info@investorintel.com.

Get ready EV Metal Investors as global electric car sales for June 2021 increased by a massive 2.5x

written by InvestorNews | November 24, 2021

Global electric car sales for June 2021 increased by **a massive 2.5x (compared to June 2020), reaching 8.7% market share**. These results were led by Europe hitting a record market share of 19% (last year June 2020 was 8.2%) and China reaching a market share of 15% (June 2020 was 5.5%). 70% of all global electric car sales in 2021 were 100% battery electric vehicles (BEVs), the balance being hybrids. These results highlight the exponential growth and disruption that is now occurring in the car market and indicate that electric cars are now well on the way to becoming mainstream. In most cases sales are only limited by production, an example being the 1.25 million Tesla Cybertruck pre-orders, with production now delayed until 2022 due to battery shortages. Tesla Semi is another example.

The lithium-ion battery shortages are being caused by a lack of new production capacity, but even worse is the shortage of EV battery metals. I say even worse as it usually takes 5-10+ years for a new EV metals mine to make it to production, compared to only 2 years for a battery or car factory. This means that this decade the choke point for EV supply is expected to be the battery metals.

In June 2021, the International Energy Agency (IEA) announced forecasts for 2020 to 2040 total demand increases of **lithium 13x to 42x, graphite 8x to 25x, cobalt 6x to 21x, nickel 7x to 19x, manganese 3x to 8x, rare earths 3x to 7x, and copper 2x to 3x**. These types of numbers are unprecedented and will be an enormous challenge for the mining industry to bring on adequate supply.

IEA forecast for clean energy metals 2020 to 2040

Source: International Energy Agency 2021 report

On July 1 Reuters reported:

“Shortages flagged for EV materials lithium and cobalt…..High lithium prices have failed to spur investment in new capacity due to lower long-term contract prices, while the problem for cobalt supply is that it is mainly a byproduct of copper, meaning investment decisions are based on copper prices……BMI’s George Miller forecasts a LCE deficit of 25,000 tonnes this year and expects to see acute deficits from 2022. “Unless we see significant and imminent investment into large, commercially viable lithium deposits, these shortages will extend out to the end of the decade," Miller said……Analysts at Roskill forecast cobalt demand will rise to 270,000 tonnes by 2030 from 141,000 last year."

Investors are now catching on and a lithium miner's price surge has begun

A combination of greater investor awareness and rising EV metal prices is now resulting in sizable price movements for the miners, lithium being the prized example. Lithium prices have more than doubled from their lows and many lithium miner stock prices have gone 3-12x as a result.

Lithium miners stock prices have increased as much as 1,126% since May 2020

Source: Yahoo Finance

What should investors do now that EV metal miners stock prices are flying higher

New investors are now facing a conundrum – Do they buy now into stocks that have already risen dramatically or do they wait for a pullback? The answer will depend on an individual investor's tolerance for risk and their time frame for investing. My view is that it is still not too late as the EV and associated battery and EV metals boom should run for at least a decade or two as we still have a huge way to go before all new cars are electric. Here are some recent forecasts to help you decide:

- BloombergNEF Economic Transition Scenario: Passenger EV sales pa are projected to increase sharply, **rising from 3 million in 2020 to 66 million in 2040**.

- UBS: **By 2025, we think around 25% of new cars may be electrified. By 2030, the share may reach 60–70%.**
- Bank of America (BoA)**: EVs to represent 67% of total car market share by 2030**. EV batteries will reach a 'sold out' scenario in the next 5 years.
- Whitehouse: President Biden outlines target of **50% Electric Vehicle sales share in 2030**.
- EU: Proposes end to the internal combustion engine in 2035.

My view is that the UBS and BoA forecasts above will prove to be the better forecasts, and they align with my own forecast of 25% by end 2025 and 75% by end 2030. Ask yourself why anyone would want to buy a gasoline car after about 2023-25 when an electric car is the same price or cheaper, has 3x less running costs, and 5-10x less maintenance costs. Not to mention the better driving experience. History shows that when a new technology is better change happens exponentially.

Bloomberg's forecast for passenger electric cars to 2040

Source: BloombergNEF Economic Transition Scenario

Closing remarks

Electric vehicles are now rapidly moving towards becoming mainstream. The choke point in supply will most likely be the EV metals. These can include any or all of **lithium, graphite, cobalt, nickel, manganese, rare earths, and copper.**

Given the demand surge ahead this decade it is still not too late to invest into the EV sector. At InvestorIntel we cover a wide range of EV metal miners and some EV related stocks, as you can see in our member's area here.

Fasten your seat belt and be sure not to miss the biggest trend this decade!

Avoiding A Critical Technology Metals (Lithium, Cobalt and Nickel) Disaster in the Real World

written by Jack Lifton | November 24, 2021

Mineral economists advising the U.S. government make mathematical models to predict real world outcomes even though they do not know if they have failed to include an important, even critical factor, or if they have the right data, until the model, as it always does, fails to reproduce real world measured results. Even then they do not know what is missing, because if they did, they would have included it in the first place. Because Cancel Culture now dominates the increasingly authoritarian and intolerant (of "different" ideas) world view of academic administrators, even physical scientists have succumbed to the nonsense of calling out, as biased, and refuting, various data, and its interpretation, which in the past was regularly included in models, thus distancing the models' results even further from reality.

The mistakes this incomplete or even just false modeling makes in the social sciences are bad enough, but in the case of mineral economics it could be fatal to the continuation of American global military hegemony.

Earlier this week, a publication called the "Rare Earth Observer" put it quite well. The author said that "… the Green New Deal utopians have no idea of the cost and difficulties of creating an entire new infrastructure. Nor do they understand that a new infrastructure would generate enormous carbon emissions by itself. ***Nor do they understand that the minerals and materials that go into electric power and batteries and new electricity grids and so forth are simply not available to the United States at the present time…."***

American Federal bureaucrats are almost uniformly drawn from the academic or governmental staffs' worlds. Hands on experience is rare although STEM degrees are not.

The models used by the United States' Geological Survey, once the mineral world's gold standard, today describe known, developed, mineral deposits (aka, mines) by calling them "resources." But a resource is on a ticking countdown clock. The "life" of a mine is the length of time it is projected to deliver a mineral, profitably. This means in practice how long the mine's ore grade will be high enough to make recovery and extraction profitable with known technologies. The minerals that might be able, someday, to be recovered ***economically*** are called "reserves."

A mineral not in parts of the earth that is currently accessible physically or technologically or both is known as a reserve, a very fluid term. The ocean or an asteroid can be styled as a deposit and then the economically unobtainable minerals become "reserves."

The only minerals that matter are those that can be extracted economically with proven technology.

Here is the reasoning of an American bureaucrat, or, sadly, a procurement officer at an American OEM car maker: To produce 50%

of our product line as BEVs, battery powered electrics, will require enough lithium, cobalt, and nickel to make 10,000,000 100 kWh lithium ion batteries per year. This will require 160,000 tons of lithium annually. **That is twice as much lithium in total as was produced in 2019.** But the learned mineral economists at several New York and London based banks have written that lithium production by 2030 will be 14 times today's level, so using this wisdom plus my reading of the global lithium "reserves" at millions of tons in government (drum roll) official publications, such as the Federal Reserve's "Dick and Jane Can Produce Anything You Can Dream Up at No Added Cost," I, the bureaucrat or sourcing executive, conclude that I can make as many BEVs as my President directs, so there. By the way, as the production of lithium increases and is increasingly expensive the cost will go down due to "economy of scale."

In summary, to make the world green simply suspend rational thinking, real world data, learned expertise, and, last, but not least, common sense.

If this nonsense persists all critical technology metals are going to be very very expensive as resources are used up.

Why lithium and rare earths are truly a bull market and the EV transition is just

bull.

written by Jack Lifton | November 24, 2021

The Global OEM (Original Equipment Manufacturer) automotive industry has begun a mostly politically (The [consumer] market is not demanding this change!) driven transition from manufacturing and selling vehicles using fossil-fueled internal combustion engines (ICE) power trains to those using electric motor propulsion (Electric Vehicle (EV)), based on electricity stored in and delivered from rechargeable lithium-ion batteries. The relatively recently created Chinese domestic OEM automotive industry is already leading the pack in the proposed transition due to basic geopolitical and economic reasons; t**he Chinese government has for some time now already mandated and implemented an industrial policy to support the creation of a total domestic Chinese supply chain for the production of EVs.** One result of this mandate has been the creation of a secure supply of all of the critical materials for EVs sufficient to ensure the ultimate maximum practical conversion of the Chinese domestic vehicle fleet to EVs. **China's government has mandated that 25% of all motor vehicles produced in 2025 be battery-powered electric vehicles (BEV).** This means that Chinese BEV production will increase from today's 10% of total production or more than 2,000,000 units per year to more than 5,000,000 units per year by 2025.

The Chinese lithium-ion battery manufacturing industry is the world's largest and already has enough capacity in existence or under construction to support a total domestic supply chain to meet the 2025 mandate and beyond.

This Chinese preemptive move has left the rest-of-the-world's automakers in an existential crisis. To understand the nature of this crisis we need to look at some numbers:

1. The global new production of lithium (measured as a metal) in 2020 was 82,000 mt or 82,000,000 kg. This was a tripling of global output over that in 2010,
2. The global new production of cobalt (measured as metal) in 2020 was 140,000 mt or 140,000,000 kg,
3. The global new production of magnet rare earths in 2020 was 40,000 mt or 40,000,000 kg.
4. The global production of motor vehicles in 2020 was 78,000,000 of which some 2.5%, let’s say 2,000,000 were EVs, and
5. The largest producer of BEVs in 2020 was Tesla, which sold somewhat more than 500,000 of them in that year.

I know that there are already 15 or 16 manufacturers of BEVs, and I know that Nickel and Manganese are important battery metals, but that isn’t going to matter much if there isn’t enough lithium around.

Lithium is the most important battery metal, simply because you cannot make a lithium-ion battery without it.

No matter what the lithium-ion battery chemistry, you need 10kg of lithium, measured as metal, to provide a battery with 60kWh of capacity, which is the standard value in the basic Tesla Model 3, the world’s current best selling BEV.

Global lithium production as I stated above was 82,000,000 kg in 2020. If all of it were to be used to make lithium ion batteries of the capacity used in the Tesla Basic Model 3 then 8,200,000 batteries and thus the same number of new BEVs could be produced or 12% of the 2020 NEW production. Therefore at current lithium production, 12% of new motor vehicle production annually (assuming that such production stays at 82,000,000 per year) or 8,200,000 would/could be BEVs. There are currently some 1.4 billion motor vehicles in use globally – 325 million of them are in North America alone. Thus at current lithium production, it would take 40 years to convert the current North American fleet if all of the world's lithium were used just to make domestically manufactured or sold BEVs! For the global fleet, it gets even worse; it would take 150 years to do the same thing.

The obvious solution as noted by those "experts" who are completely ignorant of mineral economics is to simply increase lithium production. If we want the total conversion of the (current) global fleet to take place in 15 years then we only need to increase lithium production by a factor 10 to 820,000 tons per year, which is more lithium than has ever been produced in total, since it was first produced commercially in the mid-twentieth century.

I'm going to go out on a limb here and say that given sufficient time and capital new lithium production might be doubled in 5 years and that this level of production could be maintained for a decade (It takes typically 5-10 years to prove a resource, finance, get regulatory approval, and meet target production levels, but some relatively large projects have been doing these things for several years already. Therefore by 2025, the global OEM automotive industry could be producing 17,000,000 BEVs annually. We would then be looking at a global fleet conversion to BEV time of only 75 years. Of course, that level of lithium production could not be maintained anywhere near long enough due to exhaustion of the mines through grade deflation, but that doesn't bother the "experts," since they don't know about that.

Let's look at magnet rare earths also, since even a BEV using a lithium iron phosphate battery with no cobalt, nickel, or manganese is today ideally using a rare earth permanent magnet motor, because it is the most efficient traction motor. Our reference Tesla Model 3 uses about 5 kg of neodymium iron boron magnet in its traction motor and the small accessory (window, seat, power steering) motors now standard on all cars, ICSs or

EVs. This is about 1.67 kg of neodymium/praseodymium (75/25) per 5 kg of magnets.

Global production of such magnets in 2020 was at least 150,000 mt or 150,000,000 kg, so there was enough, if all were used for this purpose, for 30,000,000 BEVs using rare earth permanent magnet motors, but there is a problem. Rare earth permanent magnet motors as generators are used in large quantities in direct drive wind turbine generators and as motors are used as well as in aerospace, home appliances, cell phones (the speaker magnet and the vibration mode are forms of rare earth permanent magnet devices), personal computers, industrial fork-lifts, industrial motors, etc. Let's be generous and only use 25% of global rare earth permanent magnets for these purposes. We are now reduced to being able to produce 22,000,000 BEVs per year. Luckily that's more than enough for the total of all of the BEVs for which we have enough lithium annually (If and when Li production doubles from the 2020 level).

More "experts" will say that recycling of lithium-ion batteries will solve the supply shortfall. Guess again. The average useful life of a North American car is now 12 years; in Europe, it's a bit longer. Therefore in 2030 if all of the BEVs produced in 2020 were "recycled" then enough lithium and rare earths might be recovered to build an additional 2,000,000 new 2031 BEVs.

One more thing: Lets assume that stationary and back-up storage, personal computers, cell phones, and power tools will consume some of the lithium supply, say 20%. That will leave us with just enough new lithium annually for 13,000,000 new BEVs, so it's going to take 100 years to replace the current (2020) global motor vehicle fleet.

The politicians have an easy solution to this dilemma they just put on their pointed hats and predict that the lithium (and rare earth supplies) will be increased by a factor 10 or more so that the transition can occur with a decade or two, long after they have retired as wealthy men or women.

Who is to be left holding the bag? Of course, the average consumer will be told that it is evil to drive an ICE, and, if the politicians have their way, the cheap energy upon which our civilization is founded will gradually become so expensive that the wildly ineffective alternate energy prices will look good to the elites who have VSBEVs (Virtue signaling battery electric vehicles) parked in their heated garages in their walled compounds.

Be that as it may the real losers in the Robin Hood contest for critical materials for BEVs will be the OEM automotive manufacturers who cannot get the necessary raw materials and/or the finished lithium-ion batteries to make enough BEVs to break even.

China produces 60% of all of the global refined lithium (and has contracted for at least that much of new production scheduled to come online by 2025) for battery production and 90% of the end-user products enabled by the magnet rare earths. Therefore 60% of all new BEVs will be made in China for the foreseeable future, and any use of rare earth permanent motors for anything will be dependent on Chinese manufacturing and export availability from China!

In 2025 China will probably have sufficient lithium supplies to make (the equivalent of) 8,000,000 Tesla Model 3s, the entire rest of the world will have just enough to make 5,000,000. The Ford Motor Company has already said that it will have 40% of its 2025 production as BEVs. That’s about one million cars in America and another million in China. VW, Toyota, Honda, Daimler, Renault-Nissan, and Hyundai made 55 million cars/trucks outside of China in 2020. They will at most be able to make 7,000,000 BEVs, in 2025, if China will supply the batteries and rare earth permanent magnets for 3 million of those not made and/or distributed in China.

The only way the non-Chinese OEM automotive manufacturers can survive will be by making lots of ICEs and hoping that the price of fossil fuel hasn't climbed so high that non-elites can still afford it. But these ICEs will be showing their age, since the huge amount of capital in the world's most capital intensive industry will have been diverted to the development of BEVs that cannot be built.

If the EV "transition" continues I predict a consolidation of the global non-Chinese OEM automotive industry. Many famous names will go the way of the Dodo. Avoid automotive stocks where the management avoids addressing the rationing problems for lithium and rare earths.

The Robin Hood effect; moving the supply production target farther and farther away ceases to be effective when the price of lithium gets so high that the U-Curve asserts itself and batteries get too expensive to compete with fossil fuels.

Watch out if more South Americans, Africans, and Indians want BEVs, electric bikes, electric scooters, and the like. All will need lithium and the rare earths.

In the meantime and for probably the rest of this decade lithium is a bull market; the rare earths are a bull market; and the EV transition is just bull.

Before we can climb out from the Chinese control of rare earths and battery materials – we must understand our past.

written by Jack Lifton | November 24, 2021

Technology is the engineering of science, and manufacturing engineering is the scaling up of engineering to enable the efficient and economical mass production of finished goods.

The scientific development of the rare earth permanent magnet and of the lithium-ion battery both occurred primarily in the United States in the greatest period of consumer technology development in American history; from 1945 until the end of the twentieth century.

Until the moon landing in 1969 the US Department of Defense (DoD), from the beginning of World War II, and NASA, from 1961-69, was the majority funding entities for both science and technology. Since then private corporations have provided the majority of funding for consumer product development.

The current awakening of government to a critical materials' supply crisis as a security issue has highlighted the failure of American manufacturing to pay any attention to the dangers of just-in-time supply chains, made fashionable beginning in the 1980s as a technique to free up the capital required by inventories of raw materials and semi-finished goods. For the capital-intensive OEM automotive, aerospace, and allied industries this was a "no brainer."

Overlooked completely at that time was the end of corporate subsidies for and thus the demise of stand-alone in-house education in specialty manufacturing engineering (now called “automotive engineering in the OEM automotive industry). The General Motors Institute, GMI, in Flint, Michigan, for example, was a company-owned engineering college the students of which were typically GM employees in what is now called work-study programs. This ensured **continuity** as older engineers both taught and worked alongside the “students” in any one of the many parts plants and assembly plants in Flint and nearby Saginaw, Michigan, where foundries and the world’s largest steering gear manufacturing operations operated.

One of GM’s parts operations in Indiana was called the Magnequench Division; it was the world’s largest manufacturer of rare earth permanent magnets.

GM and Ford were heavily invested in science. The General Motors Technical Center and the Ford Scientific Laboratory were outstanding, but the managers of the corporations were losing focus on the long term and entering the long decline in their fortunes due to just-in-time outsourcing and the emphasis on share price, not corporate citizenship, aka, “financialization.”

Hugely expensive attempts at automation in the late 1970s and early 1980s had convinced American OEM automotive that it wasn’t going to work, so instead of profit growth through technological productivity increases the managers turned to cheap overseas labor. At first American engineers were sent to organize and manage operations in “developing” countries like China. It was assumed, as a matter of faith, that the Chinese in particular would never learn how to develop “native” industries to compete with American ones in producing goods for the American home market. Poorly made Japanese cars were just then the source of much derision in Detroit’s toniest suburbs. Korean cars were non-existent.

In the last 20 years of the twentieth century, the American Big Three car makers disassembled their vertically integrated operations, their in-house engineering continuity "colleges", and any long-term planning they might have looked at in favor of just-in-time outsourcing and management by the metric of share price only.

As I recall rare earth permanent magnets were first studied by the Russians in the late 1960s, by the 1970s both Japan's Sumitomo and General Motors had developed and begun manufacturing and using samarium cobalt types. In the late 1970s, cobalt pricing spiked (take note of this well those who look for big increases in rare earth, lithium, and cobalt prices as a supply or demand driver!) and this caused General Motors to switch over to neodymium iron boron magnets for its miniaturization of electric motors needs. The capacity for the production of the separated rare earths needed soon overwhelmed the then Molycorp's mine and separation capacity (7,000 tpa), and it (Molycorp) sought to outsource. The Chinese, eager for investment, and jobs, and having the large accessible deposits (as byproducts of mining the iron ore, magnetite) of light rare earths in the Bayan Obo region of Inner Mongolia, where health, safety, and the environment were of no interest soon became the biggest miners and separators of light rare earths using the chloride based solvent extraction technology proved out and gifted to them for that purpose by Molycorp.

Most commentators say that, after the above transfer of technology, the rest is history. But that means overlooking something. The Chinese did not just take over a technology and keep it static. They did at first, but soon, it was noticed by their leader, Deng Xiaoping, and soon thereafter the state underwrote a massive rare earth use and production research and development program while such programs in the west withered and died.

Rare earth mining and separating in North America ceased in 1998, the manufacture of rare earth metals, alloys, and magnets in North America ceased shortly thereafter, and the large-scale company set up originally by Sumitomo and GM for that purpose, Magnequench, which had dominated the production of rare earth permanent magnets for many years, was, after many years during which it was unable to compete with Chinese rivals, ultimately sold to a Canadian concern that moved it to China in 2004.

It is not possible to ignore the fact that competence erosion in the extraction, separation, making of metals and alloys from, and making magnets based on rare earths did not occur as these technologies left North America. It is also foolish to not consider China's massive intellectual property developments in all of those rare earth sourcing, refining, and in the development of and manufacturing of rare earth enabled product technologies can be just ignored by those who think that throwing money and university research at a problem can miraculously overcome a generation of neglect and a criminal discontinuity of engineering skills.

Whether or not the US can re-create a total domestic rare earth enabled products supply chain will depend on whether or not the management of such attempts has enough perspective to find engineers, still alive who created the rare earth refining, metal and alloy making, and permanent magnet industry and entice them to train a new generation. I personally think we can still do this and be globally competitive, but I am skeptical of financiers who know nothing of how technologies are commercialized.

And until there is a focus for this work in the form of a commitment by, for example, the US DoD to take or pay for enough tonnage of rare earth permanent magnets and to pay for the tooling to produce the more than 500 different specifications of rare earth permanent magnets used in weapons systems, nothing will happen.

European manufacturers of products using rare earth permanent magnets still have a small domestic supply chain that has maintained continuity for 45 years. But Europe has no rare earth mines. America has such a mine, and North America has many such deposits in development. America also has the only licensed and capable processor of purchased monazite in the Western World. That project is up and running. It will deliver the first multi-ton lot of radiation-free mixed rare earth carbonate to a European customer next month. That customer will separate the rare earths and deliver the magnet ones to a British company that will turn the delivered oxides into metals and alloys, which in turn will go to a German company to be made into magnets for a German OEM automotive company’s EV powertrains.

The question now is will the US government wake up to the fact that it must use Title 7 of the Defense Production Act to assemble an industrial panel to address this issue.

The Chinese are watching intently.

Jack Lifton on how the lithium-ion battery material supply chain will determine if

America can go EV

written by InvestorNews | November 24, 2021
In this episode of InvestorIntel's **Critical Minerals Corner with Jack Lifton**, Jack talks about the lack of discussion about matching the supply and demand of lithium-ion battery materials in order to make an electric vehicle revolution possible.

In this InvestorIntel video, which may also be viewed on YouTube (click here to subscribe to the InvestorIntel Channel), Jack went on to say that lithium is the most essential component of any lithium-ion battery. He pointed out that the current world production of lithium is not sufficient to electrify all the vehicles of just the United States. "100% electric car is not possible without a very large increase in the production of lithium worldwide," he added.

To watch the full video, click here

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If you have any questions surrounding the content of this interview, please email info@investorintel.com.

Nano One Performs Well in Solid State Battery Tests at the University of Michigan

written by InvestorNews | November 24, 2021

Nano One Materials Corp. (TSXV: NNO) reported this week that its technology performed well in solid-state battery testing with the University of Michigan (UM).

UM’s battery laboratories are exploring various aspects of battery components, designs, interfaces, and assembly of solid-state electrochemical batteries.

Nano One focuses on its patented process for the production of cathode materials used in lithium-ion batteries and is collaborating with the UM on the development of innovative solid-state battery technology.

Richard Laine, Ph.D., Professor of Materials Science and Engineering at the UM commented, “Initial results from our evaluations show that Nano One’s HVS materials perform well with our innovative agricultural waste derived electrolytes and we look forward to advancing our collaboration to demonstrate a viable solid-state battery configuration.”

Cathode Key for Power and Reducing Costs

The cathode determines the battery’s capacity and voltage, and can comprise 20% or more of the costs of a lithium-ion battery. Nano One has developed technology for the low-cost production of high-performance lithium-ion battery cathode materials used in electric vehicles, energy storage devices, and consumer electronics.

Nano One has programs underway with multiple academic research groups, automotive equipment manufacturers, and battery manufacturers to test its lithium-nickel-manganese-cobalt-oxide (NMC) and high voltage spinel (HVS), also known as lithium-nickel-manganese-oxide (LNMO), cathodes in different solid-state battery systems.

LNMO cathodes have garnered industry attention by providing a low-cost, fast charging, and cobalt-free solution, key in cost-effective, large-scale commercial applications.

In December 2020, Nano One announced that it entered into a cathode evaluation agreement with an undisclosed, American-based, car manufacturer. This agreement is in addition to the deals announced with Volkswagen, Pulead, Saint Gobain, and an undisclosed Asian cathode producer.

Nano One's proprietary "One Pot" furnace process creates a coated single crystal powder that protects the cathode from side reactions while allowing the transfer of lithium ions between electrolyte and cathode.

In addition, the "One Pot" process offers the flexibility to use either lithium carbonate or lithium hydroxide as the reaction with the other metal inputs is indifferent to the type of lithium input and produces a finished cathode powder when thermally processed in a furnace.

It is also an environmentally friendly process using limited water and produces no waste stream as it eliminates intermediate steps and by-products in the process.

The Basics of Battery Technology

Reduced to its basics, a lithium-ion battery consists of 4 components: (1) a Cathode, the source of the lithium ions, (2) an Anode, the storage area of released lithium ions, (3) the Electrolyte, the medium which helps the ions flow, and (4) the Separator that prevents contact between the Cathode and the Anode.

The chemical reaction creates a voltage potential between the cathode and the anode. The voltage is the electrical force from the power source, the higher the voltage, the more power it can send to the load, such as a motor.

A solid-state battery uses solid electrodes and a solid electrolyte, instead of liquid or gel electrolytes, found in conventional lithium-ion or lithium polymer batteries. As a solid-state battery can handle more charging and discharging cycles before degradation, it promises a longer lifetime.

In November 2020, Nano One reported that its HVS cathode when paired with a conventional electrolyte and a graphite anode achieved over 500 fast charge and discharge cycles at 45°C and also reached 1000 fast charge and discharge cycles at 25°C. These durability test results confirmed that its technology is stable at elevated operating temperatures required for automotive, power tools, and energy storage applications.

Cashed Up to Reach Commercialization

Recently, Nano One announced it received $4.46 million from the exercise of stock options and warrants since its last financial update dated October 1, 2020, and brings the company's cash balance to approximately C$28 million, including $14.37 million the company raised in October 2020.

Final Thoughts

Nano One's technology is well-positioned to capitalize on the opportunities in the battery technology industry as economies shift to electrification efforts from solar, wind, and electric vehicles to reduce greenhouse gas emissions from fossil fuels.

This week, the Toronto Stock Exchange (TSX) Venture Exchange's named Nano One to its "2021 Venture 50", an annual ranking of the top-performing companies on the exchange. Companies are selected based on share price appreciation, trading volume, and market capitalization growth. Nano One's stock price is up almost 300% in the past year.

Even with the recent stock price increase, there is plenty of market opportunity for the company. Nano One estimates the global cathode market could reach US$27 billion by 2026 and the company is focusing on potential licensing partners for its technology that should mitigate some of the risks.

SOURCE:

The Tesla led electric vehicle boom will lead to a tsunami of demand for the EV metal miners

written by InvestorNews | November 24, 2021

The recent electric vehicle (EV) stock prices surge is telling a story. The story is one of change. The change is that electric vehicles are coming much sooner than many think. While EV manufacturer stocks have surged, battery manufacturers have done well, the EV metal miners are yet to jump. This presents one of the biggest investment opportunities of the 2020s decade, as a tsunami of demand hits the EV metal miners.

Tesla's (NASDAQ: TSLA) stock is up over 8 fold the past 14 months (up 492% the past 1 year) and is now the world's largest car company by market cap. Tesla is rapidly gaining market share and is severely production constrained, as shown by their over 650,000 Cybertruck orders, not to mention a backlog of orders for Model Y, Roadster 2 and Semi.

In fact it was reported yesterday: "Later this year, we (Tesla) will be building three factories on three continents simultaneously." This followed the Tesla Q2 earnings release with Tesla now achieving 4 quarters of consecutive profitability making them now eligible to join the S&P500, a move that would typically see a surge of Index funds buying the stock. Meanwhile other pure EV plays are also booming. Nikola Corporation (NASDAQ: NKLA) is up 285% in the past year and NIO Inc. (NYSE: NIO) is up 250%. Will Fisker (NYSE: SPAQ) be next?

Lithium-ion battery megafactories are being built as fast as they can to meet the surging battery demand. There is currently over 115 Li-ion battery megafactories either built or in planning until 2029. This equates to enough capacity to make 39 million EVs per annum by 2029. This is a massive increase on the 2.2 million electric cars sold worldwide last year.

As a result, shares of the leading battery manufacturers are flying higher. LG Chem is 57% higher the past year and Chinese giant Contemporary Amperex Technology Co., Limited ("CATL") is 174% higher over the past year.

The 2017 boom in EV metals was merely the entree. What is coming this decade is so much bigger. Nickel sulphate battery demand is set to lead the pack with a staggering **14x increase** in demand from 2019 to 2030. Aluminum, phosphorous, and iron will also be needed to meet the EV production surge. Copper demand for EVs is forecast to surge **10x** due to its use in electric motors, wiring, and charging infrastructure. Finally the other battery metals are all set for a surge in demand. These can perform the best as they are often smaller markets with supply constraints as most investors know with cobalt in particular highly reliant on the volatile and corrupt DRC.

- Graphite – A **10x** increase in battery demand from 2019 to 2030.
- Lithium – A **9x** increase in battery demand from 2019 to 2030.
- Cobalt – A **3x** increase in battery demand from 2019 to 2030.
- Manganese – A **3x** increase in battery demand from 2019 to

2030.

Note: Rare earths will also see a surge in demand as they are needed for powerful magnets in EV motors and wind turbines.

Bloomberg forecasts a tsunami of demand coming for EV battery metals this decade

When have you ever heard of a car manufacturer publically saying this? Elon Musk's plea yesterday for mining companies is quoted below:

"Please mine more nickel……Tesla will give you a giant contract for a long period of time if you mine nickel efficiently and in an environmentally sensitive way."

Closing remarks

The EV boom is about to take off as EV prices become purchase price competitive with conventional cars by ~2022. The battery factory build out is well underway. What is lacking is investment into the EV miners to supply what will be the much needed raw materials, hence Elon Musk's plea to miners. Many investors don't understand to bring on a new mine to full production can take 5-10 years, compared to 1-2 years for an EV or battery factory. EV metals supply constraints will be the biggest obstacle that the EV boom will face this next decade.

For investors the opportunity is now clearer than ever. Buy EV metal miners with quality assets in safe jurisdictions and with ability to scale rapidly to meet surging demand. While current producers are the safest and preferred way, the near term junior producers (developers) can offer tremendous returns, albeit with higher risk.

Disclaimer: The InvestorIntel Sr Editor Matthew Bohlsen currently owns shares in Tesla. The information in this article is general in nature and should not be relied upon as personal financial advice. For more information, contact Tracy Weslosky at info@investorintel.com.