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ECONOMIC UPDATE

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EXECUTIVE SUMMARY

AMERICAS: THE U.S. ECONOMIC RECOVERY CONTINUED AT A MODEST PACE over the first weeks of 2021, with businesses optimistic about the months to come, according to the Federal Reserve. **Factory orders** rose 2.6% in January as manufacturers continued to lead the way for the U.S. economic recovery. **Industrial production** surged 0.9% in January (the most recent monthly figures available), led by manufacturing output gains of 1.0% and a 2.3% jump in mining. It was the ninth straight monthly advance in factory production. **Employers added 379,000 jobs to payrolls** and the unemployment rate ticked down to 6.2%. Most of the job gains occurred in the leisure and hospitality sector. **Household income** jumped 10% and consumer spending rose 2.4%, priming the economy for a burst in growth this year. **Retail sales** boomed in January, rising an unexpected 5.3%, the first increase in four months. **Consumer confidence** improved in January and February. **The housing market** remains one of the strongest segments of the economy. Existing home sales in January surged 23.7% on a year-on-year basis. **Producer prices** jumped 1.3% in January and have accelerated 1.7% over the past 12 months. Higher inflation is anticipated by the spring as price declines early in the coronavirus crisis wash out of the calculations.

OVERSEAS: SURGING DEMAND FOR GOODS AND A SHORTAGE OF EMPTY CONTAINERS AT ASIAN PORTS have sent container-shipping costs skyrocketing. The price of shipping goods from North America to Asia has doubled. **Demand for manufactured goods drove extended growth in factories across Europe and Asia** in February, but a slowdown in China underscored the challenges to achieve a sustainable recovery from the pandemic. The **final global PMI index** improved to a three-year high in February.

STEEL: A FRESH ROUND OF DISRUPTION IN THE U.S. STEEL INDUSTRY is driving up costs and squeezing profits at steel-consuming manufacturers. **Steel is in short supply and prices are surging.** Unfilled orders for steel in the last quarter were at the highest level in five years with inventories at a 3.5-year low. The benchmark price for hot-rolled steel in February was at its highest level in 13 years. U.S. steel prices are 68% higher than the global market price. Steel mill capacity utilization is well below the level of last February.

METALS/COMMODITIES: EV SURGE SENT COBALT PRICES SOARING. Energy-dense cobalt is used as the stabilizer in batteries, protecting the battery's cathode from corrosion that can lead to a fire. In 2017 and 2018, during an earlier rush of interest in EVs, the price of cobalt quadrupled in the space of two years before a boost in production calmed the market down. **Nickel prices** are up 70% from COVID-lows. **Zinc's price trajectory** has been similar. **Iron ore prices** recently surged to a nine-year high of \$176/tonne.

AEROSPACE: JUNO MISSION EXPANDS INTO THE FUTURE. NASA has authorized a mission extension for its Juno spacecraft exploring Jupiter. The agency's most distant planetary orbiter will now continue its investigation of the solar system's largest planet through September 2025, or until the spacecraft's end of life. **The extended mission's science campaigns** will expand on discoveries Juno has already made about Jupiter's interior structure, internal magnetic field, atmosphere (including polar cyclones, deep atmosphere and aurora) and magnetosphere, providing a wealth of new science opportunities that the extended mission capitalizes on.

AUTOMOTIVE: WHEN THE EV REVOLUTION ARRIVES, WILL THERE BE ENOUGH PLACES TO PLUG IN? The country will need thousands of charging stations for drivers to accept vehicles that are powered by batteries alone, but **automakers and charging companies** are struggling to raise the numbers because they're investing before demand arrives. With more than 40 fully electric models on the market in the U.S., or coming within the next three years, auto and charging company executives say the demand is on the way.

STEEL/MEDICAL: STAINLESS STEEL IS CRUCIAL IN FIGHT AGAINST INFECTION. Non-toxic, chemically inert and with non-absorbent properties, stainless steel can be safely sterilized without any corrosion or degradation. A recent university study examined the **enduring power of stainless steel** by testing the effectiveness of both new and old surfaces, with a "cycle of fouling and cleaning" developed to simulate aging. There was also no discernible difference in effectiveness between the new or aged stainless steel.

ENERGY: JEFF BEZOS IS BACKING AN 'ANCIENT' KIND OF NUCLEAR FUSION. Magnetized target fusion (MTF) dates back to the 1970s when the U.S. Naval Research Lab first proposed it, but its proponents say the technology is now about to reach the commercial power market. **An MTF reactor made by Canada's General Fusion** (Jeff Bezos-backed) is pressurized to super-heat plasma. This pressure is applied by pistons that coordinate to make a pressure wave. From there, the rest is a more prosaic business. Hot neutrons escape the plasma and are captured in the liquid metal, and their energy powers a heat exchanger to generate power.

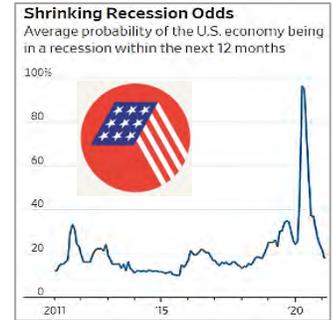
INNOVATION: THE RECHARGEABLE LITHIUM-ION BATTERY IS POISED TO DISRUPT INDUSTRIES. After a decade of rapidly falling costs, **the lithium-ion battery has reached a tipping point.** No longer just for consumer products, it is poised to transform the way the world uses power. Companies are working on new configurations that could significantly enhance the power and further lower battery prices. The value of such a breakthrough could be measured in the billions of dollars, if not trillions.



THE AMERICAS

- **The U.S. trade deficit** expanded by 1.9% to \$68.2 billion in January as American consumers stepped up purchases of imported products. Imports increased to \$260.2 billion, up 1.2%, while exports grew 1.0% to \$191.9 billion. The deficit in trade in goods with China declined to \$26.25 billion. Exports to China fell 12.2%; while imports declined 6.6%.
- **U.S. import prices** jumped 1.4% in January, adding to mounting evidence that inflation is returning to pre-crisis levels. Import prices had fallen sharply early in the pandemic. Excluding fuel, import prices increased 0.8% in January. Over the past year import prices minus fuel have risen 2.5%. U.S. export prices rose 1.3% in January.
- **U.S. employers** added 379,000 jobs to payrolls in February in what marks a sharp pickup from earlier this winter. The unemployment rate ticked down to 6.2% from January's 6.7% rate. Most of the job gains occurred in the leisure and hospitality sector, which includes restaurants, adding 355,000 jobs. There were smaller gains in temporary help services, healthcare, retail and manufacturing.
- **U.S. consumer confidence** improved again in February, after increasing in January. The Conference Board Index now stands at 91.3, up from 88.9 in January. The index stood at 132.6 before the viral outbreak a year ago. After three months of consecutive declines, the Present Situation Index—based on consumers' assessment of current business and labor market conditions—climbed from 85.5 in January to 92.0 in February.
- **U.S. retail sales** boomed in January, rising an unexpected 5.3%. It was the first monthly increase in four months, buoyed by stimulus payments that many households received in the most recent virus-relief package. Sales were led by motor vehicles, with receipts at auto dealerships accelerating 3.1% after increasing 2.0% in December. Retail sales increased 7.4% from the same month a year ago.
Key Update: U.S. retail sales are expected to rise between 6.5% to 8.2% to more than \$4.3 trillion in 2021 as more people get vaccinated and the economy reopens, the National Retail Federation said. NRF expects the overall economy to gain between 220,000 and 300,000 jobs per month in 2021.
- **U.S. consumer prices** rose 0.3% higher in January, the fastest pace in five months, largely because of higher gasoline prices (+7.4%). A separate "core" measure of inflation that strips out often-volatile food and energy costs was flat in January. The rate of inflation over the past year was unchanged at 1.4%. Before the pandemic erupted, consumer inflation was running at a higher 2.3% clip.

- **The U.S. economy** is expected to expand more rapidly in 2021 than previously projected, but it will take several years for output to reach its full potential, according to the Congressional Budget Office. GDP is expected to grow 3.7% by the 4thQtr of 2021 compared with a year earlier and to expand 2.4% in 2022. The CBO estimates the jobless rate will fall to 5.3% by the end of 2021 from 6.8% at the end of 2020, but the number of people employed won't return to the level seen before the pandemic until 2024.
Key Update: Economists are increasingly optimistic about economic growth this year. GDP is expected to expand nearly 4.9% by economists surveyed in February by the WSJ, an improvement from their 4.3% forecast in January.
- **U.S. gross domestic product** grew at a 4% annual rate in the final three months of 2020 but shrank last year by 3.5%, the largest amount in 74 years, which ended the longest U.S. economic expansion on record — nearly 11 years.
- **U.S. industrial production** surged 0.9% in January, led by manufacturing output gains of 1.0% and a 2.3% jump in mining. It was the ninth-straight monthly advance in factory production which is supported by low customer inventories and lean stocks at manufacturers. However, motor vehicles and parts output declined 0.7%. Production at auto plants has been hampered by a shortage of semiconductors. Overall capacity use for the industrial sector increased to 75.6% which is 4.0% below its 1972-2019 average.
- **Durable goods orders** increased for a ninth-straight month in January, advancing 3.4%. Orders for core capital goods, a closely proxy for business spending plans, rose 0.5%. Orders for defense aircraft and parts rose 63.5% and orders for nondefense aircraft and parts shot up by 389.9%.
- **U.S. producer prices** jumped 1.3% in January. In the 12 months through January, the PPI accelerated 1.7%. Higher inflation is anticipated by the spring as price declines early in the coronavirus crisis wash out of the calculations.
- **U.S. manufacturing** grew in February despite disruptions in the supply chain from poor weather, the ISM reported. The monthly PMI index increased 1.9% to 53.2% from 51.3 in January. The production index dipped, while the new orders index increased. The acceleration in manufacturing activity resulting from a sharp dip in production coupled with a gain in new orders, supports the notion that much of the weakness in economic data was weather-related.





- **Factory orders** rose 2.6% in January as manufacturers continued to lead the way for the U.S. economic recovery. Factory goods orders were boosted by strong demand for electrical equipment, appliances and components, as well as primary metals and fabricated metal products. Orders for machinery fell.
- **U.S. service sector activity** continued to expand in February, albeit at a softer pace than in January with the ISM Services PMI declining to 55.3 from 58.7. The New Orders Index declined to 51.9 from 61.8, the Employment Index edged lower to 52.7 from 55.2.
- **The U.S. Leading Economic Index** rose 0.5% in January. The Conference Board said January's gains were broad-based and suggest economic growth should improve gradually over the first half and expects the economy to expand by 4.4% in 2021 after a 3.5% contraction in 2020.
- **The housing market** remains one of the strongest segments of the economy. Existing home sales in January edged up 0.6% to an annual rate of 6.69 million units. Existing home sales surged 23.7% on a year-over-year basis. The inventory of existing homes on the market in January 2021 was 25% below January 2020. The median existing house price shot up 14.1% from a year ago to \$303,900. New home sales rose 4.3% to an annual rate of 923,000. Housing starts declined 6.0% to an annual rate of 1.580 million units amid soaring lumber prices. Softwood lumber prices jumped a record 73% on a year-on-year basis in January.
- **U.S. household income** jumped 10% in January as the government delivered stimulus payments to households and consumer spending rose 2.4%, priming the economy for a burst of growth in 2021. The increase in income was the first since October and the second largest on record, eclipsed only by last April's increase when an initial round of pandemic-relief payments were delivered.
- **The U.S. budget deficit** widened sharply in January, as the latest coronavirus-relief package from Congress sent direct stimulus payments to millions of Americans. The monthly deficit widened to an estimated \$165 billion vs. \$33 billion in January 2020 and \$144 billion in December. For the first four months of the 2021 fiscal year, which started Oct. 1, the federal budget deficit rose 90% to \$738 billion.
- **Construction spending** in the U.S. rose 1.7% to an annual rate of \$1.52 trillion in January 2021, an all-time high. Spending on private construction advanced 1.7%, lifted by spending on residential, lodging, transportation and manufacturing projects. Public construction outlays also increased 1.7%, mainly boosted by a 5.8% jump in highways and streets construction.

- **U.S. worker productivity** dropped at a 4.8% annualized rate last quarter, the deepest rate of contraction since the 2ndQtr of 1981, but the trend remains positive as the pandemic weighs heavily on the less productive industries like leisure and hospitality. Hours worked rose at a 10.7% rate, following a 37.1% pace in the 3rdQtr. Hourly compensation grew 7.0% in 2020 after rising 3.6% in 2019.
- **ArcelorMittal/Nippon Steel Calvert** broke ground for a massive expansion project valued at \$775 million that will add an electric arc furnace to the steel mill north of Mobile. The new arc furnace will be able to produce 1.5 million tons of steel slabs per year. Construction is expected to take 24 months. The expansion will create 200 direct and 100 indirect jobs. AM/NS Calvert was originally built for \$4 billion by ThyssenKrupp. The facility was acquired by ArcelorMittal and Nippon Steel as a joint venture in 2014.
- **American Metal Manufacturers and Users**, a trade group representing more than 30,000 companies in the manufacturing sector, has called for the termination of Trump's steel tariffs. Its members are getting hit by a fresh round of disruption in the U.S. steel industry. Steel is in short supply and prices are surging. Unfilled orders for steel in the last quarter were at the highest level in five years with inventories at a 3.5-year low. The benchmark price for hot-rolled steel in February was at its highest level in 13 years. Steel prices are 68% higher than the global market price. Soaring prices are driving up costs and squeezing profits at steel-consuming manufacturers.
Key Update: Domestic steel mills that idled furnaces last year amid fears of a prolonged pandemic-induced economic downturn have been slow in ramping up production, despite a recovery in demand for cars and trucks, appliances and other steel products. Capacity utilization at steel mills has moved up to 75% after falling to 56% in the 2ndQtr of 2020, but utilization is still well below the 82% level of last February.
- **Nucor Steel** said its 1stQtr earnings may exceed \$900 million vs. \$20.3 million a year ago. "We are encouraged by positive economic trends and the robust demand we are seeing across our markets," Nucor President and CEO Topalian said. Hot-rolled coil prices surged 9.78% in February.
- **Steel mills** in the U.S. shipped 7.049 million tons of steel in December, a 12.1% decline from December 2019. Shipments for the full year 2020 were 81 million tons, a 15.8% decrease vs. 2019 shipments of 96.178 million tons.





- **Steel imports into the U.S.** were 2.422 million tons in January, including 1.239 million tons of finished steel (down 23.1% and 24.8% respectively vs. January 2020). Total steel and finished steel imports in January were up 62.2% and down 7.5% from the prior month. Finished steel import market share was an estimated 15% in January. (See **Appendix: Steel**, page 14)
- **The U.S. Court of International Trade** upheld the Section 232 national security tariffs on steel imports, denying a steel importer's challenge to the duties. A three judge panel found that the Commerce Dept. had properly applied a Cold War-era trade law in imposing the 25% tariffs. The American Iron and Steel Institute praised the decision and urged the new administration to maintain the tariffs.
- **NAS and Outokumpu** announced stainless steel price increases effective for February deliveries. Base price increases ranged from 3.5¢/lb to 5¢/lb. As the only producer of 72" wide in North America, Outokumpu increased its wide extra to 18¢/lb. Alloy surcharges rose for the third consecutive month. Both NAS and Outokumpu revised their equalized freight rates, which took effect in March. The Stainless Monthly Metals Index (MMI) increased by 4.5%, as stainless flat-rolled base prices continue to move upward due to extended lead times and limited domestic capacity.
- **Service centers** are attempting to replenish inventories of stainless steel products that ended January 14% below year ago levels. MSCI reported 358,000 tons on hand, or 2.5 months of supply. January stainless shipments were 41,700 tons, down 11% from January 2020, but manufacturing sector customers are still purchasing to meet current requirements. With ATI exiting the standard stainless sheet market in a few months, lead times at the three remaining domestic stainless mills have extended into June.
- **USW members** overwhelmingly voted to authorize a strike at ATI, moving a step closer to a work stoppage at the struggling Pittsburgh-based stainless steel giant. Both sides had agreed to a one-year contract extension in March last year to focus on the pandemic. That extension expired Feb. 28. A new contract would cover roughly 1,300 employees in nine locations. ATI reported a loss of \$1.6 billion in 2020. In December, it announced a restructuring that will eliminate about 400 jobs, with 200 of them in the Pittsburgh region.
- **U.S. service center shipments** of all steel products in January fell 11.8% from January 2020 and shipments of aluminum products declined by 5.6%. Though down on a year-over-year basis, steel and aluminum shipments in the U.S. and Canada continue to recover from their lows in May 2020 in the U.S. and April 2020 lows in Canada.

- **General Motors** extended production cuts at three North American plants until at least mid-March due to the global semiconductor chip shortage, while vehicles at two other factories would only be partially built. GM said it would focus on keeping production running at plants building its highest-profit vehicles (full-size pickup trucks and SUVs) and make up as much lost production as possible once the chip shortage eased. (See **Appendix: Automotive**, page 11)
Key Update: Asian chipmakers are rushing to boost production but say the supply gap will take many months to plug. German chipmaker Infineon said the shortage would worsen in the near term. The chip shortage is expected to cut 1stQtr global output by more than 670,000 vehicles and last into the 3rdQtr. AutoForecast Solutions estimates the global industry could lose almost 1.3 million vehicles.
- **General Motors** made more than \$6 billion last year, one of its highest profit totals ever, despite the pandemic that shuttered auto plants for nearly two months and sent car sales tumbling. Brisk sales of pickup trucks and S.U.V.s in the second half of the year offset the damage from the pandemic in the spring. Revenue declined 11%, to \$122 billion. GM has said it expects lost production from an unfolding shortage of computer chips to erode its bottom line this year by \$1.5 billion to \$2 billion.
- **President Biden** issued an executive order launching an immediate 100-day review of supply chains for four critical products: semiconductor chips, large-capacity batteries for electric vehicles, rare earth minerals and pharmaceuticals.
- **Canada Nickel Co.** held talks with U.S. government officials about supplying nickel for electric car batteries, amid mounting concern in Washington about China's dominance of global supply chains. Construction of a \$1B mine and mill at the company's nickel deposit in Ontario is slated for 2023. The outreach to Canada Nickel shows heightened U.S. government interest in securing supplies of critical minerals used in everything from EVs to advanced weaponry.
Key Update: Despite the hype around electrification and battery demand, the stainless steel industry remains the primary driver of nickel consumption. However, investors are enthused by a longer-term vision supported by analysts suggesting demand from the battery sector could increase from 92,000 tons in 2020 to 2.6 million tons in 2040. Despite rising LME inventory of refined metal, prices are pushing close to 17-month highs at \$18,675 per metric ton.



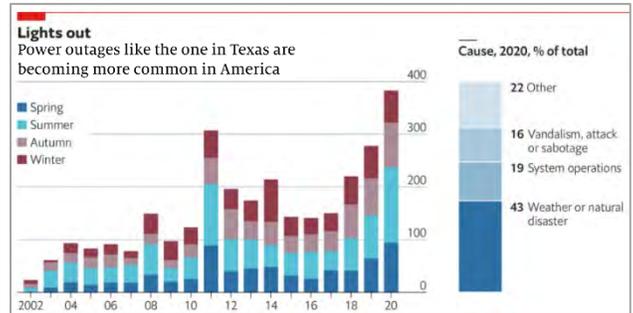


- **NASA** landed a new robotic rover on Mars after a seven-month 292-million-mile journey to directly study whether there was ever life on the red planet. Its most ambitious effort in decades, the \$2.7B robotic explorer carries a sophisticated set of scientific tools that will bring advanced capabilities to the search for life beyond Earth. The rover will spend the next two years prospecting for evidence of ancient microbes and pack up any promising soil and rock samples into small tubes to be cached for retrieval by future missions and brought back for analysis. (See **Appendix: Aerospace**, page 9)



- **SpaceX Starship SN10** landed successfully at the end of a high-altitude test flight, in contrast to its predecessors SN8 and SN9, which crashed into the ground. However, the next-generation space vehicle put down heavily on its extended legs, a fire developed and SN10 exploded on the landing pad. Still, SpaceX was encouraged by the test. The prototype successfully executed its in-flight maneuvers and managed to make a reasonably soft landing.
- **Bombardier** will cease production of its Learjet before the end of 2021 and cut 1,600 jobs. For some time, buyers have shifted toward heavier private planes. Ironically, some now see better prospects for the Learjet’s market segment than for most in the embattled aviation industry. Analysts at Jefferies expect private aircraft deliveries to rise 10% this year after a 24% decline in 2020, led by light and medium-size jets. Heavy ones are forecast to keep falling.
- **United Airlines** is buying 25 new Boeing 737 MAX jets and bumping up its orders for dozens more as it positions its fleet for a travel rebound. It’s a boost for Boeing, which lost hundreds of MAX orders during a nearly 2-year grounding.
- **Generac** said that demand for alternative home power sources is surging, causing a backlog of orders for generators amid an increase in extreme weather events. The weather emergency in Texas has led to national discussions about the reliability of power grids in the U.S.
- **Texas’s largest electric-power cooperative** has filed for bankruptcy. Brazos EPC said it is overwhelmed by the more than \$2.1 billion in sudden bills to cover the cost of purchasing energy during the weeklong extreme winter weather that blanketed the state. Freezing temperatures in February knocked power plants offline and left millions of customers without electricity for several days.

- **Freezing weather** across the U.S. in February sparked another rally in energy prices and put WTI (West Texas Intermediate) crude on pace to settle above \$60 a barrel for the first time since the early days of the coronavirus pandemic. WTI crude futures are up about 24% so far in 2021. The recent rally in crude prices marks an extension of the oil market’s rebound since the coronavirus pandemic gutted demand for petroleum products throughout much of 2020. (See **Appendix: Energy**, page 10)



- **The FDA** approved, cleared or authorized 132 novel medical devices in 2020, surpassing the 40-year high set in 2017 and capping off 10 years of increases. Of the thousands of clearances every year, FDA considers only those devices with a breakthrough designation to be novel. While COVID-19 played a role in making 2020 a record year, the vast majority of novel devices brought to market last year had nothing to do with the pandemic, the FDA said.
 - **Fourteen major health systems**, with millions of patients in 40 states, are banding together to launch Truveta, a new data-driven platform focused on collaborative approaches to precision medicine and population health. Many of the biggest and most recognizable providers in the U.S., such as AdventHealth, Northwell, Novant, Providence and Tenet, have joined for the launch of Seattle-based Truveta, which will draw on their vast troves of normalized and de-identified data, with a keen eye on privacy and security protections. (See **Appendix: Medical**, page 13)
- Key Update:** *The Truveta platform, by normalizing structured and unstructured data types from across those major health systems, seeks to drive approaches to diagnoses, geographies and demographics. Through automation technology, it can deliver continuous learning to physicians, researchers, pharma developers and others.*
- **Pfizer** expects to generate \$15 billion from the sale of its COVID-19 vaccine developed with BioNTech. The company plans to deliver two billion doses of the vaccine in 2021. Pfizer forecasts 2021 sales of between \$59.4 and \$61.4 billion, with vaccine sales contributing nearly 25% of the total. (See **Appendix: Medical**, page 12)

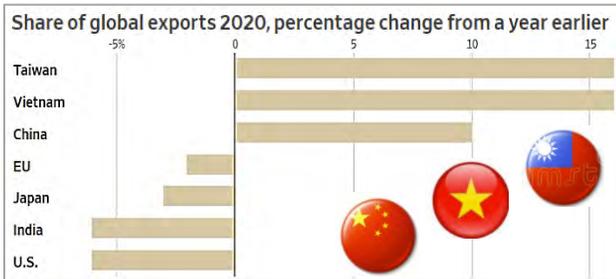
EUROPE, AFRICA & THE MIDDLE EAST

- **Demand for manufactured goods** drove extended growth in factories across Europe and Asia in February, but a slowdown in China underscored the challenges countries face as they seek a sustainable recovery from the COVID-19 pandemic. IHS Markit's final Manufacturing Purchasing Managers' Index (PMI) jumped to a three-year high of 57.9 in February from January's 54.8 for one of the highest readings in the survey's 20-year history.
- **The U.K. economy** recorded its biggest contraction in more than 300 years in 2020, underscoring the pandemic's economic toll on a country that has also suffered one of the world's deadliest outbreaks. GDP shrank 9.9% over the year, the largest annual decline among the Group of Seven advanced economies. France's economy shrank 8.3% and Italy's contracted 8.8%, according to provisional estimates. German GDP declined 5%. The U.S. shrank 3.5 percent.
- **Thyssenkrupp** is no longer in negotiations with Liberty House for the sale of its steel business. If successful, the deal would have merged Europe's fourth and second biggest steel producers. The German-based conglomerate said it intends to develop the steel division on its own. Liberty said the discussions had been "suspended at this stage due to differences in pricing expectations".
- **ArcelorMittal 4thQtr steel shipments**, excluding its U.S. unit following its sale to Cleveland Cliffs, increased by 1.5% to 15.5 million tonnes vs. the 3rdQtr. ArcelorMittal reported solid 4thQtr results with EBITDA of \$1.7 billion (almost double the prior year) and ended 2020 with a net debt of \$6.4 billion, the lowest level since the 2006 merger.
Key Update: ArcelorMittal expects global apparent steel consumption in 2021 to rise between 4.5% and 5.5%, compared with a decline of 1% in 2020.
- **Swedish steelmaker SSAB** abandoned discussions to acquire Tata Steel's IJmuiden integrated steelworks in the Netherlands. SSAB noted it was leading the transformation of the steel industry to fossil-free production and couldn't align IJmuiden with its sustainability strategy. The group's goal is to be the first in the world (in 2026) to supply fossil-free steel and to be a fossil-free company by 2045.
- **Outokumpu's 4thQtr core operating profit** rose 7% YOY, as recovering demand for stainless steel outweighed a drop in prices. The company forecast 1stQtr deliveries should rise by 10-20% from the previous quarter, noting that seasonal demand is strengthening in Europe and the Americas. Outokumpu reported 4thQtr adjusted Ebitda of €78 million, up 6.8% from a year earlier.

- **The United Arab Emirates Hope satellite**, the first interplanetary probe from an Arab nation, has successfully entered orbit around Mars. The SUV-sized orbiter carries three sensors designed to make the first comprehensive weather observations across the planet's surface. The \$200 million mission is the keystone of a national effort to make science and technology mainstays of the small Gulf state's economy in anticipation of a day when its oil revenues dwindle.
 
- **Airbus** revenues plummeted by 27% to €49.9B last year, leading to a net loss of €1.13B for 2020. Deliveries of its aircraft fell by a third to 566. The company expects to deliver the same number this year. Airbus warned aircraft would remain under pressure in the year ahead amid a volatile environment created by the coronavirus pandemic.
- **Air France-KLM** said the pandemic severely impacted its earnings in 2020, pushing it deep into a net loss of €7.1 bil. Revenues plunged by nearly 60% to €11.1 bil as passenger numbers fell 67% to 28.8 million. Tightened travel restrictions are negatively impacting traffic in the 1stQtr.
- **Ford** will invest \$1 billion to convert its plant in Cologne to produce EVs, including the company's first European-built all-electric passenger car in 2023. EVs should account for all its passenger-car sales in Europe by 2030, along with two-thirds of its commercial vans and trucks.
- **Jaguar Land Rover** announced that its Jaguar brand will go fully electric by 2025. The British carmaker, owned by Tata Group of India, plans to make "almost zero" vehicles with an internal-combustion engine for its other brands by 2036, the year after Britain bans sales of new ones.
- **Volkswagen** is exploring buying chip supplies directly from manufacturers, as automakers around the world cut production or reduce working hours due to a microchip shortage. Carmakers also affected by the shortage include Ford, Toyota, Nissan and Daimler. VW expects chip supplies will remain tight during the first quarter.
- **BP and Total** won the largest share of options to build new offshore wind farms on six plots awarded by Britain, investments that are expected to eventually total billions of dollars. The options were a big move by major petroleum producers into an industry that has been dominated by smaller, specialized companies. The winning bidders agreed to initially pay about \$1.2 billion in deposits to develop offshore wind farms that will provide power to light up seven million homes. (See **Appendix: Energy**, page 10)

ASIA/PACIFIC, JAPAN, AUSTRALIA & INDIA

- **Surging demand for goods** and a shortage of empty containers at Asian ports have sent container-shipping costs skyrocketing. Since November, the cost of shipping a 40' container from Asia to Europe has risen more than three-fold, from around \$2,200 to over \$7,900. The price of shipping goods from North America to Asia has doubled. The Freightos Baltic Index, a measure of container-freight rates in 12 important maritime lanes, has doubled.
- **Global trade** has rebounded from its collapse in the early stages of the pandemic, with China and other Asian manufacturing countries grabbing a bigger slice of exports—market share they are expected to keep after the crisis fades. Global trade flows fell just 5.3% last year, after returning to pre-pandemic levels by November. The recovery in exports for Europe and the U.S. began a few months later than for China.



- **China's official gauge of factory activity** fell more than expected in February, retreating to its weakest level in nine months, as manufacturers suspended production during the Lunar New Year holiday.
- **Japan's economy** grew 3% in the fourth quarter last year for an annualized rate of 12.7%. The economy still ended the year down 4.8% and the recovery has apparently stalled in the first quarter of 2021. Consumption is sagging after a winter wave of COVID-19 forced the government to impose a state of emergency in early January.
- **Japan's factory activity** expanded for the first time in 22 months in February, as strong export demand helped manufacturers shake off the drag from the coronavirus pandemic. However, producers saw a jump in input prices, which rose at their fastest pace in a year.
- **Global crude steel production** was 1.864 billion tonnes for the full year 2020, a 0.9% decrease compared to 2019. China produced 1.053 billion tonnes of crude steel, an increase of 5.2%. The U.S. produced 72.7 million tonnes of crude steel, a decrease of 17.2% vs. the year prior. China's dominant share of global crude steel production rose from 53.3% in 2019 to 56.5% in 2020. (See **Appendix: Steel**, page 14)

- **ArcelorMittal Nippon Steel India Ltd.** signed an accord to build a steel plant in the mineral-rich eastern Indian state of Odisha with an investment of US\$6.9 billion. The planned unit will have an annual production capacity of 12 million tonnes. Mittal's move to expand in India comes at a time when the government is planning to boost investment in sectors such as housing, roads, ports and railways.
- **Toyota** expects post revenue of \$253 billion in the fiscal year ending March 31 and raised its projection for operating profit by nearly \$7 billion to \$19.1 billion. Because of the pandemic-triggered slowdown last April, Toyota predicted it would sell one million fewer vehicles over the whole year.
- **A tidal turbine** built in Scotland was installed in waters off



- Japan's Goto Island chain, the latest example of Japan's interest in tidal and wave forms of energy production. The Simec Atlantis Energy pilot turbine generated 10 megawatt hours in its first 10 days of operation. SAE said the installation is a "huge milestone for the deployment of clean, renewable energy from the tidal stream".
- **The South Korean government** signed a \$43 billion deal to build the world's biggest offshore wind power complex, as it seeks to achieve carbon neutrality by 2050. The wind complex to be built off the southwest coast will be 7 times bigger than the current largest offshore wind farm. With a maximum capacity of 8.2 gigawatts, the government is banking on it being the equivalent of 6 nuclear power stations. South Korea plans to cut its existing nuclear power plants from 24 to 17 by 2034, reducing the sector's energy output by nearly half. (See **Appendix: Energy**, page 10)
- **BHP Group** reported a US\$6.04B profit before exceptional items for the 2ndH of 2020, up 16% vs. a year ago. China's infrastructure spending stoked demand for iron ore and prices recently surged to a nine-year high of \$176/tonne, well above the \$10 to \$20/tonne that most global miners incur to mine the commodity. During the half-year period, BHP's average realized price of iron ore jumped 33% YOY.
Key Update: BHP revenue has suffered since China imposed restrictions on Australian coal imports, although the trade dispute hasn't broadened to include iron ore.
- **Copper prices** touched an intra-day high of \$4.37 a pound in late February, not far off its all-time record of \$4.58 a pound struck in February 2011. Nickel also reached levels last seen in 2011, trading at \$19,689 on the LME. Nickel is up 70% from its COVID-lows. Zinc's trajectory has been similar. (See **Appendix: Commodities**, page 15)

AEROSPACE: SIX TECHNOLOGIES NASA NEEDS TO EXPLORE MARS**Nuclear Propulsion**

The trip to Mars covers about 140 million miles. Getting there as quickly as possible will require new forms of propulsion, most likely nuclear. To that end, NASA is investigating several options, including nuclear-electric and nuclear-thermal propulsion. Nuclear-electric rockets rely on nuclear power to generate electricity and feed it to ion thrusters or some other form of electrical thrusters. For nuclear-thermal propulsion, a working fluid is heated in a nuclear reactor and sent through a rocket nozzle to generate thrust. Though never built or flown, it is estimated such a propulsion system would have double or triple the payload capacity of current chemical fuels. Nuclear-electric rockets are more efficient but don't have much thrust. Whichever system is selected, the goal is to reduce the crew's time away from Earth.

**Inflatable Heat Shield**

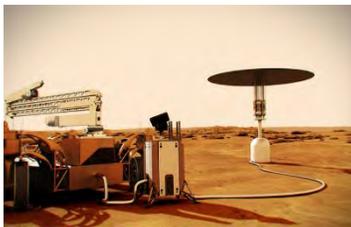
NASA is working on an inflatable heat shield that will have the surface area needed to dissipate any heat generated when a spacecraft enters a planet's atmosphere. It will be relatively small and compact before it is inflated, saving space and weight on the interplanetary trip. NASA has an upcoming flight test of a 20-foot prototype planned to show how the inflatable aeroshell performs as it enters Earth's atmosphere. Such a test could prove it can survive the intense heat during entry at Mars. Whether it will be reusable or a one-time use device is to be determined.

**Spacesuit for Travel and Exploration**

NASA engineers are working on a next-generation spacesuit known as the exploration extravehicular mobility unit, or xEMU. It will be used en route to the Moon and Mars, as well as on the lunar and Martian surfaces. The xEMU is designed to be more flexible than current spacesuits, letting the crew move more naturally and accomplish tasks that were impossible during Apollo missions. NASA will refine the xEMU for Mars missions so that it better withstands Mars' CO₂-rich atmosphere. Outer garments will also be added to keep astronauts warm during Martian winters and cool in its summers.

**A Home/Lab on Wheels**

To reduce the payload that needs to be landed on Mars, NASA wants to put the crew's living quarters in a ground vehicle. Much like an RV, the pressurized rover will carry everything astronauts need to live and work for weeks. They can drive in comfortable clothing and explore much more of the Martian surface than if they are walking. Should they need to get outside, they can don their spacesuits and leave the Martian RV to get samples or carry out maintenance. NASA has already tested rovers on Earth to gather data for developing a pressurized mobile home on the Moon. Astronauts sent to the Moon will likely live initially in a rover, and their experience will help in building the Martian version.

**Uninterrupted Power**

To keep Martian explorers alive and comfortable, they will need a power supply that works regardless of weather or sun exposure. It will also have to be light and require little fuel (in terms of mass and volume). All of this points to nuclear fission as being a more reliable option than solar power. NASA has already tested the nuclear technology on Earth and demonstrated its safety and efficiency; it can supply all of the crew's power needs for long-duration surface missions. NASA plans to demonstrate and use the fission power on the Moon first, then Mars.

**Laser Communications**

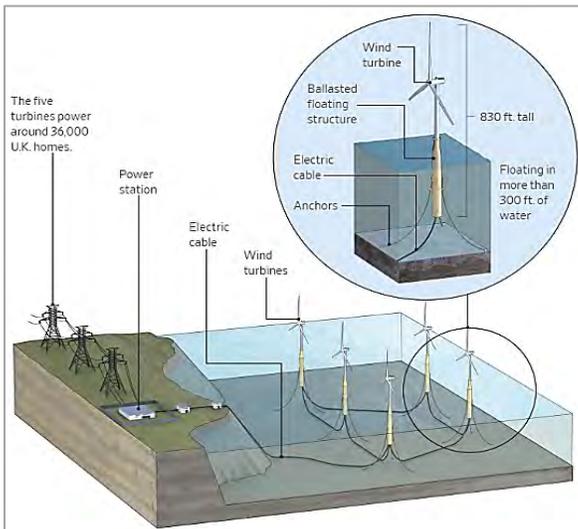
Laser communications will be needed to send large amounts of data, including high-definition images and video feeds to Earth. NASA has proven laser communications is possible with a demonstration from the Moon in 2013. The agency is now perfecting the antenna pointing system and working on ways to handle clouds and other communications disruptions. Another laser communications payload will shortly be taken into deep space to determine what is required to use the same technology millions of miles away from Earth.

ENERGY: JEFF BEZOS IS BACKING AN ‘ANCIENT’ KIND OF NUCLEAR ELECTRIC POWER GENERATION

Two competing nuclear fusion companies, each with venture capital superstars as major investors, say they’re approaching the “Kitty Hawk moment” for their technology as early as 2025. **Magnetized target fusion (MTF) dates back to the 1970s, when the U.S. Naval Research Lab first proposed it, but MTF’s proponents say the technology is now bearing down to reach the commercial power market.** Like a tokamak, an MTF reactor involves hot plasma contained by a powerful magnetic field. (A tokamak is a device which uses a powerful magnetic field to confine plasma in the shape of a torus. In geometry, a torus is a surface of revolution generated by revolving a circle in three-dimensional space about an axis that is coplanar with the circle.) The tokamak is one of several types of magnetic confinement devices being developed to produce controlled thermonuclear fusion power. While a tokamak is heated by extraordinary outside power, the MTF reactor made by Canada’s General Fusion (Jeff Bezos-backed) is pressurized to superheat the plasma. This pressure is applied by pistons that coordinate to make a pressure wave. From there, the rest is a more prosaic business. Hot neutrons escape the plasma and are captured in the liquid metal, and their energy powers a heat exchanger to make power. With a main chamber of 10 feet in diameter, General Fusion’s MTF reactor is considered small for a fusion technology intended to self sustain and generate power after reaching plasma ignition. **Meanwhile, the American company Commonwealth Fusion Systems operates with a 10-ton magnet at the heart of its fusion reactor. The superconducting magnet will trap and pressurize hydrogen to induce a powerful plasma reactor.** Last year, TechCrunch, an American online newspaper focusing on high tech and startup companies, said Commonwealth’s technology is a hypothetical “leapfrog” of the entire current generation of plasma tokamak reactors. Smaller companies like General and Commonwealth have made ambitious plans that use the huge international ITER project as a flattering comparison point. ITER plans for first plasma in 2025, with a goal to be online for ignition power in 2035. That project is also a symbol, bringing together dozens of countries with combined manufacturing and intellectual efforts toward one massive reactor. Smaller reactors without the heft of international cooperation can behave a little more nimbly, without layers of diplomacy to navigate. It’s easy to see how both approaches are helpful, but the important thing today is that no one, large or small, has reached plasma fusion that generates more energy than it consumes. Until someone does, all the timeline bickering or posturing in the world means very little. General Fusion boasts two gigantic investors: Amazon's Bezos and Shopify founder Tobias Lutke. Commonwealth has pockets about the same size and counts Bill Gates among its investors. Both Gates’s and Lutke’s investments are from firms established specifically for decarbonizing technologies.



ENERGY: FLOATING WIND TURBINES BUOY HOPES OF EXPANDING RENEWABLE ENERGY



Wind farms have been erected on land and at sea for decades, but Hywind Scotland, operated by Norwegian oil giant Equinor, is the first to float. Instead of being inserted into steel tubes buried in the seabed, the turbines sit in cylindrical buoys that are fixed to the seabed by mooring lines. **The approach promises to enable wind farms in much deeper water where there are often stronger winds, opening up swaths of untapped coastline to renewable energy.** Equinor believes that there are many countries where floating wind could be the best option for generating renewable power. In some places, such as Japan, South Korea and the U.S., a steep drop off the continental shelf means the water is too deep for fixed wind turbines, which are limited to depths of around 60 meters. Still, floating wind is almost double the cost of fixed offshore wind, which needs an average price of \$84 per megawatt-hour of electricity for projects to break even. There are dozens of concepts for floating platforms in the works, preventing the savings that come with standardization and mass production. Longer cables needed to send power back to land can also increase

expenses. The internal rate of return is around 10% for fixed wind and not yet known for floating wind. Some oil/gas companies seeking to expand in renewable energy see floating wind as a natural extension of their expertise. A handful of commercial scale floating wind farms are expected to start up by 2025, including in Spain, Italy and South Korea.

AUTOMOTIVE: GM DROPS AN 'E-BOMB', IT WILL SELL ONLY ZERO-EMISSION VEHICLES BY 2035

The days of the internal combustion engine are numbered. General Motors intends to phase out petroleum-powered cars and trucks and sell only vehicles that have zero tailpipe emissions by 2035, a seismic shift by one of the world's largest automakers that makes billions of dollars today from gas-guzzling pickup trucks and sport utility vehicles. The announcement is likely to put pressure on automakers around the world to make similar commitments. It could also embolden the administration and other elected officials to push for even more aggressive policies to fight climate change. Leaders could point to GM's decision as evidence that even big businesses have decided that it is time for the world to begin to transition away from fossil fuels that have powered the global economy for more than a century. **GM's move is sure to roil the auto industry, which employed about one million people in the United States in 2019, more than any other manufacturing sector by far. It will also have huge ramifications for the oil and gas sector, whose fortunes are closely tied to the internal combustion engine.** A rapid shift by the auto industry could lead to job losses and business failures in related areas. Electric cars don't have transmissions or need oil changes, meaning conventional service stations will have to retool what they do. Electric vehicles also require fewer workers to make, putting traditional manufacturing jobs at risk. At the same time, the move to electric cars will spark a boom in areas like battery manufacturing, mining and charging stations. There also are questions about whether there will be a supply crunch for raw materials needed to produce batteries, such as cobalt and lithium, should electric-vehicle adoption take off. **A 20% rise in the price of cobalt since the beginning of this year shows how the rush to build more electric vehicles is stressing global supply chains.** The company is counting on a new electric-vehicle technology called Ultium, developed in-house, that it says will cut battery costs by about 60% by mid-decade. GM plans to use different combinations of the same battery cells, tucked under the vehicle's floorboard, to power a range of future electric models, from big pickup trucks to affordable compact SUVs. Today, the higher cost of plug-in cars relative to gas or diesel vehicles is a deterrent for many buyers. GM expects that gap to close by mid-decade from advances in battery technology. It is investing in a \$2.3 billion battery factory in Ohio in a joint venture with LG Chem of South Korea. GM said its decision to switch to electric cars was part of a broader plan to become carbon neutral by 2040. GM will increase the use of renewable energy and eliminate or offset emissions from its factories, buildings, vehicles and other sources.

**AUTOMOTIVE: WHEN THE EV REVOLUTION ARRIVES, WILL THERE BE ENOUGH PLACES TO PLUG IN?**

The country will need thousands of charging stations for drivers to accept vehicles that are powered by batteries alone, but automakers and charging companies are struggling to raise the numbers now because they're investing before demand arrives. **With more than 40**



fully electric vehicles on the market in the U.S. or coming within the next three years, auto and charging company executives say the demand is on the way. There are now 26,000 electric vehicle charging stations open to the public in the U.S. with more than 84,000 plugs. "The automakers are committing to manufacture electric vehicles," said Electrify America, a network of charging stations being built with \$2 billion in settlement money from VW's diesel emissions cheating scandal. "Last year, automakers announced a combined \$225 billion in investments in electrification." General Motors and charging company EVGo announced plans to add about 700 fast-charging stations, tripling the number on the EVGo network over the next five years and adding 2,700 fast-charging plugs. They'll focus on 40 unspecified metropolitan areas, with emphasis on California, Texas, Florida and Illinois, building the stations near where people go to run errands, such as grocery stores or pharmacies. Typically a fast-charger can refill a battery in 30-40 minutes, so the idea is for charging to be done while people are shopping. "We've done extensive consumer research in understanding what's important to the customer," GM CEO Mary Barra said. "Clearly having a robust charging infrastructure is something that our customers have told us is important." Fast-charging stations have higher kilowatt capacities than home chargers and are important to quickly recharge batteries on newer electric vehicles that can travel 300 or more miles on a single charge. But the bulk of the nation's public charging network is much slower. The U.S. Department of Energy says there are 3,884 public fast-charging stations in the country now with 14,858 outlets. As more electric vehicles are sold, more fast chargers will be needed, especially for people who live in apartment buildings who can't charge at home. The 2,700 new fast-charging outlets will start to become available early next year. GM and EVGo say they'll invest in the outlets, but many will be built with funding from utilities, governments and public-private partnerships. More public charging stations will allow GM and other automakers to better compete with Tesla, which now leads the world in electric vehicle sales and has its own private network of fast-charging stations.



AUTOMOTIVE: RAPID, INEXPENSIVE BATTERY CHARGES FOR EVS, REDUCES RANGE ANXIETY

Range anxiety, the fear of running out of power before being able to recharge an electric vehicle, may be a thing of the past, according to a team of Penn State engineers who are looking at lithium iron phosphate batteries that have a range of 250 miles with the ability to charge in 10 minutes. "There is no more range anxiety and this battery is affordable," said Chao-Yang Wang, director of the Electrochemical Engine Center at Penn State. The researchers also say that the battery should be good for 2 million miles in its lifetime. They report that the key to long-life and rapid recharging is the battery's ability to quickly heat up to 140°F for charge and discharge and then cool down when the battery is not working. The very fast charge allows downsizing the battery without incurring range anxiety. The battery uses a self-heating approach previously developed in Wang's center. The self-heating battery uses a thin nickel foil with one end attached to the negative terminal and the other extending outside the cell to create a third terminal. Once electrons flow, it rapidly heats up the nickel foil through resistance heating and warms the inside of the battery. Once the battery's internal temperature is 140°F, the switch opens and the battery is ready for rapid charge or discharge. Wang's team modeled this battery using existing technologies and innovative approaches. By employing this self-heating method, they can use low-cost materials for the battery's cathode and anode and a safe, low-voltage electrolyte. **The cathode is thermally stable lithium iron phosphate, which does not contain any of the expensive and critical materials like cobalt. The anode is made of very large particle graphite, a safe, light and inexpensive material.** Because of the self-heating, the researchers said they do not have to worry about uneven deposition of lithium on the anode, which can cause lithium spikes that are dangerous. According to Wang, these smaller batteries can produce a large amount of power upon heating—40 kilowatt hours and 300 kilowatts of power. An electric vehicle with this battery could go from zero to 60 miles per hour in 3 seconds and would drive like a Porsche, he said. "This is how we are going to change the environment and not contribute to just the luxury cars," said Wang. "Let everyone afford electric vehicles."



MEDICAL: COVID-19 VACCINES – THE RACE TO SAVE LIVES

In November 2020, the world received the exciting news that the first COVID-19 vaccines were ready for roll out. **By the start of 2021, nearly 7.25 billion doses had been pre-purchased by countries and organizations around the globe.** Although high-income countries



are currently buying the larger shares of doses, India has ordered 1.5 billion—more than any other individual country. The U.S. pre-purchased 1.01 billion doses, and although this number is less than the amount India has purchased, the U.S. has around 330 million people compared to India's 1.3 billion citizens. Without the purchasing power of high income countries, low and middle-income countries must leverage other means to acquire COVID-19 vaccines, such as volunteering to host clinical trials in exchange for doses, as was done in Peru. India's ability to purchase 1.5 billion doses came from manufacturing agreements with vaccine producers. As a percentage of total doses sold, high-income countries bought about 54%, equating to 4 billion doses. Low and middle-income countries purchased just over 23%. Canada has reserved the highest number of doses per person

compared to any other country, ordering over 350 million vaccinations for a population of just over 38 million people, equating to nine doses per person. There are currently over 200 vaccine candidates being developed and tested at breakneck speed. However, not all of the vaccine candidates that are being pre-sold will pass the testing stage. **The Oxford University vaccine is the most popular so far, with over 2.5 billion doses sold. The academic institution, together with AstraZeneca, is doling out 500 million vaccines each to India and the U.S., as well as 400 million to the European Union.** Novavax, the second highest seller of COVID-19 vaccines, has pre-sold 1.3 billion doses. So far, the early birds Pfizer-BioNTech and Moderna have pre-sold 10% and 6% respectively of the total vaccine doses being manufactured. In terms of pricing, Pfizer-BioNTech is selling their vaccines at \$19.50 per dosage. With the current number of doses already sold by Pfizer-BioNTech, that amounts to a current revenue of over \$13 billion. In early March, the U.S. committed to buy 200 million doses of J&J 's newly approved COVID-19 vaccine. J&J promised to supply 20 million shots in March and 100 million by June. Between this vaccine and 300 million shots apiece from Pfizer and Moderna, the federal government had already secured enough supply to vaccinate the entire American population. Without COVID-19 vaccines, health and safety measures such as social distancing and self-isolation would likely stay in place for the foreseeable future. Looking beyond which countries receive the vaccines first, the World Health Organization has created a road map detailing which individuals should be prioritized, with a focus on frontline healthcare workers and the elderly. A future where life is somewhat back to normal is on the horizon, but some countries are set to get there faster than others.



STEEL/MEDICAL: STAINLESS STEEL IS CRUCIAL IN FIGHT AGAINST INFECTION

In the late 19th century, Joseph Lister was developing practical applications of the germ theory of disease in relation to ensuring sanitary medical settings. His pioneering aseptic surgery techniques – which involved combating infection by spraying surfaces, implements and even patients with corrosive carbolic acid – paved the way for modern medical practices. In 1913, a crucial invention would allow for patients to undergo medical treatment in reliably sanitary environments. The many properties of this invention – stainless steel – resulted in it being used in a number of applications across the healthcare industry. **This unique material, which is used in hospitals all across the world, is relied upon because it is easy to clean, non-porous and corrosion-resistant, even when it has been repeatedly sanitized with the powerful chemicals needed to combat bacteria.** The WHO cites infections acquired by patients while undergoing treatment as one of the most serious challenges facing modern healthcare delivery. Hundreds of millions of patients worldwide are affected every year, so the need to maintain sanitary conditions is paramount. Another aspect is the growing antibiotic resistance that is reducing the effectiveness of certain vital medical treatments and making it ever more important that surfaces and objects in patient areas can be easily and reliably disinfected.



Stainless steel’s role in maintaining clinical safety cannot be underestimated. **Non-toxic, chemically inert and with non-absorbent properties, stainless steel can be safely sterilized without any corrosion or degradation.** A study by Manchester Metropolitan

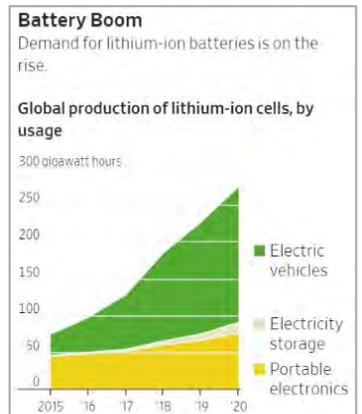


University and AgroParisTech examined the enduring power of stainless steel to deliver a sanitary environment. Previously, most research on the effectiveness of disinfectants was conducted on new surfaces. This study aimed to test the effectiveness of both new and old surfaces, with a “cycle of fouling and cleaning” developed to simulate aging. The study took the two grades of stainless steel most commonly found in hospitals and contaminated both new and aged samples with bacteria. These bacteria, which cause the majority of healthcare acquired infections, were *Staphylococcus aureus*, which is responsible for food poisoning and localized infections and can sometimes be fatal. The second, *Pseudomonas aeruginosa*, is

highly prevalent, very resistant and difficult to treat. Both sets of samples were cleaned, with the disinfectant shown to be 99.9% effective against *Staphylococcus aureus* and 97.6% effective against *Pseudomonas aeruginosa*. There was also no discernible difference in effectiveness between the new or aged stainless steel. **With the reliability of its unique properties, stainless steel is set to continue ensuring the safety and sanitation of patients across the world for the foreseeable future.**

INNOVATION: THE RECHARGEABLE LITHIUM-ION BATTERY IS POISED TO DISRUPT INDUSTRIES

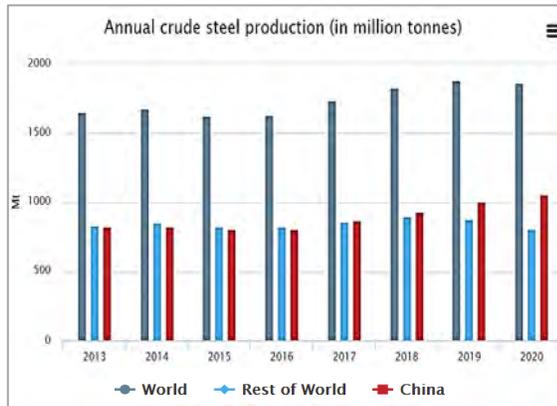
Rechargeable lithium-ion batteries were first commercially used in hand-held camcorders in 1991. A decade later, batteries enabled the rise of tech titans such as Apple by powering smartphones and wearable devices, then made their way into electric vehicles. The basic technology throughout remained pretty much the same: Lithium ions move through a liquid from the cathode to the anode and back again. **After a decade of rapidly falling costs, the battery has reached a tipping point. No longer just for consumer products, it is poised to transform the way the world uses power.** In the energy sector, affordable batteries are making it possible for companies to store electricity and harvest renewable power. In the auto industry, they are set to challenge the gas-powered engine’s century-long domination. Costs have come down so far and so fast that most car makers expect that electric vehicles, which are currently more expensive than their gas-powered counterparts, will cost the same amount to build within the next five years. The battery boom could erode demand for crude oil and byproducts such as gasoline, as well as for natural gas, which is primarily used in power plants. Companies are working on new configurations, such as solid-state batteries, which don’t transfer ions through liquid, that could significantly enhance the power and further lower battery prices. The value of such a breakthrough could be measured in the billions of dollars, if not trillions. In recent years, prices have fallen more quickly than expected due to demand from auto makers. Electric vehicle battery packs and motors currently cost about \$4,000 more to manufacture than a comparable fossil fuel-burning midsize sedan engine. By 2022, the difference will be \$1,900 and will disappear by mid-decade. The internal combustion engine has been engineered to near-perfection over a century, while the innovation of the battery-powered EV by contrast has barely begun.





STEEL: GLOBAL CRUDE STEEL OUTPUT DECREASED BY 0.9% IN 2020

Global crude steel production reached 1.864 million tonnes (Mt) for the year 2020, down by 0.9% compared to 2019.



What makes up global steel use?



SPECIALTY METALS: AT THE EXTREMES - NICKEL ALLOYS IN SPACE

The year 2020 marked the start of an exciting new decade in space exploration and innovation with nickel-containing alloys playing an important role in the construction of rockets, wheel and catalysts, to name a few applications. With its high strength and toughness, Alloy 718 (N07718), a precipitation hardenable nickel-chromium alloy used in aircraft turbojet engines, is also used in rocket engines and pressure vessels so they can handle cryogenic liquefied gases for propulsion down to -250°C. However, Alloy 718's properties make machining and forming more difficult than other materials. Investment casting can be problematic as Alloy 718 is susceptible to porosity, segregation and very coarse grain sizes, which calls for subsequent processing steps.

The solution is 3D printing, which allows for more efficient utilization of nickel based alloys such as Alloy 718 in high-performance applications with complicated designs. 3D printing can make Alloy 718 processing more convenient and straightforward, and it will ensure material properties are well preserved. This process avoids welding and machining and thus minimizes material waste. The benefit of this manufacturing method is demonstrated by the 3D printed Alloy 718 rocket engine prototype, which was entirely designed by artificial intelligence and developed by German software company, Hyperganic. Unlike a traditional rocket engine, which consists of individually designed parts that are joined together, the 3D printed prototype is one continuous piece. It includes the combustion chamber where fuel and oxidizer are burned, as well as the surface channels through which the fuel is circulated to cool the chamber and keep it from overheating. The one-piece fabrication results in the lowest weight and most effective cooling, providing the highest possible performance for a given rocket. 3D printing has also been used by the University of California at San Diego in the Ignus II Alloy 718 rocket engine for their Vulcan II rocket project. With each new application, nickel is helping space exploration go further in the future.



One-piece rocket engine, 3D printed using Alloy 718

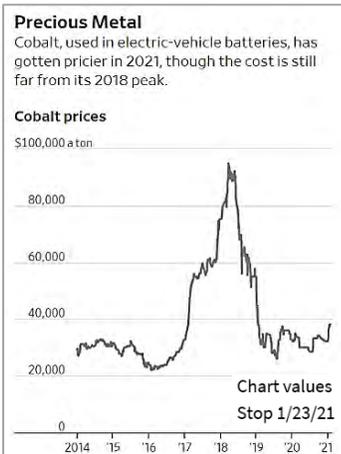
Alloy 718 is the workhorse of super alloys. A high-strength, corrosion-resistant nickel-chromium alloy used in the temperature range of -252° to 700 °C (-423° to 1300 °F). Its strength and resistance to oxidation at high temperatures make it a top choice for rocket engines. And its ductility at cryogenic temperatures enables its selection for tanks holding liquefied rocket fuel.

COMMODITIES: EV SURGE SENDS COBALT PRICES SOARING



A 55% rise in the price of cobalt since the beginning of this year shows how the rush to build more electric vehicles is stressing global supply chains. Currently, a shortage of semiconductors is slowing the recovery in auto production. Now cobalt, a blue metal that is needed for many types of batteries including those in EVs, is a concern for the auto and battery industries. **Energy-dense cobalt is used as the stabilizer in batteries, protecting the battery’s cathode from corrosion that can lead to a fire.** A majority of the world’s cobalt is mined in the Democratic Republic of the Congo. It typically is carried overland to South Africa, shipped out from the port of Durban and processed in China before the material goes to battery makers—meaning the

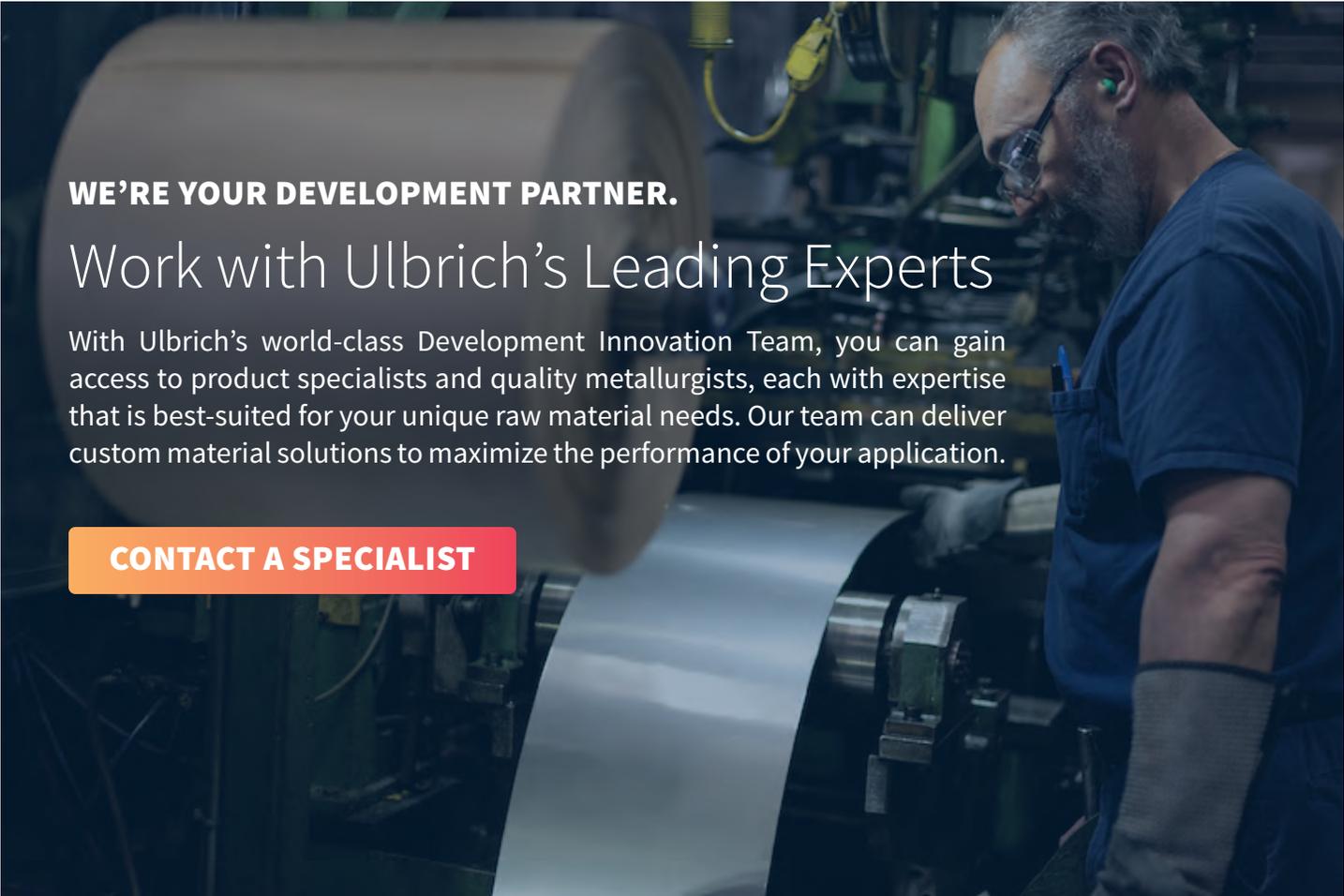
supply chain has several choke points that make it vulnerable to disruption. In 2017 and 2018, during an earlier rush of interest in EVs, the price of cobalt quadrupled in the space of two years before a boost in production calmed the market down. Recent moves aren’t as extreme, but LME cobalt spot prices breached \$50,000/tonne in February 2021 up from \$32,209/tonne in December 2020. Recent climate-change initiatives by China and Japan have accelerated a shift to electric vehicles. Tesla aims to build 20 million vehicles annually a decade from now, a 40-fold increase from last year and GM said it will sell only vehicles that have zero tailpipe emissions by 2035. More EVs mean more batteries, which account for about 40% of an EV’s cost. **Car and battery makers have been looking for more control over their cobalt supply and ways to avoid the metal altogether.** Honda formed an alliance with a leading Chinese car-battery maker, hoping that its supply-chain clout would help stabilize Honda’s battery supply. The two are also researching alternatives to cobalt. Panasonic has a joint battery-making venture with Tesla which aims to mass-produce cobalt-free batteries in two to three years. Currently, the joint venture uses a formulation called NCA, containing nickel, cobalt and aluminum, which is extremely low in cobalt at less than 5%. Meanwhile, China plays a critical role even though it doesn’t have significant reserves of cobalt itself. Chinese companies control more than 40% of Congo’s cobalt-mining capacity. To break China’s stronghold, auto makers and suppliers are trying to recycle more cobalt from old batteries and exploring other nations for alternative supplies. Another reason to look for alternatives is instability in Congo and continuing ethical concerns about miners working in sometimes-harsh conditions with rudimentary tools and no safety equipment. Conflict between the Congo government and armed militias, often over control of mineral wealth, has destabilized the nation for decades and led many companies to look elsewhere for resources.



METAL/COMMODITIES: SIX MONTH PRICE INDEX TRENDS TO MARCH 2021



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