NEWSLETTER
//SEPTEMBER 2020

STORMCROW

Critical Materials Probably Getting More Critical

September 25, 2020

Is (Trade) War Coming?

In this issue we discuss:

- **New Energy Vehicle Sales Continue to Rebound in China** New energy vehicle sales in China stayed at about the level of last year. That doesn't represent the potential for significant sales improvements that some were hoping for, but it isn't a bad thing.

- **Prices are Still Stagnant** No sign, as yet, of a massive improvement in demand for spodumene concentrate, which could signal the exhaustion of stockpiles in China. While there are signs that demand for battery materials is recovering, there is still considerable uncertainty among buyers regarding the future direction of the industry.

- **What's Hot in China** Apparently, the answer is 'Model 3's and little cars'. There is also some new excitement about EREVs, courtesy of a company that did a significant capital raise in North America.

- **Recharging Rationality** Can any of us really recharge our battery electric vehicle in five minutes, magic batteries or no?

- **Trade War Weaponry** If China is willing to make some enemies outside of the usual suspects, then maybe there are some weapons to fight back, directly, against the US embargoes on the sale of critical semiconductors to Huawei. And one of those weapons strikes the same industry, just much closer to home.

Jon Hykawy, PhD
President
jon@stormcrow.ca

Tom Chudnovsky
Managing Partner
tom@stormcrow.ca

See the end of report for important disclosures

As a Matter of Introduction…

This is our twelfth (semi)monthly newsletter (maybe? I don't feel like looking them up and counting them)! Time flies when you are having fun, and critical materials and the connected industries are, at least to us, fun. While we never produced a newsletter filled with cautions about the "best cure for high prices being high prices " during the recent lithium heyday that extended through the middle of 2017, those who sat in on Stormcrow talks at conferences know that we were out there saying it. However, we feel even more strongly that the old maxim about the "best cure for low prices being low prices" is every bit as true, and given some pessimism around the battery materials market now, we believe that some realism (along with a little hope) is required.

First, for those who don't know, Stormcrow deals with the markets for critical materials. Generally speaking, what amounts to a critical material is in the eye of the beholder, but we think of them as materials that are essential to making a product with the properties intended by its designers, even if those materials are not anything like the highest-cost item on a bill of materials. As an example, think about lithium in the battery of your cell phone. That lithium costs pennies as a raw material, but if your cell phone manufacturer was forced to do without it then the resulting cell phone would bring with it a very, very different operating experience than it currently does.

Over the coming months, we are going to deal with our views of the market prospects for some critical materials, and interesting facts about others. We will talk a little about technology and the impact, both good and bad, that it can have on demand for critical materials. We hope you find this interesting and worthwhile! Note that when not writing newsletters like this one, Stormcrow Capital functions as a corporate adviser (capital markets / financing / M&A) in the critical materials sector. We are registered as an Exempt Market Dealer in Canada *(additional disclosures included at the end of this note, for those who need help getting to sleep).*

Becalmed

Not a whole lot happened in August with respect to the prices for battery materials, except for cobalt sulfate which was sharply higher (following metal prices) but has since rolled over a bit. While we hoped things were on the verge of turning around, and we still think we are within a couple of months of that, things are still slow:

Battery-grade $LiOH \bullet H_2O$ down 2.2%

Battery-grade Li_2CO_3 down 0.9%

Battery-grade $CoSO_4 \bullet 7\ H_2O$ UP 20.1%

Battery-grade $NiSO_4 \bullet 6\ H_2O$ UP 2.4%

As mentioned, since the end of August the price for cobalt sulfate has rolled back a bit, nickel sulfate continues higher, battery-grade lithium carbonate is up a little and battery-grade lithium hydroxide is down a little. There is no overarching direction and no firm conclusions to be drawn. We are hearing that both buyers and sellers are nervous about the direction and strength of future demand.

Even up to the last couple of days, there is no movement in spodumene concentrate pricing. The price of a tonne of 5.5% concentrate remains below USD$400 a tonne when shipped into China. This is our bellwether, and we will continue to watch how spodumene pricing goes for a view into what will happen to lithium chemical prices in the medium term.

New Energy Vehicle Sales are UP!!!

New energy vehicle sales again surpassed 100,000 units in China in August. That's reassuring but not something to celebrate, because the monthly average for the last two years in China has been roughly 100,000 units a month. It suggests that nothing is permanently broken in the model for selling these things, as long as the government subsidies keep flowing. It doesn't convince us that we have reached the tipping point, either, though.

More on what vehicles are selling, below. There are some interesting things happening in the Chinese market that we just don't get to see in Tesla-centric North America.

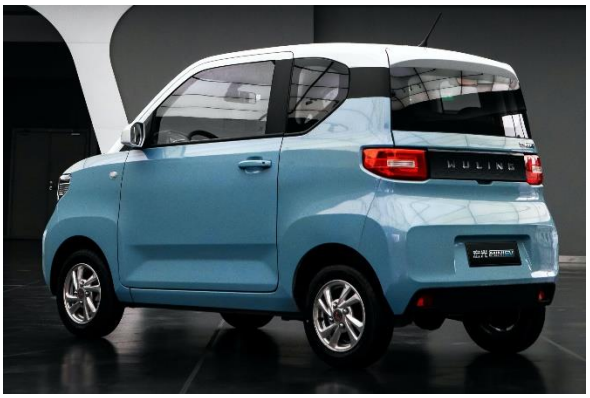
Little Cars and Luxury SUVs

Most readers are going to be aware that the Chinese new energy vehicle market is the world's largest. Over time, China has moved their incentives on vehicles to reflect a desire to be, frankly, a first-world automobile market, completely in-line with what is happening in North America or Europe. In other words, small battery electric vehicles (BEVs) with limited range have had subsidies removed while big cars with large batteries continue to be heavily subsidized. Of course, this is all in aide of reducing oil imports and decreasing pollution of all types, which is fine until you realize that a big proportion of electricity in China comes from burning coal, and so a big BEV changes the location where the pollution is happening from the back of the car to the stack at the coal plant, but since not many of them sell (relative to the size of the market) it isn't making much difference, anyway.

That is why the itemized July sales numbers and some details within those numbers are so fascinating. In July, roughly 11,600 Tesla Model 3's were sold, which is the biggest number for a single model. But second and out of nowhere is the Wuliang Hongguang Mini EV with 7,300 sales. The Mini EV also has roughly 50,000 standing orders and climbing steadily and quickly.

We all know what the Tesla Model 3 is, of course. The Mini EV is a fairly stylish mini-car with a battery of as large as 13.8 kWh and all of a 27 hp electric motor. Because the car is only about 600 kg in mass, that motor can still accelerate the little thing fairly quickly. And it sells for $4,200. In spite of no subsidies to speak of, and a profit for its manufacturer.

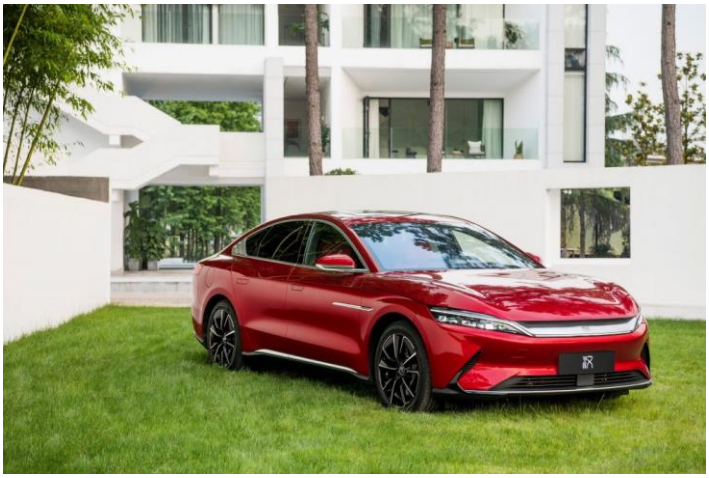
Exhibit 1 – Wuliang Hongguang Mini EV



Source: Wuliang (2020)

Given obvious demand, and the fact that anyone buying one of these is not driving around in a low-end, gasoline-powered box and polluting the air, why are the authorities in China pushing car companies toward making Model 3 clones and starving buyers in China of inexpensive options? In our view, China needs to work to find Chinese answers to Chinese problems. Instead of seeking to emulate the output of Tesla, China needs to decide what direction their automotive industry will go to not only provide environmental and economic benefits for China, but also to develop vehicles that can be exported to other nations. It isn't likely that a buyer in Germany is going to opt for the new BYD Han BEV over, say, an Audi or a Tesla (even if the high-performance model of the Han sells for only USD$40,000). But it's a lot more likely that a well-appointed little electric Mini EV is going to find a willing buyer in India, Malaysia, Indonesia or even Brazil or Argentina.

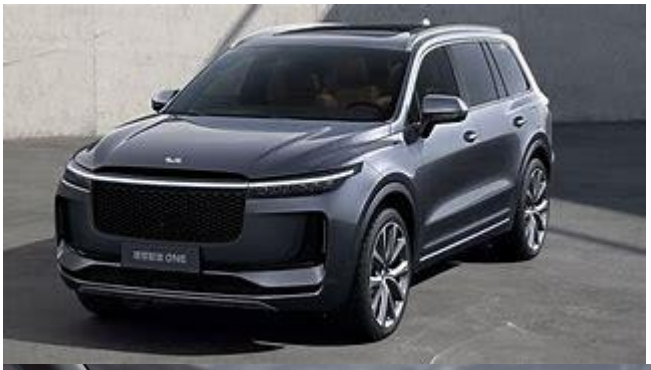
Exhibit 2 – BYD Han Sedan

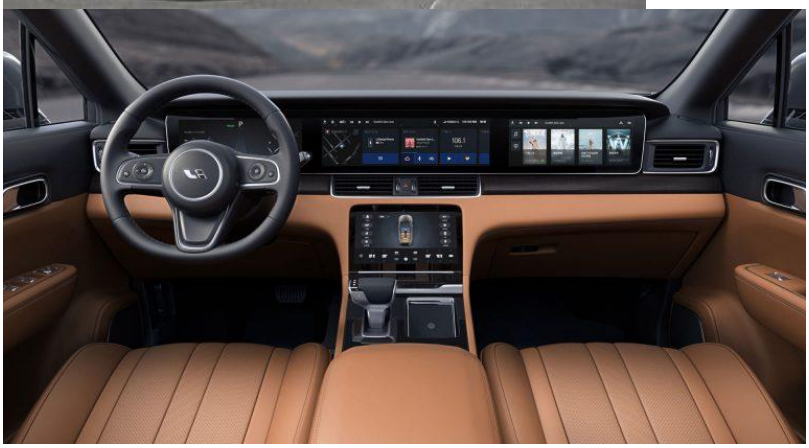


Source: BYD (2020)

One other entrant that is making noise in the US because of a recent capital-raising event is Li Auto. Their Li ONE EREV is a major departure from the norm for NEVs, precisely because it is an extended range electric vehicle. The big SUV comes with only a 40 kWh battery, so quite limited range if your desire is to go cruising in the countryside, albeit with ample energy to go to and from work. But if your plans do involve a very long drive, then the gasoline engine and alternator will start and generate electricity to keep the vehicle moving down the road for as long as there is gasoline in the tank. There is no mechanical connection between the gasoline engine and the drive wheels, the gasoline engine is strictly a mechanical device to charge the batteries.

Exhibit 3 – Li ONE EREV





Source: Li Auto (2020)

The Li ONE is decidedly not in the same market as the Wuliang Hongguang Mini EV. It sells for about USD$60,000, so about 15x what the Mini EV costs its buyer. It has leather upholstery everywhere. It has driving aids and amenities that rival or exceed anything in a Tesla, precisely because its 40 kWh battery and 1.2 liter turbocharged gas engine coupled to a generator is cheaper than a 60 kWh or 80 kWh NAC battery. But it also only sold 2,400 units in July. Because in China, cheaper is still better.

The Rationality of Rapid Recharging

In the rush to declare an end to the use of fossil fuels in passenger cars, the debate has seemed to hinge on the declining cost of batteries. The story seems to be that if battery costs fall low enough, then everyone will own a battery electric vehicle, charge up at home

and that will be that. The real issue will then be whether that automotive battery lasts for a million miles or two million or whatever. Apart from the uncomfortable fact that a big battery is always going to be an expensive thing, since there is no easy way for us to make batteries that are a tenth the size, and thus use a tenth of the raw materials yet hold the same amount of energy, there are some physical principles that make everyone owning a BEV a little more problematic than simply legislating the end to gasoline engines.

First, a tiny bit of physics, because I keep hearing these terms get mangled. There is an important distinction between power and energy. Power is the ability to do work, like accelerating a vehicle or keeping it at a constant speed on the highway as air resistance and friction between the tires and the road tries to slow it down. The metric unit for power is the Watt, abbreviated simply as W. At the scale of passenger automobiles, we normally need more power, so we usually use "thousands of Watts", or the metric abbreviation kW. Regardless, the number of kW that an electric motor can produce, in a vehicle, defines things like how high a speed it can reach, in combination with things like what motor speed leads to what power output, the weight of the vehicle and how sleekly it moves through the air.

The more commonly cited statistic is the energy carried by the battery. Energy is the power that can be delivered over a period of time, and for BEVs this is normally in metric units of thousands of Watt hours, abbreviated kWh. The more energy the battery contains, the farther the BEV can be driven and at higher speed. It shouldn't be surprising to realize that you need to use more power and thus more energy to accelerate a big, heavy BEV than to cruise at steady speed, or that you need a lot more power to cruise at 120 km/h on the highway than to cruise at 50 km/h down a city street.

Because batteries in BEVs take some time to recharge, a significant reason that potential BEV buyers cite for not being interested in buying one is the inconvenience of having to stop to recharge. Forgetting to charge the car the night before you are supposed to head out on a long drive might mean you need to add an hour or two to your travel timetable, to get the battery properly charged up. So one of the Holy Grails of battery development is to develop a battery that can be rapidly recharged without damaging the cells in the battery. Without going into detail, just remember that heat kills batteries.

We've been asked about a number of "miracle battery" companies, most recently a private company out of Israel called StoreDot. As others, they promise a battery that can be recharged in five minutes. Now, for me, that would be a great thing in my cell phone. I would love to be able to plug a charger in at the airport and grab a full charge while waiting at the gate. However, StoreDot (as the others before it, I don't mean to pick on StoreDot) are backed by venture capitalists, and the VC's (generally speaking, I don't mean to pick on all VC's, either) follow the whims of market fashion. Today, Tesla and BEVs are

the be-all and end-all, so the StoreDot battery is now going to allow your BEV to be recharged in five minutes.

So let's say that the goal is to have a BEV that is about as convenient to own as a car with an internal combustion engine. In that case, we want something that has about 500 km range on a full charge and a five-minute recharge time. To get a 500 km range, we need maybe a 60 kWh battery, what is available in some of the Teslas or the GAC Aion S sedan from China. Now, the physics of the situation takes over.

The average power draw of a home in North America, estimated by a few different sources, is around 1 kW. That can, obviously, spike up with appliance use. A hair dryer might consumer 1.5 kW. A big electric heater could suck down 10 kW on its own. But if you want to charge your 60 kWh battery from flat empty to full in five minutes, or 1/12th of an hour, then the average power required to do so would be 60 kWh/(1/12 h) = 720 kW power consumption. Or about 720x the average power draw in a home. Frankly, a whole lot more than any home I know of is even wired to provide, period. We are starting to get up to industrial levels of power when we talk about megawatts, or millions of Watts of power, and here recharging one car is pulling down 0.7 MW!

Actually, the situation is worse than what we describe above. When a lithium battery is charging, the charger keeps from damaging the battery by limiting the charging current, and thus the power, both when the battery is very near empty and when it is nearly full. But it provides a much higher power than average in the middle of the range, when the battery can accept the current without overheating. So that one BEV, to be successfully recharged in only five minutes without damage to the cells might need a peak charging power of well over 1,000 kW.

So it's likely that no one is going to be rapid charging like this at home, it will only be available at hypothetical rapid charging stations plunked down here and there across a city and out along the highways. Ok, but then let's remember that the power draw at this one location might end up rivaling the power draw at a steel minimill. If two or three BEVs are doing the five-minute recharge at the same time, peak power draw from this filling station could be 3-4 MW, more than the peak output from a single, large wind turbine.

The problem with this is that the electrical grid uses what are termed distribution substations to reduce voltages from the levels used to transmit electricity long distances, and send out that voltage at the levels we use in our homes and businesses, anything from 120 VAC to 600 VAC depending on local need. The power rating of these substations is anything from 3 MW up to 25 MW, but they are not built with a lot of slack. No utility builds a 25 MW substation in an area with only 10 MW of demand. To add 3-4 MW of new peak power use in an area will likely require a major renovation of the relevant

substation. And that can only be done if there is excess capacity on the feeder lines that are providing power to the substation. If that is not true, then new lines have to be pulled from whatever source is powering the substation to the substation, itself. This is not going to happen easily or quickly.

Now, if I want to recharge my cell phone battery in five minutes, that's easier. For example, my cell battery is 3 Ah at about 3.8 VDC, so 11.4 Wh of energy. Charging that in $1/12^{th}$ of an hour would require average power of 137 W. This, we can do, even from a simple North American wall outlet. But the itty-bitty charger I have now has an output of only about 15 W. This 137 W supercharger is going to be bigger, heavier and get a lot hotter than anything we use today. You might not want to plug it in for a five-minute blast, then unplug it and just throw it into your briefcase. But it could be done.

So, my thoughts? Being able to charge a BEV battery in five minutes is nice in theory but will be pretty much useless in practice because there won't be many places where it can be done. These rapid-charging batteries, assuming they are safe and don't suffer from premature failure due to heat, would be better used in portable electronics. But I bet that won't stop investors from chasing after the idea.

War is Coming?

There is a story brewing that is perhaps one of the most important of the year in terms of trade relations between western nations and China. Precisely because it is outside the realm of batteries and the like, it might have escaped your attention. That doesn't make it less important, though.

The United States and China have been in something of a bun-fight over trade for a good long time, now. There is blame to be assigned to both sides, as far as we are concerned, but that's irrelevant to the discussion at hand because we are stuck with the position in which we find ourselves.

To keep the story short, and I will try very hard to keep the use of acronyms to a minimum, the US has chosen to continue what seems to be a very direct campaign against Huawei by stipulating that no US company can sell sensitive technology products to Huawei without permission and a license, and any company outside of China that sells such products to Huawei won't be able to do business within the US. Among such products are items such as the system-on-chip (SoC) main processors designed by Qualcomm (their Snapdragon line) to power cellular telephone handsets or field-programmable gate arrays (FPGAs) made by Xilinx and Intel (formerly Altera) that are used to rapidly make changes to the hardware used in cellular telephone base station systems.

That embargo went into place on 14 September. Without access to these devices, among many other things, Huawei is left without a way to provide cutting-edge processing power to their high-end handset models, which is bad, but they are also left without a way to rapidly make changes to things like the hardware powering their 5G base station equipment, which is worse. While it is one thing for the US to suggest that Chinese authorities might, in some way and at some point in time, find a way to infiltrate and spy on networks incorporating Huawei hardware, it's quite another for the US to effectively tell China that not even China is allowed to build their own telecommunications networks using Huawei hardware!

Aside: we find the whole argument that because Huawei hardware is built in China, it will be used by Chinese security authorities for spying. I would make a very sizeable wager that there is at least one location in the US where people working for a 3-letter government agency are busy studying Huawei communications equipment and determining the best way to spy on Chinese (and other) networks that incorporate Huawei equipment, along with studying how to spy on networks that incorporate Ericsson or Nokia equipment. Everyone spies on everyone else and is constantly looking at ways to protect and compromise equipment used in their and other networks. That the problem is limited to Huawei equipment made in China is nonsensical, but nonsensical seems to be a good starting point for political point-scoring.

Our own theory about international relations is that nations should treat one another as neighbors. You can't really move and you can't make them move, so you might as well agree to get along. Maybe you really wish they would mow their grass more often, maybe it really bugs you, but it's probably best to just wave and smile, because unless you really have a carrot or stick that can be used, going over there and screaming at them to do something is probably not going to be productive. Your neighbors might be friendly, and that is always better than not, but they are not family. The best you can hope for is that, on things on which you agree and if it won't cost them too much, then they might help you out. And on things on which you disagree you hope that, if they are friendly, then they will do as little to antagonize you as possible. It helps to smile and wave and say hi.

Unfortunately, this is not where the US and China are right now. The US has apparently decided that stipulating Huawei equipment cannot be used for any system connecting the US government and its agencies wasn't enough. And strongly encouraging US allies to avoid using Huawei equipment also wasn't enough. The US is now effectively telling China that if they want to rapidly roll out a 5G network across their own nation then they should, perhaps, look at using western-made equipment for the network. As much as the US doesn't want to introduce potential security risks in the form of Chinese hardware into their networks, is it any wonder that China is not anxious to be forced to put western hardware into networks in China?

But, so what? Unless there is something China can do to push back, who cares? Unfortunately, there is something that can be done. It strikes back at the same industry, and it might cause damage quickly. It involves the critical material called gallium.

Gallium is a soft metal with small annual production. According to the US Geological Survey, 2019 global production of gallium was about 324 tonnes. The stuff is currently selling (in metallic form) for less than $200 a kg. And the world telecommunications industry absolutely needs it because the semiconductor gallium arsenide (GaAs) is critical to the operation of cellular telephone networks.

Every handset and base station in a cell tower has processors that properly structure and arrange data into radio signals that are then amplified and transmitted through an antenna and over the air to a receiving antenna, amplified again and then processed and passed along. Regular old silicon circuits are more than capable of keeping up with the processing and packaging of these signals. That is what the SoC in a handset is actually doing. But to amplify those signals up to meaningful levels of power and allow you to communicate with the cell tower at a distance, you need something different. You need a microwave power amplifier, and for 4G and 5G networks that means you are using a semiconductor made using GaAs or some other variant based on gallium. China makes about 96% of the gallium in the world. Do you see where we are going with this?

5G handsets might need three or four or more microwave power amplifiers. Base stations need a bunch. If you don't have them, you can't make a handset or a base station. To make them, you need a GaAs wafer. To make a GaAs wafer, you need gallium. China has the gallium. There might come a day, very soon, where China will make a quiet threat to the US that they might, in some way, declare gallium a strategic material and stringently limit sales outside of China. Effectively, they would be making the threat that if Huawei can't build their handsets and base stations, then no one else will, either.

And I am not sure if that sort of situation leads to anything good. At all.

Important Disclosures

Stormcrow Capital Ltd. ("Stormcrow") is a financial and technical/scientific consulting firm that provides its clients with some or all of the following services: (i) an assessment of the client's industry, business plans and operations, market positioning, economic situation and prospects; (ii) certain technical and scientific commentary, analysis and advice that is within the expertise of Stormcrow's staff; (iii) advice regarding optimization strategies for the client's business and capital structure; and (iv) opinions regarding the future expected value of the client's equity securities so as to allow the client to then make capital market, capital budgeting and capital structure plans. Stormcrow does publish research reports for general and regular circulation. Stormcrow is also registered in Canada with the Ontario Securities Commission in the category of Exempt Market Dealer. With the consent of Stormcrow's client, the client and/or its industry sector may be the subject of an investment or financial research report, newsletter, bulletin or other publication by Stormcrow where such publication is made publicly available at www.stormcrow.ca or elsewhere or is otherwise distributed by Stormcrow. Any such publication is limited to generic, non-tailored advice or opinions and should not be construed as investment advice that is suitable for the reader or recipient. Stormcrow does not offer personalized or tailored investment advice to anyone and its research reports should not be relied upon in making any investment decisions. Rather, investors should speak with their personal financial advisor(s).

Stormcrow intends to provide regular market updates on the affairs of the Company (at Stormcrow's discretion) and make these updates publicly available at www.stormcrow.ca. Readers who wish to receive notice when such updates become available, should browse to www.stormcrow.ca/research and click the "Subscribe to Research Distributions" link.

All information used in the publication of this report has been compiled from publicly available sources that Stormcrow believes to be reliable. Stormcrow does not guarantee the accuracy or completeness of the information found in this report and Stormcrow may not have undertaken any independent investigation to confirm or verify such information. Opinions contained in this report represent the true opinion of Stormcrow and the author(s) at the time of publication.

Any securities described in this research report may not be eligible for sale in all jurisdictions or to certain categories of investors. This report and the content herein should not be construed by anyone as a solicitation to effect, or attempt to effect, any transaction in a security. This document was prepared and was made available for information purposes only and should not be construed as an offer or solicitation for investment in any securities mentioned herein. The securities referred to herein should be considered speculative in nature and should be considered to involve a high amount of financial risk where investors may lose all of their investment.

Forward-looking information or statements in this report contain information that is based on assumptions, forecasts of future results, estimates of amounts not yet determinable, and therefore involve known and unknown risks, uncertainties and other factors which may cause the actual results, performance or achievements of their subject matter to be materially different from current expectations. No representation is being made that any investment or security will or is likely to achieve the return or performance estimated herein. There can be sharp differences between expected performance results and the actual results.

Dissemination of Research

This research report is widely available to the public via its website: www.stormcrow.ca/research

Investment Rating Criteria

We do not provide an investment rating, beyond indicating whether the target price exceeds current trading ranges by a reasonable range, indicated as "Positive", or whether the target price is either below or roughly equivalent to the current trading range, indicated as "Negative". Each investor has an individual target return in mind, we leave it to the individual investor to determine how our target and the current price fit in their portfolio.