ESG Investors look to Nano One as a connector in a sustainable future

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If you follow Jack Lifton on InvestorIntel you'll have a pretty good idea that the dream of replacing all the internal combustion engines on the road today with battery electric vehicles (BEVs) is more of a fantasy than a reality based on today's technology. The demand for raw materials, in particular lithium, just doesn't add up. Jack does a great job of explaining the math in his Lithium by the numbers article from earlier this month with a follow up to hammer the point home in Lithium: The Haves and the Have Nots from last week. In summary, the first article suggests that even if lithium production doubles by 2025 (which producers say they can do), that will only get the world to roughly 10% of annual car production being BEVs. The latter article states "There is not even the remotest possibility that global lithium (measured as metal) production could grow to this week's prediction, for example, by the child-like prognosticators at Deloitte, that in 2030 32% of all newly manufactured motor vehicles would be battery electric vehicles (BEVs)."

I think it's safe to say that most reasonable people around the world agree that reducing emissions is a positive step for humanity. But how do we think as a global community that we can achieve these goals in light of some pretty serious shortfalls in the basic building blocks to making this happen? Obviously, technology has to be the answer. We have to be more efficient with the resources we've got if we want to have any chance at not only meeting the political goals of carbon reduction but

also avoiding the often unwitnessed reality of destroying the earth by mining every possible resource required to achieve those goals.

The good news is that there is already a company out there working on technology to improve lithium-ion batteries. Nano One Materials Corp. (TSX: NANO) is a technology company with a patented and scalable industrial process for the production of low-cost, high-performance cathode powders used in lithium-ion batteries. These unique materials are being designed to add value to electric vehicles and grid storage batteries in the global push for a zero-emission future. Nano One's patented manufacturing technology – the "One Pot Process" – streamlines the production process and thereby reduces cost while enabling higher performance cathode materials as compared to the standard manufacturing process. Last year the Company announced the development of a coated, single crystal cathode material for lithium-ion batteries that provides up to 4 times improvement in longevity. Granted this doesn't necessarily reduce initial demand for lithium but it certainly helps to put less stress on the supply chain going forward.

With that said, last month Nano One announced three new patents issued and allowed in Canada, the US and China. Notably coverage for a novel method for phosphate stabilizing of lithium-ion battery cathodes. An important, low-cost durability improvement to lithium nickel manganese oxide (LNMO) cathode material which delivers energy and power on par with other high-performance cathodes and is more cost-effective because it is cobalt-free, low in nickel and does not require excess lithium. LNMO also has an operating voltage that is 25% higher than commercial high nickel cathodes, enabling fewer cells in applications such as power tools and electric vehicles while providing improved productivity, efficiency, thermal management and power. So no cobalt, less nickel and ultimately less lithium

given you don’t need as many power cells.

And then there’s the other unintended consequence of moving towards a lower carbon future, the supply chain. Currently, the cathode supply chain is long and complex. Nano One technology enables cathode materials to be manufactured directly from nickel, manganese, and cobalt metal feedstocks in the form of metal powders, metal carbonates and other salts rather than metal sulfates. Metal powders are one-fifth of the weight of metal sulfates, avoiding the added costs, energy, and environmental impact of converting to sulfate and shipping and handling of waste. Nano One’s technology aligns it with the sustainability objectives of automotive companies, investment communities and governmental infrastructure initiatives. It also offers an opportunity for metals refiners to provide environmentally, and sustainably mined sources of nickel ore to integrate and manufacture cost-reduced value-added cathode powders for direct supply to battery manufacturers.

In summary, Nano One appears to have the right technology at the right time. On top of that, the Company does it all with a lower overall carbon footprint than many, if not all, of its peers. In my opinion, the latter concept still isn’t valued as high as it should be given as most ESG investors appear to be focused on top line carbon impact, and rightfully so given that policymakers haven’t really made it an issue yet. In the meantime, as Jack Lifton educates the world that BEVs in every driveway may be a fallacy in our lifetime utilizing current technology, here’s a company that could perhaps help make it more of a reality.

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

written by Jack Lifton | July 27, 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.