EXECUTIVE SUMMARY

COMMODITIES/NICKEL: THE STAINLESS STEEL MARKET EXPERIENCED STUNNING TUMULT IN MARCH due to an LME dustup precipitated by **Russia's invasion of Ukraine and a short squeeze involving Chinese metals group Tsingshan**. When calm was restored, market conditions remained as they were with long lead times and higher prices. Prior to the LME nickel's break with reality, March nickel prices were up about 5% from February and at their highest levels since 2008. Supply shortage fears drove a rally in nickel, used in stainless steel and EV batteries, as Russia faced tightening economic sanctions. Russia accounts for 20% of global Class 1 nickel exports. On the day of the invasion (2/24), LME 3-month nickel settled at $11.63/lb. By March 7, nickel settled at $19.12/lb and spiked on March 8 with some buys as high as $45.81/lb. **The LME suspended trading**, cancelled trades and set trading limits. Some mills raised nickel premiums, while others pulled off the market to prevent panic buying. **Market-leader NAS announced a resolution** on March 18, defining the April surcharge using LME prices from 2/21 to 3/7 and excluding prices from 3/8 to 3/18, when trading was suspended. The result was an average of $12.60/lb. For the week ending 3/25, LME nickel averaged $15.19/lb vs. the February average of $10.96/lb.

AMERICAS: U.S. MANUFACTURING ACTIVITY SLOWED IN MARCH as tight supply chains continued to drive input prices higher, but factories boosted hiring, allowing them to reduce the backlog of unfinished work. **Employers** added 431,000 jobs in March, and the jobless rate fell to 3.6%. March marked the 11th-straight month of job gains above 400,000. **Rising energy, food and services prices** pushed already elevated U.S. inflation to a 7.9% annual rate in February. **Consumer confidence** rebounded in March from the prior month's one-year low, bolstered by growing labor market optimism. **Retail sales** increased 0.3% in February and were up 17.6% from a year ago. Sales at auto dealerships increased 0.8%, reflecting higher prices amid shortages, as auto manufacturers reported a decline in unit sales. **Existing home sales** fell 7.2% in February. Mortgage rates surged, with the 30-year fixed rate near a three-year high. Rates averaged 4.67% in late March. **Producer prices** rose 0.8% as goods prices shot up 2.4%, pushed up by a 14.8% spike in wholesale gasoline prices that accounted for nearly 40% of the increase in the price of goods. The PPI climbed 10% in the 12 months through February.

OVERSEAS: EUROPE'S ECONOMIC RECOVERY SLOWED IN MARCH AFTER RUSSIA'S INVASION OF UKRAINE. The war's impact rippled quickly through Europe by disrupting already strained supply chains, weakening confidence and sending raw-material and energy prices soaring. The EC prohibited imports of key iron and steel goods from Russia into the EU. **COVID-19 lockdowns** in key Chinese manufacturing and shipping hubs raised alarms over a potential new wave of supply-chain disruptions.

STEEL: THE U.S. AND BRITAIN STRUCK A DEAL TO REMOVE TARIFFS ON BRITISH STEEL AND ALUMINUM. The UK will be allowed to ship up to an annual 500,000 tonnes of steel duty-free, an amount based on the actual trading volume in 2018 and 2019. **U.S. Steel** will spend $60mn to build a pig iron caster at its Gary Works steel mill to supplant imports to its scrap-based mill in Arkansas.

AUTOMOTIVE: GM AND PG&E PLAN TO TEST THE USE OF EVS TO POWER HOMES DURING OUTAGES as the California utility works to reduce the impact of wildfires on its customers. **Vietnamese EV maker VinFast** will start building a factory in North Carolina this year, which is expected to be operational in the 2nd Half of 2024 with capacity to produce 150,000 EVs/year. **General Motors** plans to create a new, independently owned premium brand in China that will market "halo cars" with edgy designs from the U.S.

ENERGY: THE NUCLEAR INDUSTRY MAY NOT BE IMMEDIATELY AFFECTED BY SANCTIONS ON RUSSIA despite reliance on uranium imports. Sanctions would have more severe implications for advanced nuclear reactor designs, which require an advanced form of uranium fuel only available from Russia and China. **South Korea's nuclear power industry** is at an inflection point after Yoon Suk-yeol won the presidential vote and pledged to revive the fortunes of a once-dominant sector that faces stiff business hurdles.

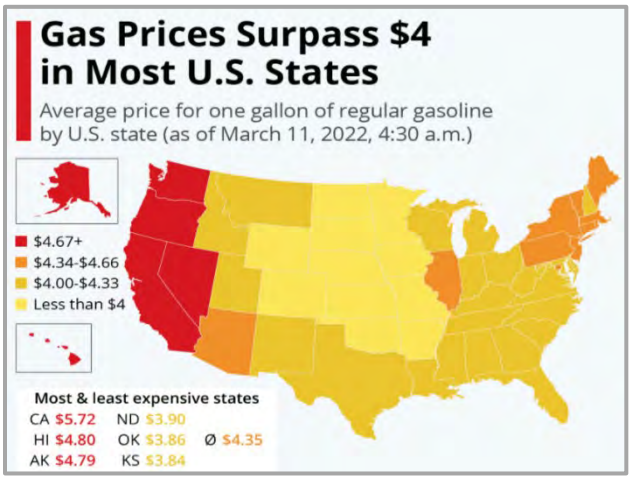
MEDICAL: NEW RESEARCH SHOWS HIGHER RISK OF DEVELOPING DIABETES AFTER COVID-19 INFECTION. A large new study found that people who recovered from COVID-19 within the past year are 40% more likely to receive a new diagnosis of diabetes compared to those who weren't infected. **NVIDIA is expanding its products for healthcare** with the launch of Clara Holoscan MGX to help medical device organizations develop artificial intelligence tools and cut the time to market for software-defined medical devices.

AEROSPACE: DELTA AIR LINES WILL HELP AIRBUS DEVELOP A HYDROGEN-POWERED PASSENGER AIRPLANE. Airbus plans to produce a small "ZEROe" passenger aircraft powered by hydrogen to enter service in 2035 and wants feedback from customers as the new aircraft is developed. **Roscosmos, the Russian space agency,** will no longer service the RD-180 rocket engines used by the United Launch Alliance, the joint venture of Lockheed Martin and Boeing, to launch national security missions for the Pentagon.

THE AMERICAS

- **U.S. producer prices** rose 0.8% in February as the prices of goods shot up 2.4%. A 14.8% spike in wholesale gasoline prices accounted for nearly 40% of the increase in goods prices. The PPI climbed 10% in the 12 months through February. Excluding the volatile food, energy and trade services components, core producer prices climbed 0.2% in February, the smallest gain since November 2020.
- **The Index of Leading Economic Indicators** rose 0.3% in February. The Conference Board said the latest results don't reflect the full impact of Russian's invasion of Ukraine, which could lower the trajectory of the LEI and signal slower-than-anticipated economic growth in the first half.
- **U.S. import prices** increased 1.4% February, boosted by strong gains in petroleum and food costs. Excluding fuel and food, import prices gained 0.6%. In the 12 months through February, prices accelerated 10.9%. Export prices advanced 3.0% and 16.6% YOY in February.
- **The U.S. trade deficit** held at a record high in February at $89.2bn. Exports of goods and services rose 1.8% to a record $228.6bn, boosted by a 1.8% jump in goods exports. Petroleum exports hit a record high of $20.3bn. Imports jumped 1.3% to an all-time high of $317.8bn, fueled by surge in crude oil, which averaged $76.37/bbl. Imports of motor vehicles, parts and engines fell $3.2bn.

  Key Update: *Trade has reduced from GDP growth for six straight quarters. Growth estimates for the 1st Qtr range from as low as a 0.4% annualized rate to as high as a 2.8% pace.*
- **U.S. retail sales** increased 0.3% in February and 17.6% from a year ago. Data for the prior month was revised sharply higher to show sales surging 4.9% instead of 3.8% as previously reported. Sales at auto dealerships increased 0.8%, reflecting higher prices amid shortages, as motor vehicle manufacturers reported a decline in unit sales in February. Receipts at service stations shot up 5.3%.
- **Durable goods orders** fell 2.2% in Frebruary. Bookings for commercial aircraft slumped more than 30%. Boeing reported 37 orders in February, down from 77 a month earlier. Orders for motor vehicles and parts fell 0.5% following a 0.7% decline in January. Excluding transportation, durable goods orders dropped 0.6%.
- **U.S. factory orders** fell 0.5% in February due to persistent shortages of materials and a shift in spending back to services, but manufacturing remains supported by low inventories at businesses The decline in factory orders in February was led by a 5.3% tumble in transportation equipment. Orders for motor vehicles and parts fell 0.6%.
- **Rising energy, food and services prices** pushed already elevated U.S. inflation to a 7.9% annual rate in February—another four-decade high, with oil and commodity market disruptions from the Ukraine crisis expected to add more cost pressures. By mid-March, the retail price of regular had increased 19.3%. The CPI rose a 0.8% in February, as a 6.6% rebound in gasoline prices accounted for a third of the increase. With inflation four times the Fed's 2% target, economists expect as many as seven rate hikes this year.



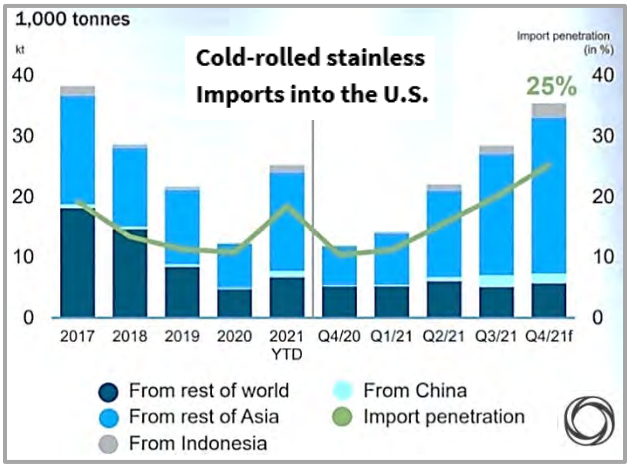
Key Update: *Inflation will mean the average U.S. household has to spend an extra $5,200 this year ($433 per month) compared to last year for the same consumption basket.*

- **U.S. manufacturing** surged 1.2% higher in February and combined with a 0.1% gain in mining to lift industrial production 0.5% higher. Production of consumer goods fell 0.4%, including a 3.5% drop in automotive products. Utilities output dropped 2.7%. Electricity fell 0.9% and natural gas declined 12%. Capacity utilization for the entire industrial sector rose 0.3 to 77.6%.
- **Consumer confidence** in March rebounded from a one-year low amid growing labor market optimism, according to the Conference Board suvey. Still, rising interest rates amid high inflation could hurt purchases of motor vehicles over the next six months and constrain consumer spending.
- **Employers** added 431,000 jobs in March, and the jobless rate fell to 3.6%. March marked the 11th straight month of job gains above 400,000, the longest such stretch of growth in records dating back to 1939. The labor-force participation rate increased to 62.4% in March, up 0.1% from February and from a pandemic trough of 60.2% in April 2020.
- **Consumer spending** rose 0.2% in February as an increase in spending on services was offset by declining purchases of motor vehicles and other goods. Personal income rose 0.5%, with wages shooting up 0.8%. When adjusted for inflation, consumer spending fell 0.4% in February.

- **Existing home sales** fell 7.2% in February to an annual rate of 6.02 million units. Mortgage rates surged, with the 30-year fixed rate near a three-year high. Rates averaged 4.67% in late March. New home sales fell 2% to an annual rate of 772,000 units. Housing starts rebounded to the strongest pace since 2006, increasing 6.8% to 1.77 million units. Applications to build eased to an annualized rate of 1.86 million units but remained at an elevated level.
- **U.S. manufacturing activity** slowed in March as tight supply chains continued to drive input prices higher, but factories boosted hiring, allowing them to reduce the backlog of unfinished work. The ISM index of national factory activity fell to 57.1 from 58.6 in February. The slowdown in manufacturing reflects a shift in spending back to services amid a significant decline in COVID-19 infections.
- **The West Coast labor contract** covering about 22,000 dockworkers, at sites including the pivotal Los Angeles and Long Beach ports, expires on July 1. Some past disputes between the union and management have proved crippling for shipments to the Western seaboard, stoking fears of a repeat just as dockyards work to clear backlogs of goods. The 29 ports on the U.S. West Coast are vital links to the global economy, processing about 44% of all inbound goods and 61% of imports from Asia.

  Key Update: *A backup of container ships waiting to unload at the Southern California ports, which reached a record 109 vessels in January, fell to 48 ships on 3/13, the smallest it has been since September. Before the pandemic, it was unusual for more than one or two ships to wait for a berth.*
- **Construction spending** increased 0.5% in February to an annual rate of $1.704 trillion. That figure is 11.2% above a year ago. Spending on private construction rose 0.8%, mostly new single family residential construction. Meanwhile, public construction outlays went down 0.4%.
- **U.S. services industry activity** rose to a reading of 58.3 in March, up from 56.5 in February. The ISM's services index reported gains in production, new orders, employment and prices. Order backlogs expanded and supplier deliveries continued to slow, all signs of brisk activity in the sector.
- **Foreign steel imports** into the U.S. in February totaled 2.339mn tons, including 1.831mn tons of finished steel and represent increases of 23% and 28% respectively vs. a year ago. YTD imports were 5.383mn tons including 4.110mn tons of finished steel, up 22% and 54% respectively. Finished steel import market share was 23% YTD.
- **U.S. steel mills** shipped 7.757 million tons of steel in January, a 1.4% drop from December 2021 but a 4.5% gain vs. a year ago. (See **Appendix: Steel**, page 8)

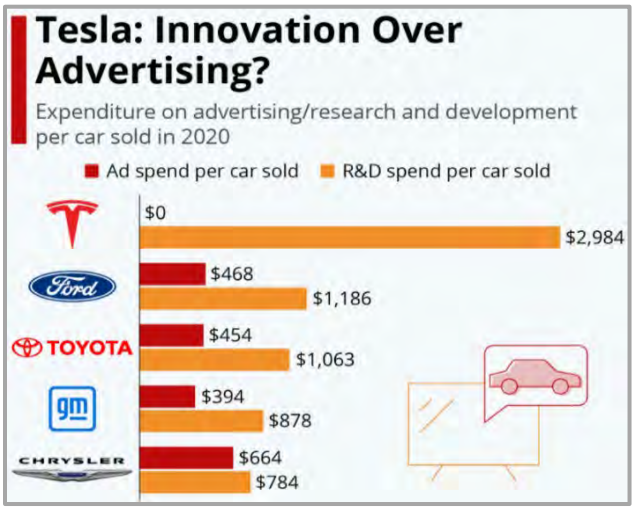
- **The stainless steel market** experienced stunning tumult due to an LME nickel dustup in March precipitated by Russia's invasion of Ukraine and a short squeeze involving Chinese metal group Tsingshan. When calm was restored, market conditions remained as they were with long lead times and higher prices. Prior to the LME nickel's break with reality, March prices were up about 5% from February and at the highest levels since 2008. Supply shortage fears drove a rally in nickel, used in stainless steel and EV batteries, as Russia faced tightening economic sanctions. Russia accounts for 20% of nickel exports. On the day of the invasion 2/24, LME 3-month nickel settled at $11.63/lb. By March 7, nickel settled at $19.12/lb and spiked on March 8 with some buys as high as $45.81/lb. The LME suspended trading, cancelled trades and set trading limits. Some mills raised nickel premiums, while others pulled off the market to prevent panic buying. Market-leader NAS announced a resolution on March 18, defining the April surcharge using LME prices from 2/21 to 3/7 and excluding prices from 3/8 to 3/18, when trading was suspended, resulting in an average of $12.60/lb.



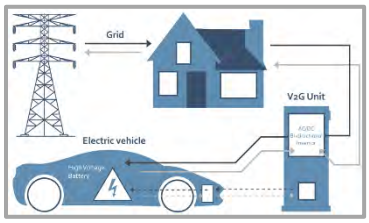
- **U.S. Steel** will spend $60mn to build a pig iron caster at its Gary Works steel mill to supplant imports to its scrap-based mill in Arkansas. The caster will produce up to 500K tons/year of pig iron and be able to supply nearly half of the ore-based metallics required for the company's 3.3mn tons/year electric arc furnace at the Big River Steel mill in Arkansas. Construction is expected to begin in the 1stH 2022 and conclude in next year's 1stH. USS is also building a new 3mn ton/year electric arc furnace/flat-rolled steel mill next to the Big River Steel facility, which will go online in 2024.

  Key Update: *The American steel industry is faced with potential pig iron shortages after Russia invaded Ukraine, stifling exports from both countries.*

- **The U.S. and Britain** struck a trade accord, removing U.S. tariffs on British steel and aluminum, while the UK will lift levies on $500 million worth of American whiskey, motorcycles and tobacco. The UK will be allowed to ship up to an annual 500,000 tonnes of steel duty-free, an amount based on the trading volume in 2018 and 2019. The deal also sets tariff-free quotas for several types of aluminum.
  Key Update: *The U.K. won't join the U.S./EU in negotiating a "Global Sustainable Steel Agreement" to encourage metals manufacturers to reduce their greenhouse gas emissions.*
- **Tesla** has become one of the world's most valuable companies, with car deliveries of almost one million last year despite global supply chain problems and the dampening economic effects of the pandemic. This has been achieved with zero spending on traditional advertising. The reliance on word-of-mouth marketing allows a far larger budget for R&D. Ford and Toyota's combined spend per car sold on advertising and R&D amounted to $3,171, similar to the amount Tesla sunk into innovation. (See **Appendix: Automotive**, pages 9 and 10)



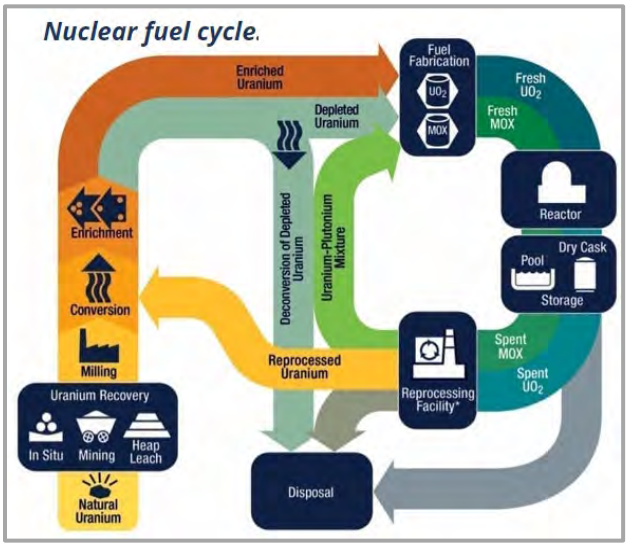
- **Auto-industry forecaster S&P Global Mobility** lopped more than 5 million cars off its projections for global production this year and next, largely due to fallout expected from Russia's invasion of Ukraine. S&PGM lowered its 2022 and 2023 estimates each by 2.6 million vehicles. The forecaster now expects auto companies to make 81.6 million cars worldwide this year and 88.5 million next year.
- **Consumer interest in electric vehicles** and other clean-energy technologies is speeding up, with gasoline prices setting records across the U.S. and oil topping $100 a barrel. In the week ended March 13, 25% of shoppers on *Edmunds.com* considered a hybrid, plug-in hybrid or electric vehicle, a 39% increase from the previous week and an 84% surge from the same period in February.
- **U.S. retail sales of new vehicles** could fall 27% to 1.044mn units in March from a year earlier, according to J.D. Powers. The consultants expect global vehicle sales in March to suffer from the added effect of the war in Ukraine and an increase in inflationary pressure on consumers worldwide. Total new-vehicle U.S. sales for the month are expected to reach 1.188mn units, a 28% decrease from last year. With supply still lagging behind demand, the U.S. average of new-vehicle retail transaction price in March is expected to rise 17% to $43,737, dropping from the previous high in December 2021 of $45,283. The annualized rate for total new-vehicle sales is expected to be 12.7mn units.
- **General Motors and PG&E** plan to test the use of electric vehicles to power homes during outages, as the California utility works to reduce the impact of wildfires on its customers. They plan to test the concept this summer with charging hardware and other technology allowing for two-way power flow from EV to home. The idea could help GM market its EVs as backup generators in emergencies, adding to their appeal. (See **Appendix: Automotive/Energy**, page 10)



  Key Update: *The PG&E pilot is one of many efforts under way to test the use of EVs as backup power sources capable of feeding into the grid, rather than just drawing from it. The idea that EV batteries could help supply a region's power grid is called vehicle-to-grid or V2G.*
- **The International Energy Agency** urged member countries to adopt "emergency measures" to cut oil demand after Russia's invasion of Ukraine. About 2.5mn bbl/day of Russian oil exports could cease in April forward because of the impact of the war and consumer boycotts of Russian crude. The IEA proposed ten measures to reduce oil consumption, including cutting speed limits, reducing business air travel and taking trains instead of planes where possible. Also on the list of suggestions are working from home three days a week, making public transport cheaper or even free, banning private cars from cities on Sundays and limiting private car access to roads in large cities.
- **An Executive Order** banning imports of Russian gas, coal and oil to the U.S. was signed by the President, making the U.S. the first country in the current alliance against Putin to do so. The ban is seen as largely symbolic by energy industry experts. U.S. imports of crude oil from Russia only made up 8% of total oil imports in 2021. The U.S. produced 33.5 trillion cu/ft of natural gas vs. imports of 2.5 trillion in 2020.

- **As Europe hunts for alternative energy suppliers,** the U.S. pledged to deliver at least 15 billion cubic meters of extra liquefied natural gas to the EU this year. Germany revealed targets to cut its dependence on Russian energy rapidly by turning to U.S. gas supplies instead. Berlin vowed to all but wean itself off Russian gas by mid-2024 and said that it aimed to become "virtually independent" of Russian oil by the end of 2022. Germany added that its target is to end its reliance on Russian coal within six months.

  Key Update: *Russia's war on Ukraine has inflicted a domestic toll that is already comparable to the worst downturns of Putin's more than two decades in power. An economy that was on track to expand this year swung into reverse in a matter of days. Bloomberg Economics' initial forecast is for Russia's full-year GDP to slump about 9% in 2022.*
- **The nuclear industry** may not be immediately affected by sanctions on Russia despite reliance on uranium imports. U.S. utilities purchase about 20% of their requirements as enriched uranium from Russia. Nuclear operators could import enriched uranium from other countries. Sanctions would have more severe implications for advanced nuclear reactor designs, which require an advanced form of uranium fuel only available from Russia and China.



- **U.S. airlines** said travel demand is roaring back, and they believe fliers will pay up to cover carriers' mounting fuel bills. In February, domestic ticket bookings and revenue rose above 2019 levels for the first time since March 2020. Carriers expect to be able to absorb higher jet fuel costs by paring back flying capacity and passing the costs along to customers. Fuel accounts for around 20% of costs and can jump to 30% or more when prices surge. Most major U.S. airlines no longer use futures contracts to hedge against price swings but buy fuel just a few weeks in advance.
- **Delta Air Lines** will help Airbus develop a hydrogen-powered passenger airplane. Airbus plans to produce a small "ZEROe" passenger aircraft powered by hydrogen to enter service in 2035 and wants feedback from customers as the new aircraft is developed. Airbus will build a demonstrator to test propulsion technology for hydrogen airplanes in cooperation with engine maker CFM International. Boeing has been more skeptical about commercial prospects for hydrogen-powered air transport by 2035, putting greater focus on sustainable aviation fuels.

  Key Update: *Delta is one of the biggest customers of Airbus. As of end-December, Delta had 368 Airbus planes in its fleet. The company has purchase commitments for another 245 Airbus planes and options for additional 120 aircraft.*
- **The James Webb Space Telescope** snapped a spectacular new photo, showing that the sun-orbiting observatory is on track to begin astronomical observations. The photo shows a distant star backed by galaxies, evidence that the 21.5/ft primary mirror of the $10bn, truck-size telescope is properly aligned and capable of gathering celestial light and delivering it to imaging instruments on board.
- **Roscosmos, the Russian space agency,** will no longer service the RD-180 rocket engines that are used by the United Launch Alliance (ULA), the joint venture of Lockheed Martin and Boeing, to launch national security missions for the Pentagon. It also will cut off the supply of the RD-181 engines used in Northrop Grumman's Antares rocket, which is used to fly cargo and supplies to the International Space Station. ULA has moved to develop another rocket called Vulcan that would use American-made engines supplied by Jeff Bezos' Blue Origin. Those BE-4 engines have been delayed, but ULA expects to receive them this year and to start flying Vulcan. See **Appendix: Aerospace**, page 13)
- **A large new study** found that people who recovered from COVID-19 in the past year are 40% more likely to receive a new diagnosis of diabetes vs. those not infected. The increased risk translates to 1% of people who have had COVID-19 developing diabetes who otherwise wouldn't have, resulting in potentially millions of new cases worldwide. Most of the people with diabetes in the study were diagnosed with Type 2, not Type 1. Researchers say COVID-19 may also be triggering an entirely new type of diabetes in which certain cells mistakenly start to raise rather than lower blood sugar. (See **Appendix: Medical**, page 12)

EUROPE, AFRICA & THE MIDDLE EAST

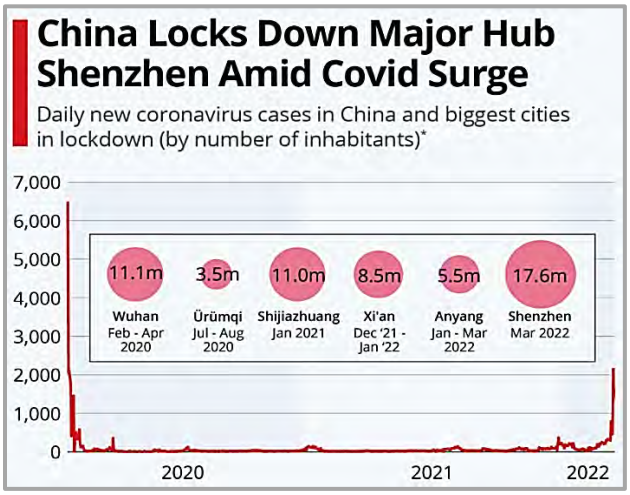
- **Europe's economic recovery** slowed in March after Russia's invasion of Ukraine. The war's impact rippled quickly through Europe, disrupting already strained supply chains, weakening confidence and sending raw-material and energy prices soaring. The lifting of pandemic restrictions on Europe's services sector is softening the blow for now, but economists expect this positive effect to fade and the war to take a heavier toll on growth as higher energy costs push up consumer prices.

- **Ford unveiled plans** for 7 new electric models in Europe by 2024, a battery-assembly site in Germany and a nickel cell manufacturing JV in Turkey, as part of a major EV push on the Continent. Ford plans to sell more than 600,000 EVs in the region by 2026 and expand its partnership with VW by producing a second EV for the European market based on VW's platform. This will double its volume of vehicles based on VW's modular electric-drive platform to 1.2 million units over six years. (See **Appendix: Automotive**, page 9)
- **BMW and Volkswagen** have both been forced to idle plants across Europe after Russia's invasion forced Ukrainian wiring plants to shut down. The country's fledgling auto industry, which boasts close to 40 parts factories, is at risk as carmakers race to relocate or duplicate the bespoke equipment needed to make harnesses.
- **Intel will invest €30bn** to boost chip manufacturing in Europe, including €17bn for a giant new manufacturing plant in Germany, using the most advanced chip-manufacturing technology. The plant is the centerpiece of a decade-long investment plan that could eventually cost €80bn. Intel is also investing €12bn into an existing facility in Ireland that operates on less cutting-edge technology.
  Key Update: The Intel German "mega fab", which is set to start operating in 2027, is intended to produce chips with features that are two nanometres or less in width.
- **The European Commission** prohibited imports of key iron and steel goods from Russia into the EU. The EC directly targeted Russian steelmakers by distributing Russian import quotas to other countries to compensate for the loss of this source of supply. The EC will also withdraw Russia's most-favored-nation designation and formalized plans to suspend Russia's membership in major global financial institutions, including the IMF and the World Bank.
- **Russian goods imports** amounted to $247 billion in 2019, the last year undisrupted by the COVID-19 pandemic. Motor vehicles and parts were the biggest item on Russia's imports list with a total trade value of $23.4 billion, while industrial machines and electrical machinery and appliances completed the top three. Following the ruble's depreciation in the wake of Western sanctions, imported consumer goods are set to become unaffordable to many Russians, if available at all.

- **European steelmakers** cut back operations as power prices surged to record levels in response to Russia's invasion of Ukraine. Acerinox partially closed its Cadiz plant, where a stainless steel mill was shut down. Hot and cold-rolling mills were still operating but may stop if the stainless steel mill doesn't resume. Salzgitter reduced its melting operations at its Peine (Germany) plant. Liberty Steel stopped production at its Rotherham mill (UK). ArcelorMittal's Sestao plant (Spain) did not resume working as previously planned due to high electricity costs.
  Key Update: *The day-ahead average power price in Spain in early March jumped to €545 per megawatt-hour, twice what it was just two weeks prior. That kind of cost pressure was mirrored across Europe.*
- **ArcelorMittal** idled three steel mills in Spain and partly closed two others after a truckers strike disrupted supplies of scrap metal, iron ore and equipment. The strike forced it to suspend production at its Bergara mill from March 16 and at its Legasa and Lesaka mills from March 26, and closed parts of mills in Gijon and Aviles for lack of supplies.
- **Europe's ExoMars mission** to land a life-seeking rover on Mars cannot launch as planned in September, following the suspension of collaboration with Russia, delaying it by at least four years. The €1.68bn ExoMars project was to have been launched on a Russian Proton rocket.

ASIA/PACIFIC, JAPAN, AUSTRALIA & INDIA

- **COVID-19 lockdowns** in key Chinese manufacturing and shipping hubs raised alarms over a potential new wave of supply-chain disruptions. Companies including Apple supplier Foxconn, Volkswagen and Toyota suspended factory operations. More than 40 Taiwan-based makers of semiconductors and other electronic components suspended work. Logistics operators are warning of potential delays over the lockdowns in Shenzhen, a key export hub with the world's fourth-largest container port.



- **Vietnamese EV maker VinFast** will start building a factory in North Carolina this year ahead of a planned U.S. IPO. The plant is an investment of $2 billion and is expected to be operational in the 2nd Half of 2024. The facility will have capacity to produce 150,000 electric cars a year.
  Key Update: *VinFast said it is working with investment banks to prepare for an IPO that would make it one of the first Vietnamese companies to be traded in the U.S.*
- **General Motors** plans to create a new, independently owned premium brand in China that will market "halo cars" brought in from the U.S. GM plans to build this new premium import business from the ground up and operate it with a high level of autonomy. "Halo cars" refer to premium, often high-performance cars that have an edgy design. The new business will be fully owned by GM.
- **Total world crude steel production** was 142.7 million tonnes (Mt) in February, a 5.7% drop compared to a year ago. Chinese crude steel output fell 10% to 75.0 Mt vs. February 2021. The U.S. produced 6.4 Mt, a gain of 1.4%. India's output was 10.1 Mt, a 7.6% gain on a year ago.
- **Global stainless steel melt shop production** for the full year 2021 increased by 10.6% YOY to 56.3 million metric tons (Mt). Output in the U.S. was 2.368 Mt, up 10.4%. European production gained 13.6% to 7.181 Mt.
- **South Korea's nuclear power industry** is at an inflection point after Yoon Suk-yeol won the presidential vote, as a pledge to revive the fortunes of a once-dominant sector faces stiff business hurdles. It's the second U-turn in less than a decade for the industry, which has been left in tatters with major talent and business losses during President Moon Jae-in's policy to exit nuclear energy. Yoon has rejected phasing out nuclear energy and made it a key pledge of his campaign to boost investment in the industry and restore its earlier preeminence as an exporter of lean and safe reactors. Currently, nuclear power makes up 27% of the country's power mix. Yoon promised to lift nuclear power's contribution to 30% by restarting construction, extending reactors' lives and export 10 nuclear power plants by 2030. (See **Appendix: Energy**, page 11)

- **The London Metal Exchange** has no current plans to ban metal from Russian producers from its system, such as nickel and copper from Norilsk Nickel or aluminum from Rusal, despite calls from some members to do so. Russia supplies about 10% of the world's nickel, 6% of its aluminum and 3.5% of its copper. A ban on Russian metal could lead to shortages and further price surges at a time of rising inflation around the world.
  Key Update: *Suspending new deliveries of Russian metal would exacerbate already tight supplies and fuel a jump in prices similar to that seen after the U.S. Treasury Department imposed sanctions on Rusal and the LME delisted its aluminum in 2018. Aluminum prices jumped 30% in just a few days after the move.*
- **South Korean steelmaker Posco** will invest $4 billion in a new lithium mining project in Argentina to tap into soaring demand for the key rechargeable battery metal. The funds will be invested in a project at a salt flat called Salar de Hombre Muerto. Posco expects to initially produce 25,000 tonnes/year of lithium hydroxide, an especially high-demand lithium product for battery makers, and reach 100,000 tonnes once the venture is completed.
- **The Kwinana refinery near Perth,** a venture between China's Tianqi and Australian miner IGO, will turn refined spodumene from the Greenbushes mine into lithium hydroxide for batteries used in EVs and grids, as countries work to loosen China's stranglehold on the lithium supply chain. Australia is the biggest exporter of lithium, with 46.4% of the market in 2020, but it has never refined the product onshore. (See **Appendix: Commodities**, page 9)

ECONOMIC UPDATE: APPENDIX TO THE APRIL 2022 ISSUE

STEEL: RUSSIAN STEEL GIANT SEVERSTAL STRUGGLES UNDER SANCTIONS

When the oligarch owner of Severstal was sanctioned by the European Union in February, the move immediately froze Severstal out of a third of its sales and set the scene for possibly the first debt default by a major Russian company since the invasion of Ukraine. **Skids of the company's steel were stranded in warehouses across Europe, one of its foreign subsidiaries was left without money to pay employees and sales staff scrambled to find new clients. Years-long relationships collapsed overnight and Western equipment was suddenly off limits.** In late March, Europe's third-largest steelmaker by output failed to make a payment on its debt—despite having funds available—after Citigroup froze interest payments to investors in the company's bonds. Severstal hasn't declared a default so far, nor have the bonds' holders or credit-rating companies. Severstal might find a way to make the payment in the coming days, especially if Mordashov were to cut or relinquish his large stake in the firm, which itself is not sanctioned. The EU sanctioned Alexey Mordashov, who owns 77% of Severstal, on Feb. 28, identifying him as the majority owner of what it described as the personal bank of senior Kremlin officials. Brussels also said Mordashov's media company had actively supported Russia's destabilization of Ukraine and that he had profited from doing business in Crimea, which Russia annexed in 2014. Even before the invasion, European customers had started to steer clear of Severstal as Russia built up its military forces on Ukraine's border. With Mordashov sanctioned, cancellations started stacking up. Severstal faces several challenges. While the company sells about 70% of its steel domestically, Russian officials have called on producers to keep prices low in the country. That production could be complicated by sanctions that prevent Western manufacturers from supplying specialized equipment to the steel and mining sectors. Exports could also be tricky for the company. Severstal has said it plans to pivot its exports away from Europe and into Asia, South America and the Middle East. **Even getting steel out of Russia is now problematic because some nations have stopped their shipping companies from carrying Russian goods, and other businesses have voluntarily shunned them.** The EU's ban on all Russian steel also means Severstal will likely face opposition from domestic rivals in any new markets. A spokeswoman said Severstal's low production costs give it a competitive advantage even in crowded markets like Asia. Finding new buyers might be hard given overcapacity in steel, underscoring the problems that Russian companies will face as they look for new markets outside of the West. Big Asian economies are net steel exporters, unlikely to take Russian steel.

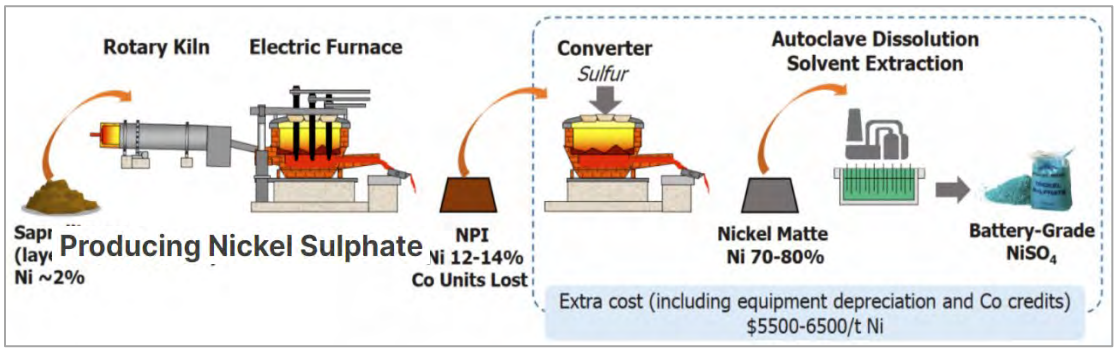
STEEL EUROPE: THYSSENKRUPP ANTICIPATES SETBACKS DUE TO WAR IN UKRAINE

Thyssenkrupp is suspending guidance on free cash flow as a result of Russia's invasion of Ukraine and putting its planned steel spin-off into abeyance. Both are setbacks to the industrial conglomerate's rebirth. Once a champion of Germany's postwar *Wirtschaftswunder*, or economic miracle, Thyssenkrupp has spent the past few years spinning off units and bolstering its balance sheet. Shares had halved in the two years before the pandemic, which brought a further halving. The suspended guidance in March ate into the subsequent rally, lopping a tenth off the shares. This year, free cash flow (pre-M&A) was expected to break even, a key data point for a company that has bled billions of euros in outflows over the past five years. Russia's invasion of Ukraine changes that due to secondary effects. The two countries comprise under 1% of turnover. **Input prices, including energy, are going through the roof and automakers, facing supply chain squeezes, are deferring buying steel.** The steel unit had been looking good. In the year to end-September, it produced ebitda of €214mn — it lost more than twice that the previous year — and had been expected to contribute more than half of this year's targeted €1.8bn operating profit. But plans to jettison Steel Europe have been dogged from the start. Brussels blocked a proposed merger with India's Tata Steel on antitrust grounds in 2019 and an attempted sale fell apart when UK industrial tycoon Sanjeev Gupta's Liberty Steel failed to secure financing. Higher steel prices should burnish the proposed unit, but 60% of Thyssenkrupp sales are on half-annual, annual or multi-annual contracts, reducing flexibility. Challenges to the group transformation are "certainly not getting any smaller", said boss Martina Merz, an obvious understatement.

AUTOMOTIVE: ELECTRIC VEHICLE PUSH BUMPS UP AGAINST CHAOS IN NICKEL MARKET

Surging nickel prices threaten to put a dent in the auto industry's EV ambitions, with the key battery metal caught up in war-induced supply worries and a short squeeze that's sent prices to unprecedented highs. While analysts say prices will subside from current stratospheric levels, the bad news is that they could remain elevated and add hundreds of dollars in costs. The EV industry was already scrambling to secure battery metals for an expected jump in demand. **The price surge means automakers will have to redouble efforts to find substitutes or alternate sources, one of which could come from Tsingshan Holding Group, the Chinese mining giant that last year introduced a way to produce battery nickel from low-grade ore.** Nickel is the single biggest component in terms of cost. For now, buyers are also saddled with a lot of uncertainty over prices. While nickel prices had been rallying for weeks amid fears of disruption from key supplier Russia, March's price spike was triggered when holders of short positions, including Tsingshan, rushed to close them out. Prices rose as much as 250% in two days to more than $100,000/tonne. Analysts say nickel could remain elevated this year, and carmakers will see higher prices that could add hundreds of dollars in cost per car. Here's how the math works. A 100 kilowatt hour battery needs about 145 pounds of nickel. Last year's average price was about $18,500 per metric ton, about $1,200 of nickel in every battery. At $29,000 per metric ton, where it closed before the worst of the short squeeze, that same battery needed more than $1,900 in nickel. It's not a huge jump, but carmakers don't like to see the cost of one material go up by $700 a vehicle. Carmakers do lock in long-term supply contracts and can avoid price hikes on the spot market for a while, but if higher pricing persists, they will be paying more. New sources are coming on line in Indonesia and Russian nickel will find its way out to China and other nations that aren't using sanctions or boycotts, but prices likely will remain elevated this year, averaging around $22,000. That will put a squeeze on the margins of an already profit-challenged part of the market and could entice auto companies to hasten their move toward other metals.

Last year, Tsingshan, the world's largest nickel producer, started shipping its first cargo of nickel matte. It's a new way to make nickel for batteries that analysts say may open up a big supply route from low-grade ore mines for EVs. While capacity is limited at the moment, Tsingshan had shipped its first batch of nickel matte for EV batteries from its Indonesia plant, with three production lines under operation with monthly capacity of 3,000 tons. The new process, if followed by other nickel pig iron producers, will likely add more to supply for battery-grade nickel. Analysts expect the conversion from nickel pig iron to nickel matte to accelerate, although this requires nickel prices to remain elevated, as this would require additional capital investments to change over existing furnaces.

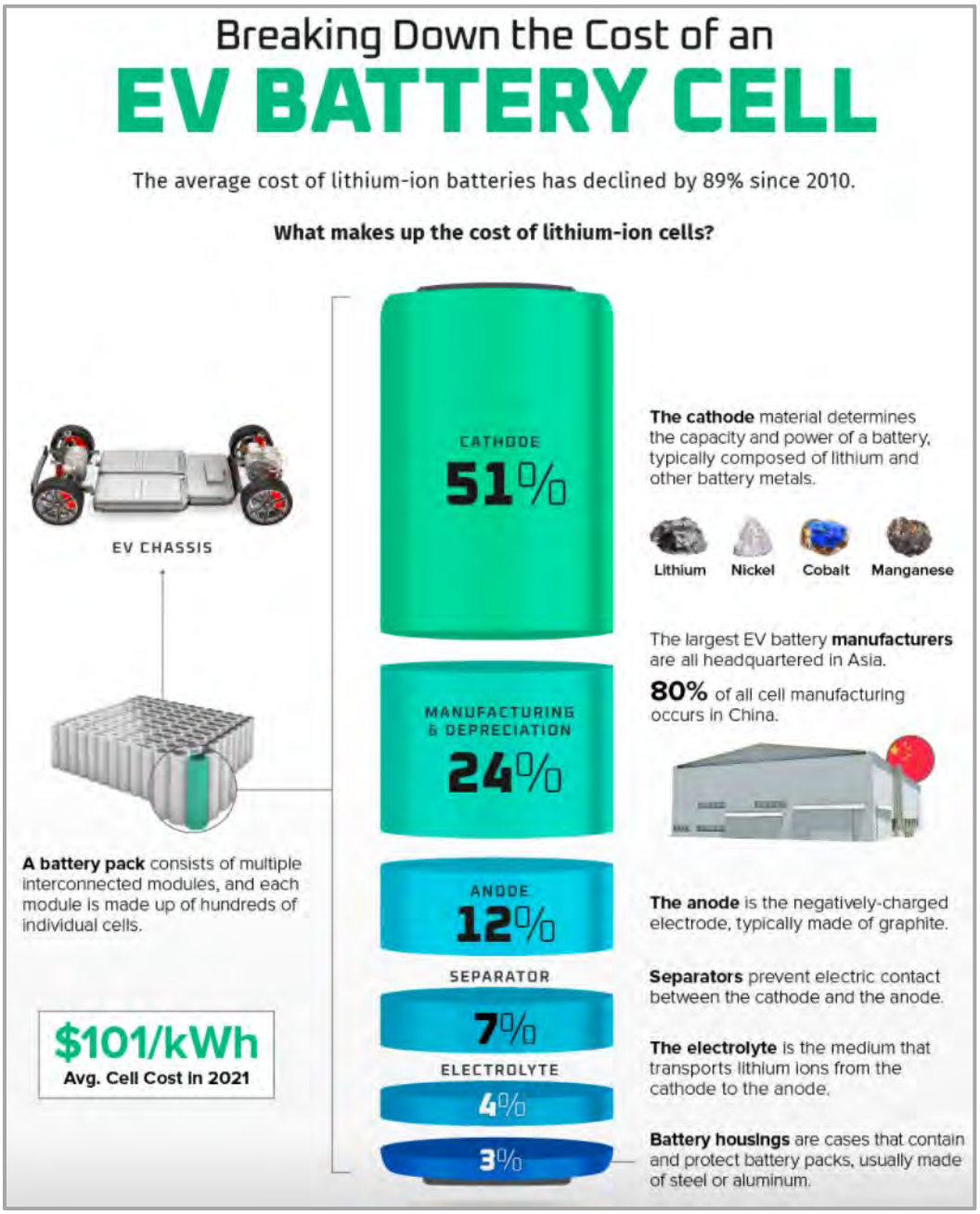


COMMODITIES: WILD NICKEL MARKET MAY GET RELIEF FROM INDONESIA'S HIGHER OUTPUT

Indonesia, the world's top nickel producer, will raise production capacity of the metal after prices soared past $100,000 a ton, while the coal market is unlikely to get similar relief. **The country is set to add 393,000 tons to 400,000 tons of nickel in metal output capacity this year, bringing the total to as much as 1.4 million tons**, according to Coordinating Minister for Investment and Maritime Affairs Luhut Panjaitan. Next year, Indonesia will add another 500,000 tons of annual production capacity, he added. "We're confident that with this additional capacity, there's more than enough to offset any lost supply from Russia or other places," Panjaitan said in an interview in Jakarta. Indonesia will monitor the market situation before deciding on its planned export tax on ferro-nickel and nickel pig iron, given the "unprecedented" situation, said Panjaitan. "We need to be mindful of the impact to consumers," he added. "We don't want to stifle the electric vehicle battery industry, and we don't want nickel prices to disrupt our target of producing lithium batteries in early 2024."

AUTOMOTIVE/ENERGY: BREAKING DOWN THE COST OF AN ELECTRIC VEHICLE BATTERY CELL

As electric vehicle battery prices keep dropping, the global supply of EVs and demand for their batteries are ramping up. Since 2010, the average price of a lithium-ion (Li-ion) electric vehicle battery pack has fallen from $1,200 per kilowatt hour (kWh) to just $132/kWh in 2021.



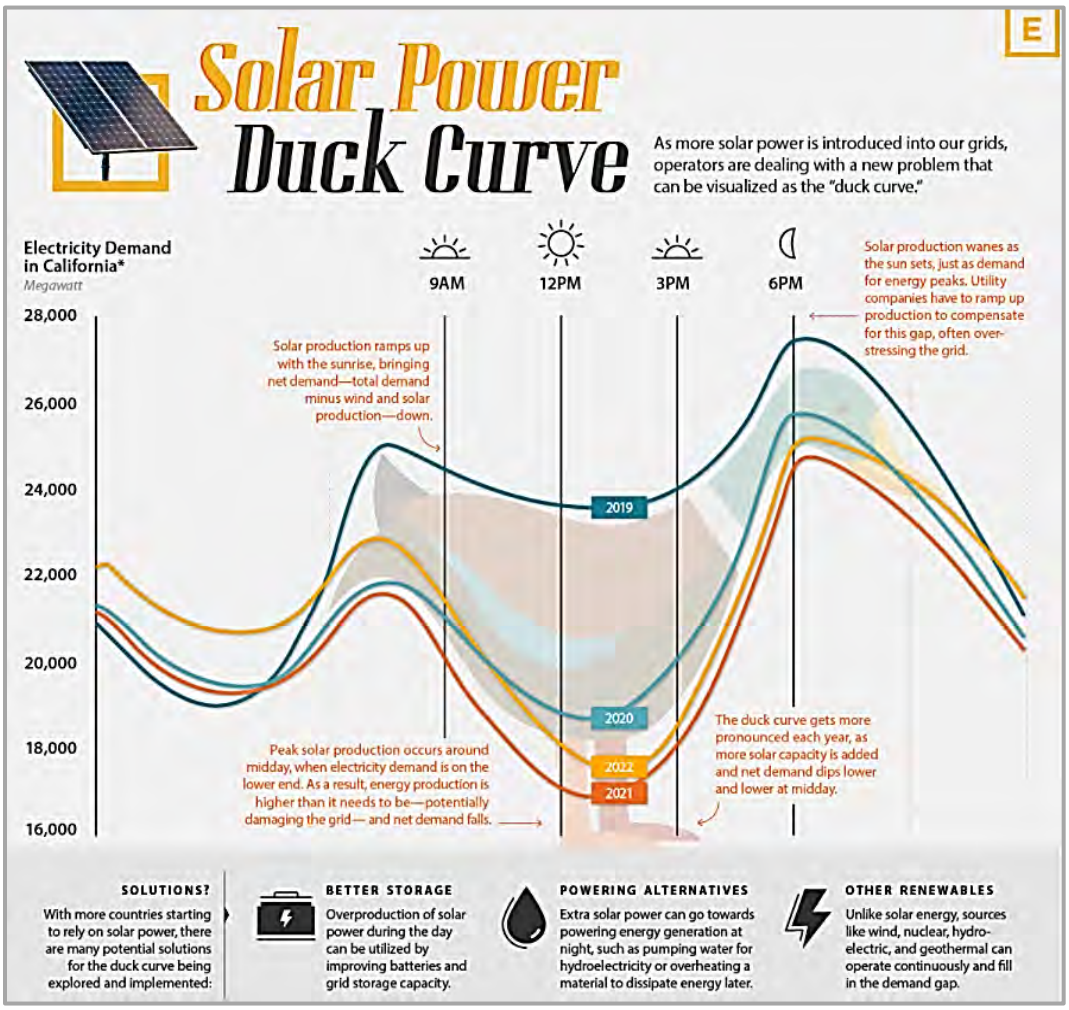
Inside each EV battery pack are multiple interconnected modules made up of thousands of rechargeable Li-ion cells. Collectively, these cells make up roughly 77% of the total cost of an average battery pack, or about $101/kWh.

Why Are Cathodes so Expensive?

The cathode is the positively charged electrode of the battery. When a battery is discharged, both electrons and positively-charged molecules (the eponymous lithium ions) flow from the anode to the cathode, which stores both until the battery is charged again. That means that cathodes effectively determine the performance, range, and thermal safety of a battery, and therefore of an EV itself, making them one of the most important components. They are composed of various metals (in refined forms) depending on cell chemistry, typically including lithium and nickel. Common cathode compositions in modern use include: Lithium iron phosphate (LFP), Lithium nickel manganese cobalt (NMC) and Lithium nickel cobalt aluminum oxide (NCA). The battery metals that make up the cathode are in high demand, with automakers like Tesla rushing to secure supplies as EV sales charge ahead. In fact, the commodities in the cathode, along with those in other parts of the cell, account for roughly 40% of the overall cell cost.

Other EV Battery Cell Components: Components outside of the cathode make up the other 49% of a cell's cost. The manufacturing process, which involves producing the electrodes, assembling the different components, and finishing the cell, makes up 24% of the total cost. The anode is another significant component of the battery, and it makes up 12% of the total cost—around one-fourth of the cathode's share. The anode in a Li-ion cell is typically made of natural or synthetic graphite, which tends to be less expensive than other battery commodities. Although battery costs have been declining since 2010, the recent surge in prices of key battery metals like lithium has cast a shadow of doubt over their future. How EV battery prices evolve going forward is uncertain given recent geo-political developments, and more specifically, the Russian invasion of Ukraine and the West's response with economic sanctions.

ENERGY: THE SOLAR POWER DUCK CURVE EXPLAINED



With the increasing demand for electricity as the world shifts away from fossil fuels, cleaner sources of energy such as solar and wind are becoming more and more common. However, as more solar power is introduced into our grids, operators are dealing with a new problem that can be visualized as the "duck curve".

Origins of the Duck Curve: In a world heavily reliant on electricity, utility companies have gotten better at using data to anticipate demand and trying to operate as efficiently as possible. Usually, power companies supply the least amount of power overnight while most consumers are sleeping, ramping up during the morning as people wake up and businesses get going. Then, at sunset, energy demand peaks. Utility companies use models to predict demand and operate as efficiently as possible by supplying more power during times of higher demand. Now, the introduction of solar power has brought about problems in these demand curve models. Since solar power relies on the Sun, peak solar production occurs around midday, when electricity demand is often on the lower end. As a result, energy production is higher than it needs to be, and net demand—total demand minus wind and solar production—falls. Then, when evening approaches, net demand increases, while solar power generation falls. This discrepancy results in a net demand curve that takes the shape of a duck, and the duck curve gets more pronounced each year, as more solar capacity is added and net demand dips lower and lower at midday.

Why the Curve is Ruffling Feathers: The drop in net demand at midday basically creates two problems. Solar energy production wanes as the sun sets, just as demand for energy typically peaks. Utility companies are having to ramp up production to compensate for this gap, often overstressing a grid that is not yet set up for these peaks. Traditional sources of energy like nuclear and coal are only economic when they are running all the time. If you have to turn them off at mid-day because the power is supplied by solar, they become economically unfeasible. Due to overproduction, solar power is already being wasted in some places where the technology is widely used, e.g., California. The problem is most intense during summer or spring when part of the solar panels has to be turned off to avoid overloading or even damaging the power grid.

Flattening the Duck: With more countries starting to rely on solar power, there are many potential solutions for the duck curve being explored and implemented. For example, overproduction of solar power during the day can be utilized by improving batteries and grid storage capacity. Extra solar power can go towards powering energy generation at night, such as pumping water for hydroelectricity or overheating a material to dissipate energy later. Unlike solar energy, sources like nuclear, hydroelectric, and geothermal can operate continuously and fill in the demand gap. While grid managers study how to serve the new supply and demand, the duck curve is one of the greatest challenges facing renewable energy.

MEDICAL: NEW RESEARCH SHOWS HIGHER RISK OF DEVELOPING DIABETES AFTER COVID-19 INFECTION

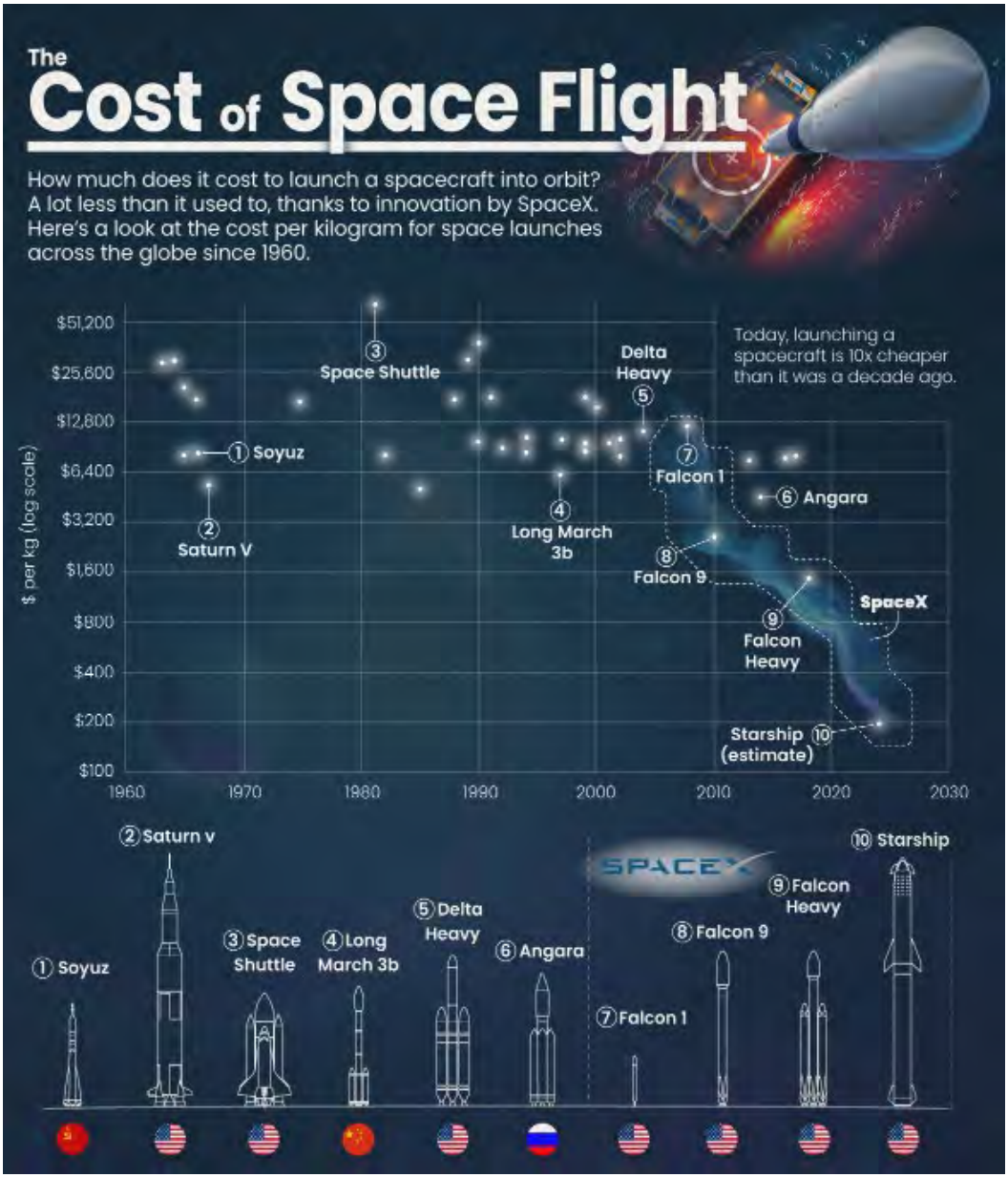
A large new study found that people who recovered from COVID-19 within the past year are 40% more likely to receive a new diagnosis of diabetes compared to those who weren't infected. **The increased risk translates into 1% of people who have had COVID-19 developing diabetes who otherwise wouldn't have, resulting in potentially millions of new cases worldwide.**

Most of the people with diabetes in the study, published in the journal *Lancet Diabetes and Endocrinology*, were diagnosed with Type 2 diabetes, not Type 1. Some researchers say COVID-19 could also be triggering an entirely new type of diabetes in which certain cells mistakenly start to raise, rather than lower, blood sugar. The study adds to evidence showing an increased post-COVID-19 risk of cardiometabolic conditions, such as diabetes, as well as heart and kidney complications. Normally when people think of long-term COVID-19 symptoms, they think of problems such as cognitive issues, fatigue or shortness of breath. But scientists say there are likely different types of long COVID, and one appears to be defined by cardiometabolic problems that arise after COVID-19. **So far, the WHO estimates there have been more than 464 million cases of COVID-19, so even small percentages of those people developing long-term complications would be significant.** "We're finding out more and more that it's not only respiratory problems or brain fog or only fatigue," said Ziyad Al-Aly, chief of research and development at the VA St. Louis Health Care System and a clinical epidemiologist at Washington University in St. Louis, who led the study. "There are heart manifestations, and clearly diabetes and kidney manifestations." In the new diabetes study, Dr. Al-Aly and co-researchers analyzed the records of 181,000 COVID-19 patients in the Veterans Health Administration system who were diagnosed with COVID-19 within the past year and compared them to more than eight million people who didn't have COVID-19. The VA study didn't look at diabetes cases by vaccination status**. "When you look at the data on a national scale, it's clearly happening even in people who have no risk factors or very little risk factors," Dr. Al-Aly said, adding that new diagnoses are happening even in young adults with a healthy weight and no previous history of high blood sugar.** It hasn't been determined why a COVID-19 infection might be leading to new cases of diabetes. One possibility is that the virus might damage the pancreas's ability to secrete insulin, the hormone that regulates blood sugar. Another theory is that the strong immune response to COVID-19 generates an inflammatory cascade that results in low-grade inflammation, which interferes with insulin secretion and sensitivity. All types of diabetes share the symptom of high blood sugars, but they are distinct conditions. Type 2 is the most common, and can be associated with diet and exercise. Typically in Type 2, people become resistant to the hormone insulin, which regulates blood sugar. The pancreas struggles to keep up with the body's increased demand for insulin, leading to higher blood-sugar levels. Type 1, by contrast, is an autoimmune disease in which the body destroys pancreatic cells that produce insulin.

MEDICAL: NVIDIA ROLLS OUT NEW TOOL FOR MEDICAL DEVICE MAKERS

Silicon Valley giant NVIDIA is expanding its arsenal of products for healthcare with the launch of Clara Holoscan MGX, a tool designed to help medical device organizations develop artificial intelligence tools. The company said the new technology was created to help industry players meet regulatory standards. "Deploying real-time AI in healthcare and life sciences is critical to enable the next frontiers in surgery, diagnostics and drug discovery," said Kimberly Powell, vice president of healthcare at NVIDIA. **"Clara Holoscan MGX, with its unique combination of AI, accelerated computing and advanced visualization, accelerates the productization of AI and provides software-as-a-service business models for the medical device industry."** The platform builds on its previously launched product, the Clara Holoscan, which was developed to give industry stakeholders a computational infrastructure to stream data from medical devices. The company said that Clara Holoscan MGX can process high-throughput data streams for real-time insights. Medical devices are becoming increasingly connected and AI-backed. NVIDIA is pitching this new tool as a way to help cut down on time to market for software-defined medical devices. The new tool can be used in a variety of ways, including medical device development through commercialization. NVIDIA has a number of initiatives in the healthcare space. In 2021, NVIDIA has also joined forces with Harvard University on an AI-based tool kit to help researchers gain access and insights about DNA. The company released an automated speech recognition and natural language processing technology that can transcribe and organize information from a telemedicine visit for patients and clinicians.

AEROSPACE: THE COST OF SPACE FLIGHT BEFORE AND AFTER SPACEX



On December 21, 2021, SpaceX's Falcon 9 rocket launched a cargo capsule to deliver supplies and Christmas gifts to astronauts in the International Space Station. Just eight minutes after liftoff, the rocket's first stage returned to Earth, landing on one of SpaceX's drone ships in the Atlantic Ocean. **This marked the company's 100th successful landing.** Like other companies, such as Jeff Bezos' Blue Origin and Ball Aerospace, SpaceX is designing and building innovative spacecraft that are speeding up space delivery by making it more routine and affordable. How much does it cost to launch a cargo rocket into space, and how has this cost changed over the years? The graphic looks at the cost per kilogram for space launches across the globe since 1960, based on data from the Center for Strategic and International Studies.

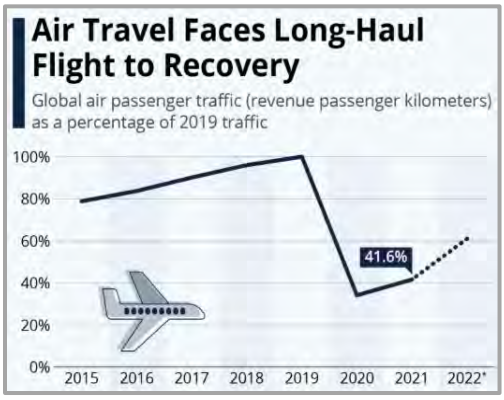
The Space Race: The 20th-century was marked by competition between two Cold War adversaries, the Soviet Union and the United States, to achieve superior spaceflight capability. The space race led to great technological advances, but these innovations came at a high cost. For instance, during the 1960s, NASA spent $28 billion to land astronauts on the moon, a cost today equating to about $288 billion in inflation-adjusted dollars. In the last two decades, space startup companies have demonstrated they can compete against heavyweight aerospace contractors as Boeing and Lockheed Martin. **Today, a SpaceX rocket launching can be 97% cheaper than a Russian Soyuz ride cost in the '60s.** The key to increasing cost efficiency? SpaceX rocket boosters usually return to Earth in good enough condition that they're able to be refurbished, which saves money and helps the company undercut competitors' prices.

Space Tourism: Although competition has brought prices down for cargo flights, human space transportation is still pricey. During the last 60 years, roughly 600 people have flown into space, and the vast majority of them have been government astronauts. For a suborbital trip on Virgin Galactic's SpaceShipTwo and Blue Origin's New Shepard, seats typically cost $250,000 to $500,000. Flights beyond that to actual orbit—a much higher altitude—are far more expensive, fetching more than $50 million per seat.

The Future of Space Flight: In a SpaceX press briefing, SpaceX Director Benji Reed said, "We want to make life multi-planetary and that means putting millions of people in space." This may still seem like a stretch for most people, but given the decreasing cost of space flights over the last two decades, perhaps the sky *won't* be the limit in the near future.

AEROSPACE: AIR TRAVEL FACES LONG-HAUL FLIGHT TO RECOVERY

As international travel came to a near complete standstill in 2020 due to the COVID-19 pandemic, the aviation industry suffered what it described as "the worst year in history for air travel demand". According to the International Air Transport Association (IATA), global passenger traffic as measured in revenue passenger kilometers, i.e., the total number of kilometers travelled by paying passengers, declined by 66% in 2020 compared to the previous year, as international passenger demand dropped 76% and domestic demand fell 49% below 2019 levels. "2020 was a catastrophe. There is no other way to describe it. What recovery there was over the Northern Hemisphere summer season stalled in autumn and the situation turned dramatically worse over the year-end holiday season, as more severe travel restrictions were imposed in the face of new outbreaks and new strains of COVID-19." said Alexandre de Juniac, IATA's Director General and CEO. **While the rapid vaccine rollout fueled hopes of a swift recovery in early 2021, those hopes were dashed with the emergence of Delta and Omicron, which disrupted international travel during the Northern hemisphere's summer and holiday season, respectively.** According to the IATA, international passenger demand remained practically unchanged at 76% below 2019 levels in 2021, while domestic demand trailed 2019 demand by 28%, a notable improvement on 2020. Overall, passenger traffic remained 58% below pre-pandemic traffic last year, highlighting how long the road to recovery still is. In 2022, the IATA expects global passenger demand to reach 61% of pre-crisis levels, but that forecast was made in October 2021, i.e. pre-Omicron, so that goal could already be in danger.

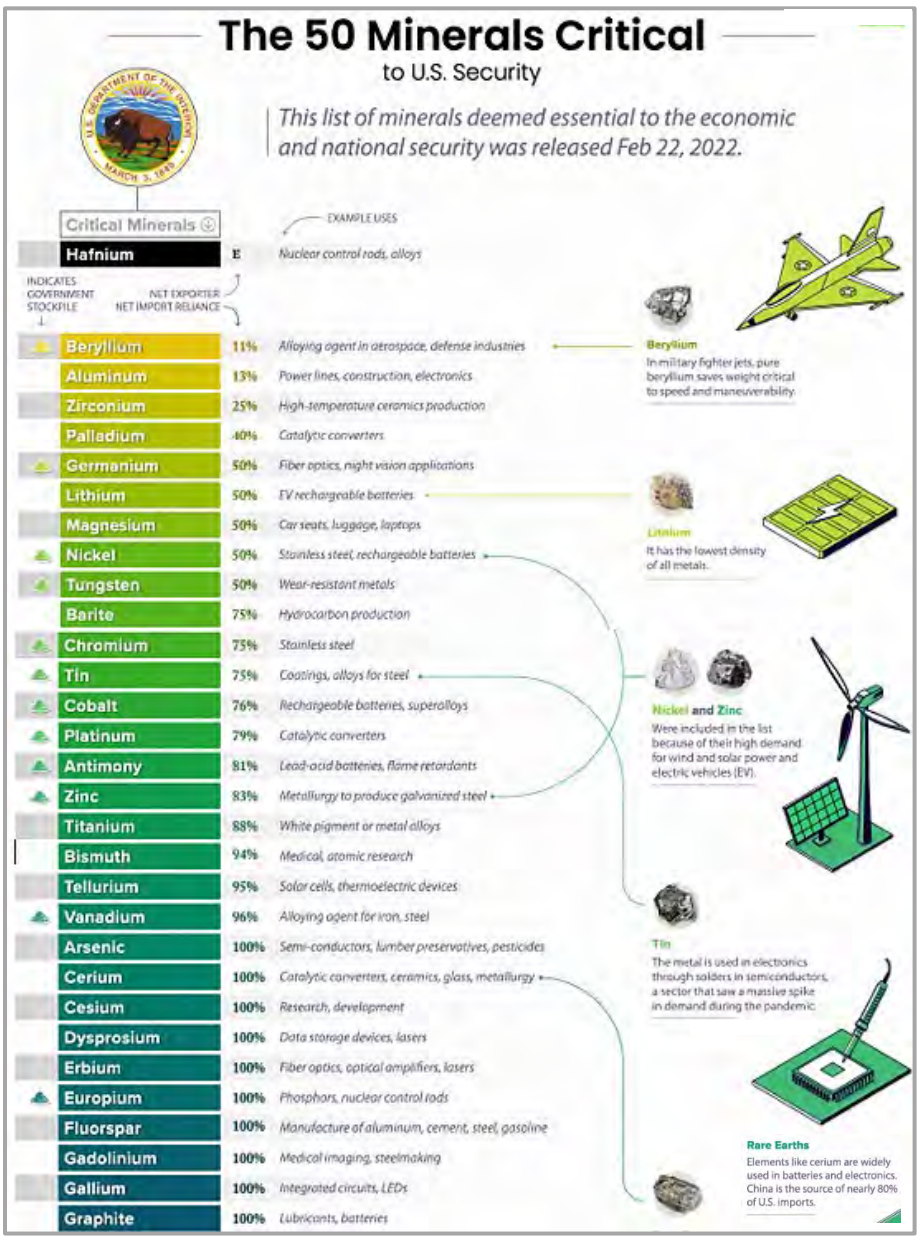


COMMODITIES/METALS: INVESTORS BET ON TECH TO UNEARTH THE METALS CARMAKERS CRAVE

A group of investors is betting that the $1.6 trillion global mining industry is ripe for the sort of digital disruption that upended the media, music and automotive industries. T.Rowe Price, Bond Capital and 12 others have raised $192 million for Kobold Metals, a Bill Gates-backed start-up that uses artificial intelligence and machine learning to find deposits of metals needed for batteries and clean energy. It comes as demand for battery metals such as lithium and nickel is expected to surge as electric vehicles become mainstream over the next two decades. **Kobold, based in Silicon Valley, estimates that more than $10tn of lithium, cobalt, nickel and copper needs to be mined to meet demand for EVs, and a growing number of traditional miners will turn to AI to help with the challenge.** BHP, the world's biggest miner, and Equinor, Norway's state-backed energy group, have partnered with Kobold. Kurt House, Kobold CEO, said mining discoveries have been getting slower and more expensive over time. "In the last 30 years, the number of discoveries per dollar of exploration capital has declined by six times." Locations where minerals can be seen from the surface have largely been found, while exploration for minerals that are harder to find is chronically underfunded. For example, BHP paid $15 billion in dividends last year but spent only $75 million on exploration. Kobold's latest funding round came after the start-up was able to demonstrate that its technology had identified accurately the composition of bedrock in northern Quebec, finding valuable minerals in an area dismissed by conventional approaches as "non-prospective." Kobold collects vast troves of historical and scientific data and uses algorithms to identify where mineral deposits might be below the earth's surface. Its technology includes machine learning tools to sift through 20 million pages of documents in the public domain — including two centuries worth of mining rights agreements in countless jurisdictions — that it sorts, digitizes and streamlines into accessible information. House said much of this so-called dark data had been forgotten or unused. He hired researchers to go through state archives in Zambia, where they found hand-painted maps on linen from the 1920s, covering the whole country and describing the land and any outcropping bodies. "We have fully digitized them and now we can look at the data through spectral satellites," House said. These methods are helping Kobold build a "Google Maps" of the Earth's crust. Once Kobold has a sense of an overlooked mineral deposit, it sends teams in to collect more data. In northern Quebec, a team of six took data and rock samples at 839 locations along 142km of traverses. The exploration included a 12-week scan by a helicopter with a metal detector 35 meters wide and weighing 771 kgs that sent electromagnetic pulses about 540 meters into the earth. Once it has done the work, Kobold buys the mining rights and will form partnerships with mining majors to split the revenue. In northern Quebec, it purchased the right to nearly 200,000 acres. Even after they have done months of work on a location, there is still a reasonable chance that minerals cannot be mined profitably. In Quebec, House said the potential value of minerals at the site is from zero to multiple billions. "Our objective is a 20% success rate — that would be way better than standard practice," said House.


Kobold workers prepare soil samples for analysis during field work in Zambia

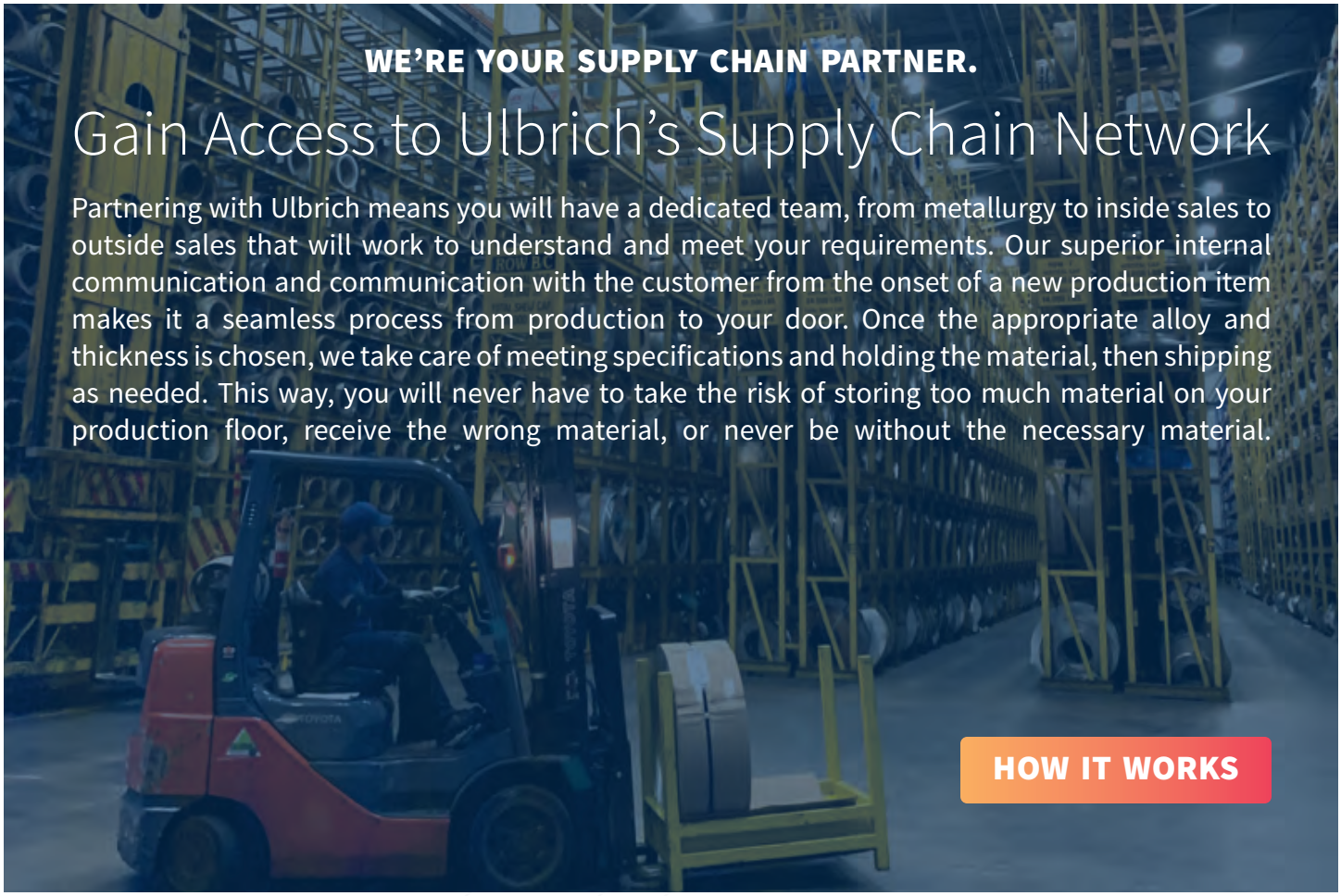
COMMODITIES: THE TOP 30 OF THE 50 MINERALS CRITICAL TO U.S. SECURITY



The U.S. aims to cut its greenhouse gas emissions in half by 2030 as part of its commitment to tackling climate change but lacks the critical minerals needed to achieve its goals. The American green economy will rely on renewable sources of energy like wind and solar, along with the electrification of transportation. Local production of the raw materials necessary to produce these technologies, including solar panels, wind turbines and EVs, is lacking, which raises concerns in Washington.

Critical Minerals Defined: A critical mineral is defined as a non-fuel material considered vital for the economic well-being of the world's major and emerging economies, whose supply may be at risk. **The 2022 list of critical minerals added nickel and zinc to the list.** The challenge for the U.S. is that the local production of these raw materials is extremely limited. For instance, in 2021 there was only one operating nickel mine in the U.S., the Eagle mine in Michigan. The facility ships its concentrates abroad for refining and is scheduled to close in 2025. The country only hosted one lithium mine, the Silver Peak Mine in Nevada. Most of the country's supply of critical minerals depends on countries that have historically competed with the U.S.

China's Dominance in Minerals: China is the single largest supply source of mineral commodities for the U.S. Cesium, a critical metal used in a wide range of manufacturing. There are only three pegmatite mines in the world that can produce cesium and all were controlled by Chinese companies in 2021. China refines nearly 90% of the world's rare earths. These elements are abundant on the Earth's crust and make up the majority of listed critical minerals. They are essential for a variety of products such as EVs, advanced ceramics, computers, smartphones, wind turbines, monitors and fiber optics. After China, the next largest source of mineral commodities for the U.S. is Canada, providing the U.S. with 16 different elements in 2021. As the world's clean energy transitions gather pace, demand for critical minerals is expected to grow quickly. The rise of low-carbon power generation is projected to triple mineral demand from this sector by 2040. The shift to a sustainable economy is important and consequently, securing the critical minerals necessary for it is just as vital.



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Charles was a Senior Vice President of procurement in the metal container industry, with a career spanning nearly four decades. He specializes in steel and aluminum procurement and utilizes his expansive knowledge of the steel and aluminum industry in the production of this detailed monthly update for Ulbrich and the company's valued employees and partners.

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