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ECONOMIC UPDATE

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EXECUTIVE SUMMARY

AMERICAS: SMALL BUSINESS OWNERS GREW LESS CONFIDENT ABOUT THE ECONOMIC RECOVERY during July as labor shortages remained a problem. **U.S. hiring** slowed sharply in August as the surging Delta variant dented the pace of the economic recovery. The economy added only 235,000 jobs, but the unemployment rate fell to a pandemic low of 5.2%. **U.S. corporate earnings** surged in the 2ndQtr after the coronavirus crisis severely depressed profits last year. Profits of companies listed on the blue-chip S&P 500 index have jumped about 90% and sales by a quarter. **The U.S. trade deficit** narrowed 4.3% in July as imports demand slowed for consumer goods and industrial supplies and materials. Exports expanded 1.3%, helped by a rebound in auto shipments. **Container ships** are stacking up again off California's jammed ports due to a flood of imports and logjams in domestic logistics networks. **Consumer prices** rose 5.4% in July vs. a year ago, but price pressures weakened on a monthly basis. **U.S. retail sales** fell 1.1% in July, autos by 3.9%.

OVERSEAS: EMERGING MARKETS ARE CONFRONTING A NEW HEADACHE — RISING INFLATION. Prices rose above 5% in Mexico and South Africa, 6% in India and Russia and 9% in Brazil. Soaring prices for food and energy are to blame. **Eurozone business activity** recorded a second-consecutive month of strong expansion in August. **China and the U.S.** are trading places in the economic growth race. U.S. GDP rose 12.2% in the 2ndQtr of this year from a year ago, outpacing China's 7.9% gain. The American edge should continue for at least the next few quarters. The reversal reflects the difference in the two nations' responses to the pandemic.

STEEL: STEEL PRODUCTION IN THE U.S. IS BACK TO 2019 LEVELS, but only in the last few months. Crude steel output for the week ending August 21 was up 27% from the same week last year. Stainless steel demand continues strong in breadth and depth with growth in all major markets. Cold-rolled coil is tight due to ATI exiting the commodity sheet markets; the other three producers can't satisfy the current demand. Stainless prices are set to rise 5-7¢/lb. in September. **Cleveland-Cliffs** reported that its mill inventory of steel rose by \$300 million during the 2ndQtr because shipments to automotive customers were 20% less than the company expected.

AUTOMOTIVE: GM IS CUTTING PRODUCTION AT EIGHT NORTH AMERICAN ASSEMBLY PLANTS IN SEPTEMBER because of the ongoing semiconductor chip shortage, now hitting its profitable truck and SUV business. **The global semiconductor shortage** has finally started to bite at Toyota. It is slashing global production in September by 40%, after reducing North American factory output by 40 to 60% in August. **The London Metal Exchange** launched a new contract for battery metal lithium, setting up a transatlantic battle with U.S. rival CME Group, as exchanges look to capture rapid growth in demand for commodities tied to the electric car industry.

ENERGY: US WIND PLANS MARYLAND'S 1ST FACILITY FOR MANUFACTURING OFFSHORE WIND FOUNDATIONS. The company leased 90 acres at the Sparrows Point Shipyard, formerly part of Bethlehem Steel. **Wind production** is expanding as the renewable energy source becomes more economically competitive with fossil fuel sources of electricity. **U.S. utilities** are looking to miniature nuclear reactors, as they seek a steady energy source that can help reduce the carbon emissions linked to climate change.

MEDICAL: A PACEMAKER THAT DOES ITS JOB, THEN PULLS A HOUDINI was developed by researchers at Northwestern and George Washington Universities. They have taken bioresorbable medical devices to a new level with the development of a transient pacemaker that disappears after it is no longer needed. **Medical-device stocks** have been star performers lately, returning 28% over the past year and 45% from their pre-pandemic high, despite the spread of the Delta variant causing hospitals to postpone elective surgeries.

INNOVATION: MAGNETS EXTRACT VALUABLE RESOURCES, ELEMENTS FROM BRINE. A team of researchers tackling the problem of finding an economic way to get valuable rare earth elements out of brine water from mining/drilling fluids, geothermal plants and seawater developed a nanotech process that miniaturizes most of the extraction and eliminates the need for ion exchange separators.

AEROSPACE: LIQUID OXYGEN (LOX) IS IN SHORT SUPPLY AS DEMAND RISES WITH COVID-19 CASES IN THE U.S. SpaceX President and COO Gwynne Shotwell said the shortage could impact upcoming launches, as many launch providers rely on LOX, a commonly used propellant. **The U.S. Air Force and several venture capital firms** are making a \$60M investment in Hermeus Corp., a startup that wants to develop the world's first reusable hypersonic aircraft. **Boeing** delivered 184 jetliners for this year through July.

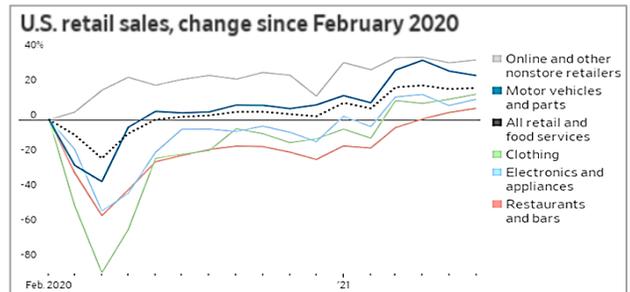
COMMODITIES: IRON ORE PRICES FELL 40% SINCE MID-JULY ON CONCERNS ABOUT DEMAND FROM CHINA, who until recently was churning out steel at record rates but now wants to keep steel output this year at 2020 levels. The price of **metallurgical coal** imported into China has soared, reaching \$440/mt at the beginning of September, up from \$230/mt in May. China's domestic coking coal output simply cannot meet steel industry demand, particularly for low sulphur coke. **Aluminum prices** are reaching 10-year highs, as buyers far from storage centers in Asia compete to line up shipments for use in beverage cans, airplanes and construction. LME aluminum forwards have climbed by a third this year to about \$2,650 a metric ton. Prices are around 80% higher than at their low point in May 2020.



THE AMERICAS.

- **Small business owners** across the U.S. grew less confident about the economic recovery during July as labor shortages remained a problem, according to an August survey. The National Federation of Independent Business Optimism Index fell 2.8 points to a reading of 99.7 in July. A record high forty-nine percent of small business owners reported unfilled job openings in July.
- **The Index of Leading Economic Indicators** climbed 0.9% in July to 116.0 with all components contributing positively. The Conference Board said that while the Delta variant and inflation fears may create headwinds for the economy, it expects real GDP growth for 2021 to reach 6.0% YOY, before easing to a still robust 4.0% growth rate for 2022.
- **Consumer confidence** dropped in August to a six-month low, with concerns over the Delta variant and elevated prices weighing on Americans' views of the economy. The Conference Board's index fell to 113.8 from 125.1 in July.
- **U.S. corporate earnings** surged in the 2ndQtr after the coronavirus crisis severely depressed profits in the same period last year. Profits of companies listed on the blue-chip S&P 500 index have jumped about 90% when taking into account reported results and estimates for the 10% of companies that have not yet disclosed their figures. Sales for companies increased by about a quarter.
- **Durable goods orders** dipped 0.1% in July, pulled down by a 2.2% decline in orders for transportation equipment. Non-defense capital goods orders were flat. Civilian aircraft orders tumbled 48.9%, as Boeing received only 31 aircraft orders compared to 219 in June. Orders for motor vehicles and parts rose 5.8% in July after climbing 1.8% in June.
Key Update: Automakers have been adjusting their production schedules by foregoing annual plant shutdowns for retooling in July to manage their chip supply. This action likely contributed to the July jump in motor vehicle orders.
- **U.S. import prices** rose 0.3% in July, the smallest gain since November. Imported fuel prices rose 2.9% in July, down from gains in excess of 5% in the prior two months. Over the past year, the price index for imports has risen 10.2%. Export prices rose 1.3% in July. Over the past year, export prices have risen at a 17.2% rate, up from 16.9% in June.
- **The U.S. trade deficit** narrowed in July, shrinking 4.3% from the previous month to \$70.1 billion. Imports fell 0.2% as demand slowed for consumer goods and industrial supplies and materials. Exports expanded 1.3% to \$212.8 billion, helped in part by a rebound in auto shipments, which had been suppressed by a semiconductor shortage.

- **U.S. hiring** slowed sharply in August as the surging Delta variant dented the pace of the economic recovery. The economy added only 235,000 jobs. The unemployment rate fell to a pandemic low of 5.2% from 5.4% in July. Wages increased 0.6% from a month earlier and 4.3% from a year ago. Hiring was particularly weak in the services sectors that involve in-person interaction.
- **U.S. retail sales** fell 1.1% in July, amid cooling purchases of goods and signs of some pullback in consumer demand as cases tied to the Delta variant rose. Sales dropped across several categories but primarily autos, which were down 3.9%. Sales at restaurants and bars rose 1.7%, while sales at nonstore retailers (a proxy for online retail sales) fell 3.1%.



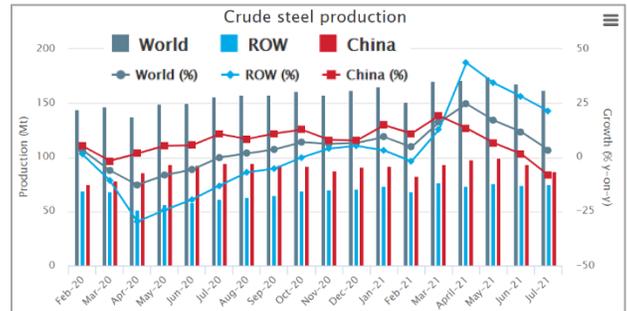
Key Update: Goldman Sachs economists lowered their tracking estimate of U.S. economic growth in the 3rdQtr to 5.5% from 9% due to the impact of the Delta variant but raised their forecast for the fourth quarter and beyond.

- **Consumer prices** rose 5.4% in July vs. a year ago but on a monthly basis, price pressures weakened. The CPI climbed 0.5% in July from June, a significantly slower pace than its 0.9% increase in June. The core price index increased 4.3% from a year ago and 0.3% from June. Gasoline prices picked up 2.4% and grocery prices climbed 0.7%, both categories rising at a slightly slower monthly pace than in June.
- **U.S. industrial production** rose 0.9% in July, the fastest pace in four months. Annually, output was up 6.6%. Manufacturing output returned to positive territory, adding 1.4% in July amid an 11.2% gain for motor vehicles and parts, as vehicle manufacturers either pared or canceled retooling shutdowns in the month. At an annual rate, vehicle assemblies rose to 9.7 million units in July. Mining production gained 1.2%, while utilities output fell 2.1%.
- **The ISM index of national factory activity** inched up to 59.9 in August vs. July's 59.5. The six largest manufacturing industries, including computer and electronic products, chemical products and transportation equipment, reported moderate to strong growth. Manufacturers of computer and electronic products said that while a global semiconductor shortage was impacting supply lines, they had so far "been able to manage it without impacting clients".



- **U.S. factory orders** rose 0.4% in July and 18% YOY. Business spending on equipment remained strong. Manufacturing was holding up despite persistent supply constraints and some spending rotating back to services from goods. Orders for transportation equipment fell 2.1%.
- **Growth in the services sector**, where most Americans work, slowed in August after setting a record pace in July. The ISM survey of service industries decreased to a reading of 61.7 in August after hitting a record high of 64.1 in July.
- **U.S. producer prices** increased 1.0% in July, matching June's rise. In the 12 months through July, the PPI has jumped 7.8%, a record high since the measure was introduced in 2010. Three-quarters of July's gain was driven by a record 1.7% one-month increase in services. Twenty percent of the increase in services was due to margins for automobiles and parts retailing, which rose 11.2%.
- **U.S. worker productivity** increased at a 2.3% annualized rate in the 2ndQtr and the 1stQtr was revised lower to a 4.3% rate instead of the previously reported 5.4% pace. Hourly compensation rose at a 3.3% rate in the 2ndQtr and followed a revised 1.4% growth pace in the first quarter.
- **U.S. consumer spending** slowed in July, increasing 0.3% overall. Demand is shifting back to services like travel and leisure. Goods spending fell 1.1%, led down by motor vehicles. Spending on services rose 1.0%. Personal income rose 1.1%. Record high stock market prices and accelerating home prices are boosting household wealth.
- **U.S. existing-home sales** rose 2% in July to an annual rate of 5.99 million. July sales were up 1.5% from a year earlier. The inventory of homes for sale at the end of July was up 7.3% from June and the highest since last October. Sales of new U.S. single-family homes increased 1% in July after three straight monthly declines. Housing starts dropped 7.0% to an annual rate of 1.534 million units. Permits issued for future homebuilding rose 2.6%. The S&P Home Price Index rose 18.6% in the year that ended in June.
- **U.S. construction spending** rose slightly (+0.3%) for July. Total spending saw a 6.2% increase during the first seven months of 2021 vs. the same period in 2020. Residential construction inched up just 0.5% to \$773.0 billion in July, yet it is a healthy 27% above the same month in 2020.
- **Container ships** are stacking up again off Southern California's jammed ports, as a flood of imports and logjams in domestic logistics networks hit operations at the biggest U.S. gateway for seaborne trade. Dozens of container ships were anchored off the adjacent ports of Los Angeles and Long Beach in recent days. The two ports handle more than a third of all U.S. seaborne imports.

- **Steel mills** in the U.S. shipped 8.031 million tons of steel in June, a 0.6% increase from the previous month and a 33% improvement from June 2020. Shipments YTD through June were 45.696 million tons, an 11.5% increase vs. the same period in 2020. (See [Appendix: Steel](#), page 11)
- **U.S. Steel** will be idling a blast furnace at Gary Works at the end of September for up to 38 days and a second furnace at Gary in November for 10 days. USS has also scheduled one of the two furnaces at Granite City for maintenance the first week of October. Its subsidiary Big River Steel will be idle for two weeks in October. Nucor, Cleveland-Cliffs and Steel Dynamics have also scheduled outages in the 4thQtr.
Key Update: Flat-rolled carbon steel inventories are rising but still lean, with less than 60 days on-hand and replenishment a challenge. Lead times are 10-13 weeks with most production committed to contractual customers, with spot tonnage nearly nonexistent.
- **Global crude steel production** was 161.7 million tonnes (Mt) in July, a 3.3% increase compared to July 2020. YTD through July, global crude steel output was 1.165 billion MT an increase of 12.4% over the same 2020 period. China's production of crude steel fell by the widest YOY margin since the 2008 global financial crisis. Early indicators suggest it might have slipped again in August. The usually prodigious flow from China has fallen by 12.5 million metric tons in July from May's record high output.



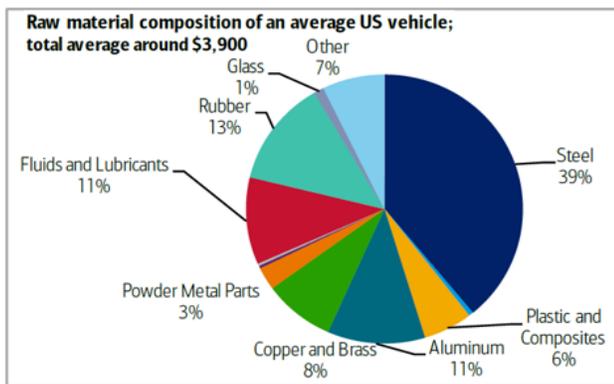
- **Steel production in the U.S.** is back to 2019 levels, but only in the last few months. Crude steel output the week ending August 21 was up 27% from the same week last year. Production year-to-date totaled 60.2 million net tons, up 19.8% vs. the same 2020 period. Capacity utilization has averaged 80.4% this year compared to 67% during the same time frame in 2020.
- **Steel imports into the U.S.** were 3.010 million tons (MT) in July, including 2.060MT of finished steel. Total steel imports YTD through July compared to last year increased 17.4% to 17.729MT and finished steel imports rose 20.6% to 12.086MT. Finished steel import market share in the U.S. over the first 7 months of 2021 was estimated at 21%.



- **Stainless steel sheet mills** raised base prices 3-5¢/lb. effective August 1st. The base price increases are dwarfed by the surcharges, up 25¢/lb on grade 304 and 49¢/lb on grade 316. Demand continues strong in breadth and depth, with growth in all major markets. Cold-rolled coil is tight due to ATI exiting the commodity sheet markets; the other three producers can't satisfy the current demand. Service center stainless shipments YTD July were up 12.9% at 1.06 million tons. Inventory was down 4.2% from a year ago and was less than at any point since 2019. Such dynamics typically open the door to imports, but overseas markets are also strong, so foreign mills have little surplus for export. Steel tariffs at 25% also discourage an influx of imported stainless.

Key Update: *With prices set to rise 5-7¢/lb in September, some buyers attempted to purchase more stock before increases take effect, exacerbating the scramble.*

- **Cleveland-Cliffs** reported that its mill inventory of steel rose by \$300 million during the 2ndQtr because shipments to automotive customers were 20% less than the company expected. Cliffs said it was able to redirect some of that steel to the spot market, where the company was able to sell it for higher prices than the auto makers typically pay under purchase contracts with the Cleveland-based steelmaker.
- **U.S. retail auto sales** were expected to fall 14.3% in August from a year ago to 987,000, as the global semiconductor shortage coupled with the fast spreading Delta variant of the coronavirus squeezed inventory at dealerships. Dealers currently have about 942,000 vehicles in inventory, compared with about 3 million two years ago.



- **General Motors** will recall about 73,000 Chevrolet Bolt electric vehicles at a cost of \$1 billion to address fire risks and indefinitely halt sales over the battery issue. The massive recall comes as the company is aggressively moving to ramp up electric vehicle sales. Meanwhile, GM is cutting production at eight North American assembly plants in September because of the ongoing semiconductor chip shortage, now hitting its profitable truck and SUV business.

- **U.S. auto safety regulators (NHTSA)** identified 11 crashes since early 2018 in which a Tesla vehicle, using the company's driver-assistance system, struck one or more vehicles involved in an emergency-response situation. NHTSA is studying the Autopilot system in some 765,000 Tesla vehicles from the 2014 through 2021 model years. Autopilot is available on vehicles made in late 2014 and later. Such investigations can, but don't always, lead to recalls. (See **Appendix: Automotive**, page 13)

- **Tesla** is working on a humanoid robot that will leverage Tesla's experience with automated machines in its factories, as well as some of the hardware and software that powers the company's Autopilot driver assistance software. The robots will be designed to handle "tasks that are unsafe, repetitive or boring," the company said. Elon Musk, who has spoken repeatedly about his fears of runaway AI, said the Tesla Bot is "intended to be friendly," but that the company is designing the machine so that "you can run away from it and most likely overpower it". The robot will be 5'8" tall, weigh 125 pounds, and have a screen for a face.



- **Boeing's Starliner spacecraft** will be returned to a factory for "deeper-level troubleshooting" to fix stuck valves that have delayed a planned launch this summer until perhaps next year. Boeing said its preliminary analysis indicated that moisture in the spacecraft's propulsion system somehow resulted in corrosion on 13, or more than half, of valves and prevented them from opening properly.

Key Update: *NASA has said it wants to have two U.S.-based companies available to transport astronauts to and from the space station. Right now, the agency has one confirmed provider, SpaceX, in place for those flights. Its second option is to contract for seats on Russian rockets.*

- **The U.S. oil and gas pipeline industry** is looking for new opportunities to lay steel in the ground with pipes that carry the CO² produced when fossil fuels are burnt. In response, pipeline operators are pointing to their potential as a link in carbon capture and storage systems (CCS), in which CO² emissions are trapped in underground reservoirs where they can be kept out of the atmosphere. Pipelines would move CO² from industrial flues to the reservoirs. The U.S. has about 5,150 miles of CO² pipelines. The Council on Environmental Quality said that a CCS industry large enough to help meet the country's goal of net zero emissions by 2050 could require 68,000 miles of new CO² pipelines at a cost of as much as \$230 billion.



- **Boeing** delivered 28 planes to buyers in July as revived domestic travel fuels 737 MAX deliveries, but the 787s remained in inventory for a fourth month due to defects. Boeing has delivered 154 737 MAX jets since that aircraft returned to service in November 2020. Overall, Boeing delivered 184 jetliners for the year through July. Boeing received orders in July for 31 aircraft, including 19 of its 737 MAX jets and 12 of its larger widebodies.

(See **Appendix: Aerospace**, page 9)

- **GE Aviation** signed a \$716 million contract with India's Hindustan Aeronautics, for 99 F404 engines for Indian fighter aircraft. The deal with GE Aviation will see the F404-GE-IN20 engine power the Tejas, a light combat aircraft (LCA) with a single engine. GE committed to deliver all 99 engines and support services by 2029. F404 engines have logged more than 14 million engine flight hours and powered 15 different production and prototype aircraft.



- **Investors** poured an annual record \$4.3 billion into electric air taxi start-ups this year as many hope to uncover "the next Tesla". Funding hit this level in the first 8 months of 2021. Funding for all types of air mobility technology, including drones, has soared 83% to more than \$10.4 billion in five years. It is one of the hottest markets, even though most start-ups lack a prototype able to carry passengers.

- **Liquid oxygen** (LOX) is in short supply as demand rises with COVID-19 cases in the U.S. As hospitals struggle to treat patients, SpaceX worries the shortage could also jeopardize upcoming launches. Hospitals treating COVID-19 patients rely on LOX for ventilator treatments, and with rising numbers, LOX is becoming hard to find. SpaceX President and COO Gwynne Shotwell said the shortage could impact upcoming launches, as many launch providers rely on LOX, a commonly used propellant.

- **USW union president Thomas Conway** called for refinery and chemical plant workers to include decarbonization as part of contract proposals to be made to U.S. oil companies in January. In remarks to the USW national oil bargaining policy conference, he said decarbonization projects should be viewed as necessary capital investment programs.

Key Update: *Officials from USW locals representing 30,000 refinery and chemical plant workers met to develop proposals to be used in talks in January with Marathon, which is representing the nation's oil companies for the first time. The 2022 contract talks will come after national refining capacity fell 4.5% in the COVID-19 pandemic.*

- **Wind production** is expanding as the renewable energy source becomes more economically competitive with fossil fuel sources of electricity. Turbine demand this decade is expected to double vs. the previous 10 years, but companies face an array of challenges in manufacturing and moving the increasingly large turbines. A quadrupling of transportation costs and increases in steel, copper, aluminum and carbon fiber prices will likely drive wind-turbine prices up by 10% over the next 18 months.

- **US Wind plans** to develop Maryland's first facility for manufacturing offshore wind foundations. The company leased 90 acres at the Sparrows Point Shipyard, formerly part of Bethlehem Steel. The Sparrows Point mill on the site was once the largest integrated mill in the world, supplying steel for warships, the Empire State building and the Golden Gate Bridge, shipping its last tons in 2012. Developers say the site could become one of the largest U.S. staging ports for the offshore wind power industry.

- **Pfizer** has agreed to buy oncology biotech Trillium Therapeutics in a deal worth \$2.3 billion. The company is betting on the success of two Trillium drugs in early to mid-stage trials. The treatments harness the immune system to tackle blood cancers such as leukaemia and multiple myeloma. (See **Appendix: Medical**, page 12)

Key Update: *Blood cancers make up about 6% of all cancers, with 1 million patients around the world diagnosed with a hematological condition in 2020.*

- **Philips** announced a Class I recall of 4 million sleep apnea and ventilator devices. More than 100 injuries and 1,200 complaints have been reported. The recall opened the door for rival ResMed to fill the void. ResMed said the recall could add up to \$350 million in sales. Phillips has suffered a €10bn drop in market cap since airing the problem in April.

- **Medical-device stocks** have been star performers lately, returning 28% over the past year and up about 45% from their pre-pandemic high, despite the spread of the Delta variant causing hospitals to postpone elective surgeries. The index earlier shed 28% in the winter of 2020 as the pandemic began and hospitals had to treat COVID patients.

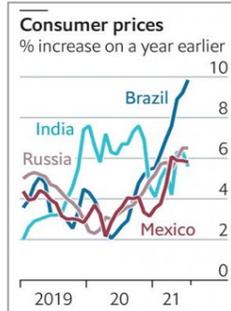
- **Medtronic** aims to beef up its ear, nose, and throat portfolio with the proposed acquisition of Intersect ENT, for \$1.1B.

Intersect developed the Propel and Sinuva sinus implants which open sinus passageways and deliver an anti-inflammatory steroid to aid in healing. These products will allow Medtronic to expand its offerings for chronic rhinosinusitis patients.



EUROPE, AFRICA & THE MIDDLE EAST

- Emerging markets**, battered by extreme weather and waves of COVID-19, now confront a new headache — rising inflation. Inflation rates across the developing world have leapt well above central banks' target rates. Over the summer, it rose above 5% in Mexico and South Africa, 6% in India and Russia and 9% in Brazil. Soaring prices for food and energy are to blame. They have surged as a result of recovering global demand meeting supply disruptions, caused by clogged shipping lanes and weather-damaged crops.



Key Update: While high prices help the commodity-exporting sectors of some emerging economies such as Brazil, they are pushing some central banks to take aggressive action. Both Russia's and Brazil's have raised interest rates by a full percentage point over the past month.

- Eurozone business activity** recorded a second consecutive month of strong expansion in August, suggesting that the bloc is on course for healthy 3rdQtr growth, according to economists. The IHS Markit flash composite purchasing managers' index reached 59.5, down slightly from its fifteen-year high of 60.2 in July.
- Eurozone inflation** hit its highest level in almost a decade in August amid signs that shortages of semiconductors and other important manufacturing components are pushing up the prices paid by consumers. Consumer prices were 3% higher in August than a year earlier, a pickup from the 2.2% rate of inflation recorded in July.
- The rally in European steel prices** may finally be running out of steam. A dip in iron ore prices, cheaper imports and a seasonal slowdown in demand are conspiring to cool benchmark prices of steel on the Continent. The price of hot-rolled coil futures tapered off gradually in August after six consecutive months of gains, which gave Europe's steelmakers some of their biggest profits in years. In the U.S., the rally continues. Hot-rolled coil futures are approaching \$2,000/ton, aided by tariffs on foreign imports that the administration is in no hurry to remove.
- The era of cheap natural gas** is over, according to analysts. The lower-cost, cleaner fuel is popular globally, but low prices dampened investments in liquefied natural gas terminals. The result now is tight supplies overseas where European market prices are up more than 1000% from record lows in May 2020, while Asian rates are up six-fold.

- The IEA** sharply lowered its oil demand forecasts for the rest of the year after several major energy-consuming countries imposed fresh curbs to stop the spread of the Delta variant. After surging in June, oil demand abruptly reversed course in July. The IEA put growth at 500,000 barrels/day lower in the 2ndHalf vs. its last estimate. Global oil demand is now seen as rising 5.3M b/d on average to 96.2M b/d in 2021 and by a further 3.2M b/d in 2022. Before the pandemic began, it was almost 100M b/d. (See **Appendix: Energy**, page 8)

- BHP** began talks over a potential merger of its petroleum division with Australia's Woodside in a move that would mark the exit of the biggest miner from the oil and gas industry. BHP's oil and gas unit could be worth \$13bn. BHP has also put its last thermal coal mine up for sale as it looks to focus on greener commodities.

- The European Union** is working on proposals to jump-start home output of a type of specialist magnet vital in EV motors by offering support to local producers so they can compete with Chinese rivals. The moves to support production of rare earth permanent magnets would mirror legislation introduced in the U.S. in August to offer tax credits to domestic makers of the devices. China supplies 98% of EU demand for magnets made from rare earths, a set of 17 minerals used in electronics, defense and aerospace.

- Sweden's SSAB** made the world's very first "fossil-free" steel delivery, created with green hydrogen instead of coal and coke, to Volvo to be used in electric trucks. A milestone in decarbonization, SSAB's HYBRIT process uses hydrogen as the reductant, as iron ore and limestone are combined to create steel, replacing coke. The traditional blast furnace is replaced with an electric arc furnace. SSAB's hydrogen electrolyzers and electric arc furnaces are run on renewable energy and the iron ore is extracted by "fossil free" mining operations.

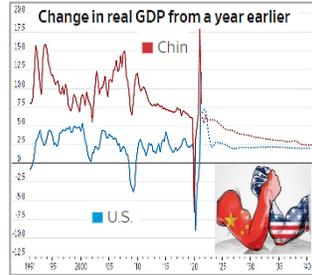


Key Update: Sweden is poised to lead the way on green steel, with the world's largest green steel facility set to start production in 2024. H2 Green Steel (H2GS) is working with a budget of around US\$3B. It will use hydrogen produced with renewable energy. By 2030, H2GS expects to be producing 5M tonnes of high-quality zero-emissions steel annually.

- The EU-funded Laser Lightning Rod project** is undergoing tests atop a Swiss mountain. A super laser shoots a thousand pulses per second into clouds through which lightning naturally passes to a safe discharge point. The technology has promise for use at airports, wind turbines, power plants, arenas, skyscrapers and forests.

ASIA/PACIFIC, JAPAN, AUSTRALIA & INDIA

- China and the U.S.** are trading places in the economic growth race. U.S. GDP rose 12.2% in the 2ndQtr of this year from a year ago, outpacing China's 7.9% gain. The American edge should continue for at least the next few quarters, the first sustained period since at least 1990 in which the U.S. economy grew faster than China's. The reversal reflects the difference in the two nations' responses to the pandemic. Although the U.S. economy took longer to right itself than China's, the U.S. poured far more resources into a recovery. Vaccinations, massive fiscal stimulus and near-zero interest rates have pushed the U.S. ahead of China in GDP growth.



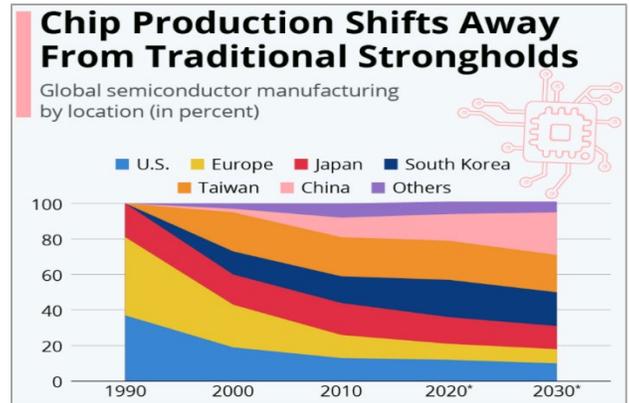
- Qantas** reported an annual loss of \$1.83 billion, due mainly to coronavirus-related restrictions on international travel. The Australian airline lost revenues worth \$16 billion due to the pandemic. Alan Joyce, Qantas CEO, said that "trading conditions have frankly been diabolical". Still, he expects a surge in demand by December when borders reopen and vaccination rates in Australia reach 80%.
- China's coal-powered steel mills expansion** accelerated sharply in the first half of this year, exposing government reluctance to sacrifice industry-fueled growth to hit climate goals. Analysis of Beijing approvals found 18 steelmaking blast furnaces and 43 coal-fired power plants were announced up to the end of June. As steel prices surged, 35mn tonnes of coal-dependent ironmaking capacity was announced in the first half of 2021, more than in all of 2020. If built, the combined coal and steel projects would emit about 150mn tonnes of carbon dioxide a year, equivalent to the total emissions of the Netherlands.

Key Update: A summer of widespread power rationing caused by surging demand has added to Beijing's hesitance to cut back on coal-fired generators.

- Taiwan Semiconductor Manufacturing Co.** plans to increase the prices of its most advanced chips by roughly 10%, while less advanced chips used by customers like auto makers will cost about 20% more. The company has said it plans to spend a total of \$100 billion over the next three years on new factories and equipment, as well as research and development. It is expanding its production capacity in Nanjing, China, and has started construction on a \$12 billion facility in Arizona.

- The global semiconductor shortage** has finally started to bite at Toyota, highlighting how a resurgence in COVID-19 infections from the Delta variant is now stifling chip manufacturing in SE Asia, worsening a parts crisis for car companies. Toyota is slashing global production in September by 40% to 540,000 vehicles, down from the 900,000 originally forecast. In North America, Toyota reduced factory output by 40% to 60% in August.

Key Update: Other global companies have also set back projections for a return to normalcy, with many now saying shortages of components could stretch into 2022.



- Backlogs at global shipping ports** and local lockdown measures in countries such as Vietnam, are forcing some firms to expedite shipments originally slated for ocean cargo. Airfreight accounts for less than 1% of global trade by weight but more than 30% by value. The global average rate for air cargo in August stood at \$3.39/kg, up 6% from January and 14% from a year earlier. Rates for shipping cargo from Southeast Asia to the U.S. have jumped 24% over the past year to \$7.66 per kilogram.
- Iron ore prices** have fallen roughly 40% since mid-July on concerns about demand from China. The benchmark price fell as low as \$130.20 a metric ton on 8/19, following a 15% single-day nosedive to its lowest value since November 2020. The commodity hit a record above \$233 a ton as recently as May. An expectation that China's steel output will shrink is fueling the fall. China, which until recently was churning out steel at record rates, wants to keep steel output at 2020 levels this year.
- Aluminum prices** are reaching 10-year highs, as buyers far from storage centers in Asia compete to line up shipments for use in beverage cans, airplanes and construction. LME aluminum forwards have climbed by a third this year to about \$2,650 a metric ton. Prices are around 80% higher than at their low point in May 2020, when the pandemic hammered sales to the aerospace and transportation industries. (See **Appendix:Commodities**, page 15)



ECONOMIC UPDATE: APPENDIX TO THE SEPTEMBER 2021 ISSUE

ENERGY: SOLAR ENERGY COST DECLINES CONTINUE TO SURPASS EXPECTATIONS

The Exponential View of Solar Energy: The human brain is terrible at comprehending exponential growth. Much like the power of compound interest is a magical force for investors, it is also possible for innovations and technological break-throughs to build off each other in the physical world, creating a similar compounding effect. The first chart looks at how solar technology has surpassed all expectations from an economics perspective, including those initially set by the International Energy Agency (IEA). The second chart displays a new set of predictions for solar energy economics over the next 30 years.

Solar Energy: The Tech Overachiever: Back in 2010, the cost of utility-scale solar power ranged between \$0.25-\$0.37 per kWh. This meant it was at least three times as expensive as fossil fuels, and solar was highly cost-inefficient at the time. Going forward, most organizations projected a linear path for whittling down the cost of solar. The IEA forecast that the global cost of solar would drop to roughly \$0.22/kWh by 2020. In reality, the price dropped to about one-fifth of that at \$0.04/kWh.

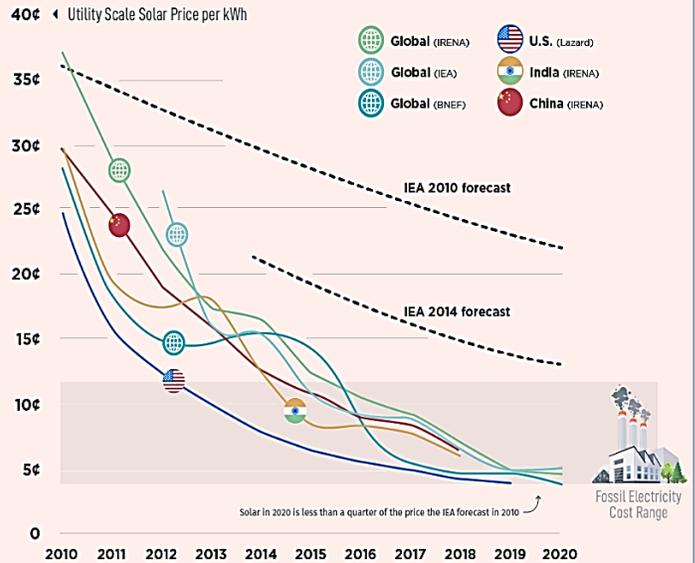
Wright's Law: Ramez Naam, the co-chair for energy and the environment at Singularity University, points out in his blog that the exponential decrease in solar costs stem from **Wright's Law: For most technologies, every doubling of cumulative scale of production will lead to a fixed percentage decline in cost of the technology.** Professor Naam says this occurs through "learning-by-doing", and more specifically: (1) Innovation that improves the technology itself; (2) Innovation that reduces the amount of labor, time, energy and materials needed to produce the tech. Put another way, the more solar panels we make and the more we install, the better we get at the whole process over time. Further, once we're making thousands or millions of panels, the costs come down exponentially, much like what happened with lithium-ion batteries.

The Future of Solar Costs: Over the years, Naam has taken his own stab at forecasting the cost of solar energy into the future, leveraging the idea of Wright's Law. The third chart is what he sees coming, based on using a 30% learning rate for solar. With solar energy costs plummeting to record lows and global installations continuing to ramp up, it's possible that solar forecasters may no longer forget about the exponential nature of solar production.

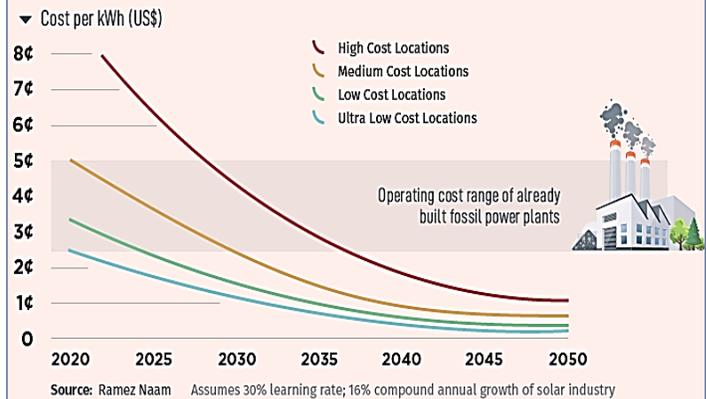


SOLAR ENERGY COSTS

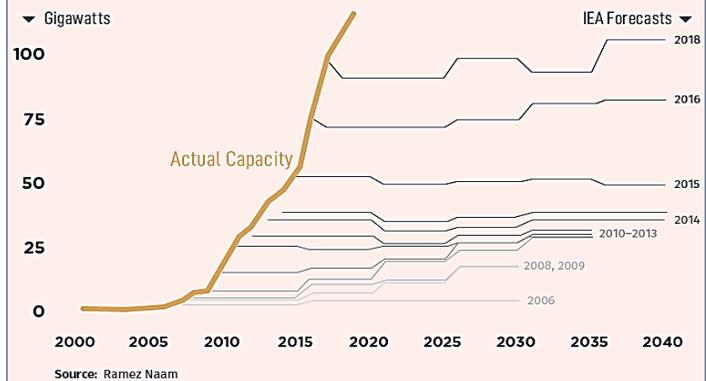
KEEP BLOWING AWAY OFFICIAL FORECASTS



FUTURE SOLAR COSTS BY YEAR

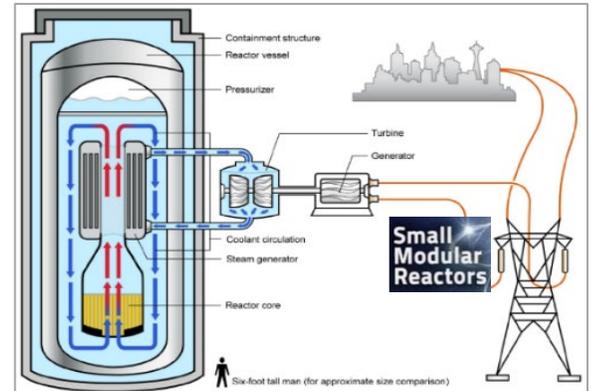


IEA'S SOLAR CAPACITY FORECASTS



ENERGY: UTILITIES EYE MINI NUCLEAR REACTORS AS CLIMATE CONCERNS GROW

U.S. utilities are looking to miniature nuclear reactors, as they seek a steady energy source that can help reduce the carbon emissions linked to climate change. **While power companies have stopped building big nuclear reactors because of cost overruns and construction delays, not all utilities are giving up on nuclear power. Several U.S. utilities and power consortia have entered into partnerships with manufacturers to build small modular reactors (SMRs) attracted to their potential to produce carbon-free, 24-hour-a-day power.** Dozens of SMR developers world-wide are testing designs for the reactors, which have less than a third of the generating capacity of traditional nukes and have components that can be mass-produced in factories. Their development is backed by the U.S. Energy Department, which said last fall that it would invest \$3.2 billion over seven years to support such projects to boost cleaner technologies and decarbonize the power sector. However, SMR makers are still years away from proving that the technology can live up to its promise. None of the designs being tested across the country have fully made it past the U.S. regulatory review process, and the first miniature reactors likely won't start delivering power to customers until the end of the decade, at the earliest. Opponents question whether the shrunk nuclear reactors can shed the problems that have plagued the now aging fleet of full-size plants, such as costly development times, nuclear waste management and safety concerns. Some power companies see promise in the technology but have stopped short of committing to any agreements until it is proven cost-effective. Many SMR makers are keeping the exact price tag on their projects confidential but analysts think costs could range from tens of millions for the smallest microreactors to low billions for larger projects. TerraPower's 345-megawatt Sodium reactor will cost about \$1 billion, with a levelized cost of electricity—or generation cost over the plant's lifetime—estimated in the \$50 to \$60 range per megawatt-hour. The same metric for a new combined-cycle natural-gas plant ranges from \$44 to \$73 per megawatt-hour. There is only one full-size nuclear plant under construction in the U.S.—Southern Co.'s expansion of its Vogtle facility in Georgia. The project is more than five years delayed and billions of dollars over its initial projected cost. Numerous plants around the country are in the process of being closed or decommissioned, as the industry faces political opposition to nuclear power and competition from low-cost natural-gas power plants and renewables such as wind and solar. Utilities that have bought into the SMR promise say that relying on renewables and storage technology alone isn't enough to reach goals to slash carbon emissions within the next couple of decades. SMRs have the ability to “load follow,” or ramp up and down quickly to match electricity demand throughout the day. This characteristic makes them a good partner for renewables, whose output is dependent on weather conditions and time of day.

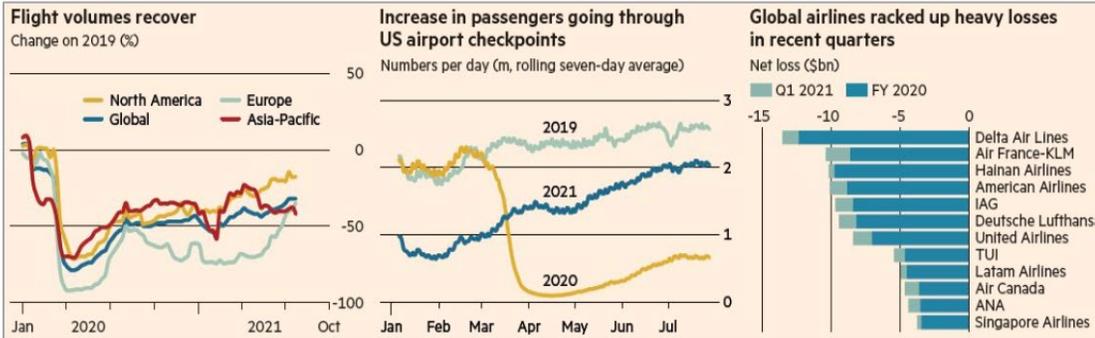
**AEROSPACE: STARTUP GETS \$60M FROM THE U.S. AIR FORCE TO BUILD A HYPERSONIC PASSENGER PLANE**

The U.S. Air Force and several venture capital firms are making a \$60 million investment in Hermeus Corporation, a Georgia-based startup that wants to develop the world's first reusable hypersonic aircraft. **The end goal is a passenger aircraft that can fly in excess of five times the speed of sound, capable of traveling from New York to Paris in 90 minutes instead of the seven hours it takes most commercial airliners today.** Although the Air Force's investment is small, it could give the service a window into the development of groundbreaking technology and help broaden its base of potential suppliers. “Ultimately we want to have options within the commercial aircraft marketplace for platforms that can be modified for enduring Air Force missions such as senior leader transport, as well as mobility, intelligence, surveillance and reconnaissance, and possibly other mission sets,” said Brig. Gen. Jason Lindsey, the service's program executive officer for presidential and executive airlift. The contract covers a period of three years and sets five objectives for Hermeus. For instance, the company is tasked with building three prototypes of its Quarterhorse aircraft, testing a full-scale reusable hypersonic propulsion system and providing data to the Air Force that it can use in future war-gaming efforts. The first Quarterhorse aircraft will be unmanned to eliminate the risk of having a human pilot fly an experimental aircraft and allow the company to move to flight testing earlier. The company has already built and tested a subscale hypersonic engine prototype and is working on a full-scale engine demonstrator. After the three year development effort, the Air Force will evaluate Hermeus' progress and determine next steps, the service said. “When it comes to technology, we often hear the term ‘game-changing,’” said the commander of the Air Force Research Laboratory. “However hypersonic aircraft and propulsion systems are truly game-changing and will revolutionize how we travel, just as automobiles did in the last century. We are excited to be part of this effort and to help propel this important technology.”



AEROSPACE: COMMERCIAL FLIGHT VOLUMES RECOVER AFTER HEAVY AIRLINE LOSSES

The black clouds hanging over aviation seem to be lifting to reveal at least some blue sky. Cautious optimism is slowly spreading across large parts of the ravaged airline industry, which has suffered its worst-ever crisis as one of the hardest-hit sectors in the pandemic, with executives betting vaccines and loosening travel restrictions have helped clear a path to recovery. **Confidence is growing fastest in the**

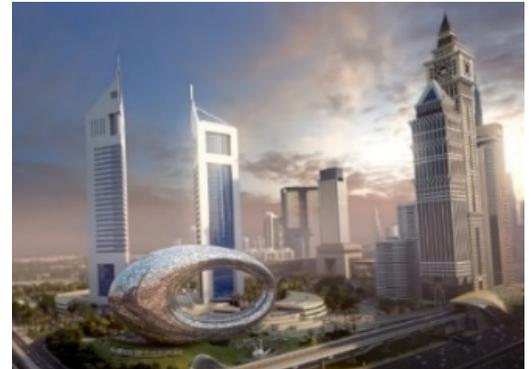


U.S. with carriers starting to report profits due to a buoyant domestic market, while in Europe the new upbeat mood has prompted the region's airlines, such as easyJet and Ryanair, to plan a ramp-up in their flying schedules during the late summer.

STAINLESS STEEL: MUSEUM OF THE FUTURE FEATURES AN EXTRAORDINARY STEEL SUPERSTRUCTURE

Dubai's Museum of the Future, a true architectural experiment: The uniqueness of Dubai's new Museum of the Future is its extraordinary form, made possible by its steel superstructure and façade. The elliptical 'torus' design covered in Arabic calligraphy

was conceived by architect Shaun Killa of Killa Design. When it is completed this year, the 78 meter-tall Museum of the Future will be a showcase for innovation and technology, so its futuristic shape is fitting. The initial inspiration for the building was to create a form that represents the client's vision of the future. Killa said, "The physical building with its exhibition floors represents our understanding of the 'future' as we know it today and for the next five to 10 years." The void at the building's center represents everything that is as yet unknown, the future. The architects designed the museum in three main parts: the green mound (which doubles as a landscaped three-storey podium), the building on top and the void within. Inside, it will house six column-free exhibition floors and one floor of administration offices above the podium, a food and beverage deck, along with an auditorium, retail shops, parking and services. UK firm BuroHappold Engineering was brought in to execute Killa's ambitious vision. "Translating the design's artistic and metaphorical concepts into a 30,000/m² building clad in stainless steel was always going to be a challenge," the engineers said.



Ahead of the curve: BuroHappold started by fine-tuning the theoretical shape of the building to remove as many of its complicated curves as possible. Then the steel framework and the lightweight façade were designed. The framework is a diagrid made up of 2,400 diagonally intersecting steel beams. Keeping the structure lightweight was vital, so the 11,000/m² of flooring deployed in the museum was constructed from composite floor deck. Using modular steel-built flooring allowed for speedy installation, while lowering the impact on the building's foundations. Exacting computer modelling insured all the internal steel tubes were designed at exactly the same diameter, making construction significantly faster and simpler. Once the reinforced concrete ring beam and tower which support the diagrid were built, the steel work was completed in a mere 14 months.

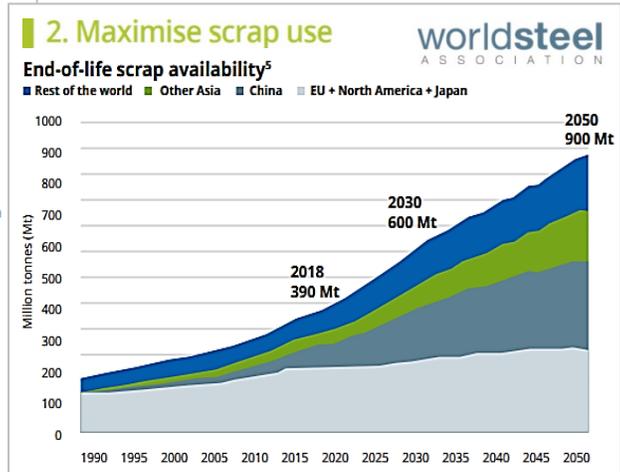
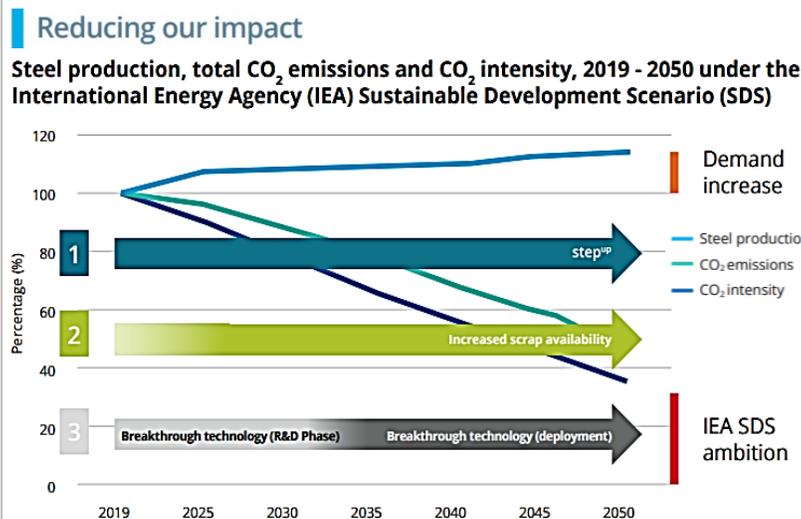
Poetry in steel: The framework maps the torus shape and supports the 890 stainless-steel-clad glass fibre reinforced plastic panels that form the seamless silvery façade. The thousands of interlocking steel triangles were produced by 3D printers. Cut out of these panels are phrases of poetry written by Dubai's ruler. The cursive scripts also act as the museum's windows, which will be lit up by 14km of LED lighting. Now in its final phases, the \$136 million MOTF is positioned above the city's elevated, driverless metro system on the edge of the financial district. Its opening is due to coincide with Dubai's hosting of the World Expo in October 2021, and the museum's founders hope to attract more than 1 million visitors a year.



The Museum of the Future represents a radical alternative to the traditional skyscraper form and because of its complexity and unusual shape, the steel framework – rather than a concrete or steel shell – was seen as the best solution.

STEEL/ENVIRONMENT: CLIMATE CHANGE AND TRANSFORMING STEEL PRODUCTION

The World Steel Association recently released a public policy paper, *Climate Change and the Production of Iron and Steel*. The paper outlines the steel industry's challenges and opportunities with respect to reducing CO₂ emissions in line with the aims of the Paris Agreement. The paper stated, "Steel production remains a CO₂ and energy-intensive activity. However, the steel industry is committed to continuing to reduce the footprint from its operations and the use of its products. There is no single solution to drastically reducing CO₂ emissions from our industry, and we believe that individual countries are best placed to assess and implement policy and technical strategies to suit their particular circumstances. **However, the main elements of the industry's response, applicable to steel producers everywhere, are: (1) Reducing our own impact; (2) Efficiency and the circular economy; and (3) Developing advanced steel products to enable societal transformations.**"



Cost implications

Each company's choice of which breakthrough technology to invest in will to a large degree depend on the resources available and the policies in place. However, even if the conditions are good, it is clear that the production of low-carbon steel is going to be more expensive than steel production today. **The IEA estimates the additional production cost to be between 10% and 50% compared to today, a cost increase significantly exceeding production margins.** However, the steel industry will continue to reduce costs by improving its operational efficiency and deploying intelligent manufacturing technologies, partly offsetting the additional cost. Since the transformation of the industry will be gradual, with some companies/countries/regions moving faster than others, steel produced using low-carbon technologies will be competing with conventionally produced steel (and other conventionally produced materials) in the same market for some time. This will create a first mover disadvantage and policy support will therefore be needed.

3. Breakthrough technology

Currently, the only technically and commercially feasible way to produce steel from iron ore⁸ is through the use of fossil fuels as reducing agents. The blast furnace is the dominant technology used to reduce iron ore today. The modern blast furnace is continually being developed and refined and currently operates close to the efficiency limit of the reduction process. Therefore, to achieve the drastic reductions needed, an entirely new, transformative approach to ironmaking is required and there are several promising initiatives under development. These fall into three broad categories:

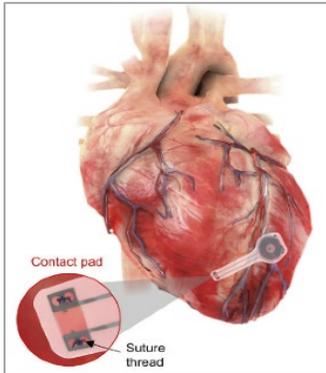
1. Using carbon as a reductant while preventing the emission of fossil CO₂, for example using carbon capture, utilisation and storage (CCUS) and/or sustainable biomass.
2. Substituting hydrogen⁹ for carbon as a reductant, generating H₂O (water) rather than CO₂.
3. Using electrical energy through an electrolysis-based process.

This reliance on fossil fuels defines the steel industry's past as a major emitter of greenhouse gases, but we are committed to a low-carbon future.

Partnerships between governments and the steel industry are fundamental to a sustainable future

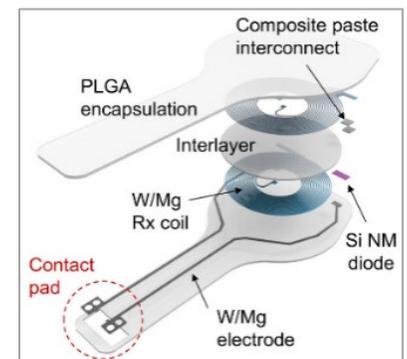
MEDICAL: A PACEMAKER THAT DOES ITS JOB, THEN PULLS A HOUDINI

Researchers at Northwestern and George Washington Universities have taken bioresorbable medical devices to a new level with the development of a transient pacemaker that disappears after it is no longer needed. The thin, flexible, lightweight device could be used in



patients who need temporary pacing after cardiac surgery or while waiting for a permanent pacemaker. **All components of the pacemaker are biocompatible and naturally absorb into the body's biofluids over the course of five to seven weeks, disappearing without needing surgical extraction.** The device wirelessly harvests energy from an external, remote antenna using near-field communication protocols — the same technology used in smartphones for electronic payments. This eliminates the need for bulky batteries and rigid hardware, including leads, which may introduce infections or become enveloped in scar tissue, causing further damage when removed. “Hardware placed in or near the heart creates risks for infection and other complications,” said NU’s John A. Rogers, who led the device’s development. “Our wireless, transient pacemakers overcome key disadvantages of traditional temporary devices by eliminating the need for percutaneous leads for surgical extraction procedures, offering the potential for reduced costs and improved outcomes in patient care. This unusual type of

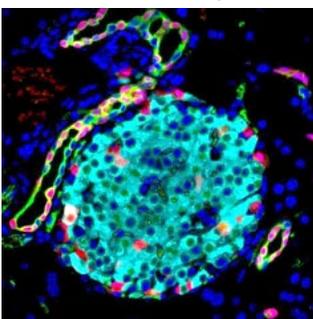
device could represent the future of temporary pacing technology.” Rishi Arora, MD, a cardiologist at NU Medicine, explained that sometimes patients only need pacemakers temporarily, and after the heart is stabilized, the device is removed. “The current standard of care involves inserting a wire, which stays in place for 3 to 7 days which has potential to become infected or dislodged,” said Arora. GW’s Igor Efimov, who co-led the study, said the technology opens an entirely new chapter in biomedical research. “The bioresorbable materials at the foundation of this technology make it possible to create a whole host of diagnostic and therapeutic transient devices for monitoring progression of diseases and therapies, delivering electrical, pharmacological, cell therapies, gene reprogramming and more,” said Efimov. With this leadless biocompatible pacemaker, the circuitry is implanted directly on the surface of the heart, and can be activated remotely. The device then dissolves on its own, avoiding the need to surgically remove the pacemaker electrodes. With further modifications, it eventually may be possible to implant such bioresorbable pacemakers through a vein in the leg or arm.



MEDICAL: PANCREATIC BETA-CELL BOOST IN MICE PAVES WAY FOR FUTURE DIABETES TREATMENTS

A research team has uncovered the role of a gene that is critical to boosting the number of insulin-producing cells during the early development of the pancreas. **The findings could bolster diabetes research efforts and eventually lead to new replacement therapies for the disease.**

Researchers studied the RE1 Silencing Transcription Factor gene, also known as REST, in mouse and zebrafish models, as well as in human pancreatic organoids. Researchers have previously suspected a role for this gene in pancreas development, though studies so far have been inconclusive. They found that REST is expressed in embryonic pancreatic cells which are yet to differentiate, as well as in adult cells which form the pancreatic duct. The researchers did not detect REST activity in adult beta-cells that produce insulin. Experiments with mouse models revealed that knocking the REST gene out at the early embryonic stage, before the pancreas is formed, resulted in doubling the number of insulin-producing cells. The cells were maintained into adulthood, with all mice showing normal weight. Further experiments using zebrafish models found similar boosts to beta-cell formation. (Pictured: A cross-section of islets of Langerhans, a cluster of cells within the pancreas that are responsible for the production and release of hormones that regulate glucose levels. Insulin in beta cells is stained in cyan, cytokeratin 19 in ductal cells in green, red fluorescent protein in ductal cells in red and cell nuclei are blue.) Inactivating REST was not able to boost beta cell formation after the pancreas has already formed. “Though important for the development of the pancreas, we have shown that REST is not the sole guardian of endocrine differentiation. However, if one day we come up with a future cocktail of drugs to boost insulin-producing cells in the pancreas, I suspect that REST inhibitors would be part of the recipe,” said Jorge Ferrer, senior author of the study. New therapies and treatments that can boost or replace the number of insulin-producing beta cells in the pancreas would transform the treatment of diabetes, which affects over 400 million people worldwide. For people with type 1 diabetes, the only alternative treatment to daily insulin shots are transplantations, requiring potential side effects through taking immunosuppressant medication and hampered by a shortage of organ donors.



AUTOMOTIVE/AI: YOUR NEXT CAR MAY ANTICIPATE YOUR NEEDS, LET YOU ADD FEATURES

The next time you buy a car and fret about whether or not to splurge on that snazzy new feature, fear not: Chances are you'll be able to download it later. In the past, the ordeal of deciding which features you could afford and which you could live without may have been painful and time-consuming, mainly because you were stuck with whatever suite of options you chose until the time came to buy another car. Those days are quickly fading as cars morph from vehicles to get around town to artificial intelligence-enabled, smartphone-like connected devices packed with software for work and play. In the near future, cars will be able to constantly update and adapt to situations months and years after the time of purchase. They will also be able to use AI to anticipate the needs of drivers and passengers to tailor their offerings accordingly. **This AI system also has the potential to create a new business model for auto makers, with car owners paying on-demand fees or monthly subscriptions to get access to new features.** These could include additional horsepower from the electric motor that you might only need on a road trip through mountainous terrain. Or a subscription for heating the steering wheel and seats during the winter. Auto makers like GM, Ford, VW, BMW and Mercedes-Benz are shifting from banging metal to software-centered design with which they hope to make money even after they have sold you the car. Tesla has been doing this for years. Early on, it took control of the software development process, from chip design to AI systems. The company is already collecting huge amounts of data from customer vehicles that it uses to improve the car's systems through over-the-air updates, which automatically and remotely update the car's software, just like with a smartphone. Tesla offers subscriptions for what it calls "Premium Connectivity," which covers things like video streaming and live traffic visualization. Elon Musk has raised the possibility that Tesla could offer its advanced driver-assistance package as a subscription but has not launched that yet. Older auto makers are following Tesla's lead. Many have created in-house software operations to catch up. A VW division is developing core software for the company's vehicles and aims to have a system in place with advanced autonomous functionality by 2025. AI promises to become more deeply embedded in the car to adapt the experience to individual users. As the car collects data from a person's daily routines, it learns how that person drives, who usually sits in the car, where they often go. With access to a person's digital calendar, the car's AI assistant could begin to anticipate routines—even deciding on its own to wake you early enough to avoid heavy traffic. Even as the technology is developed, it is not certain that consumers will subscribe to features, such as seat heating, that now come standard. The auto industry is trying to replicate a move the software industry made from selling software licenses for one-time fees to creating recurring revenue by making customers subscribe.

**AUTOMOTIVE: LME LAUNCHES LITHIUM FUTURES CONTRACT TO CAPITALIZE ON DEMAND FOR EVS**

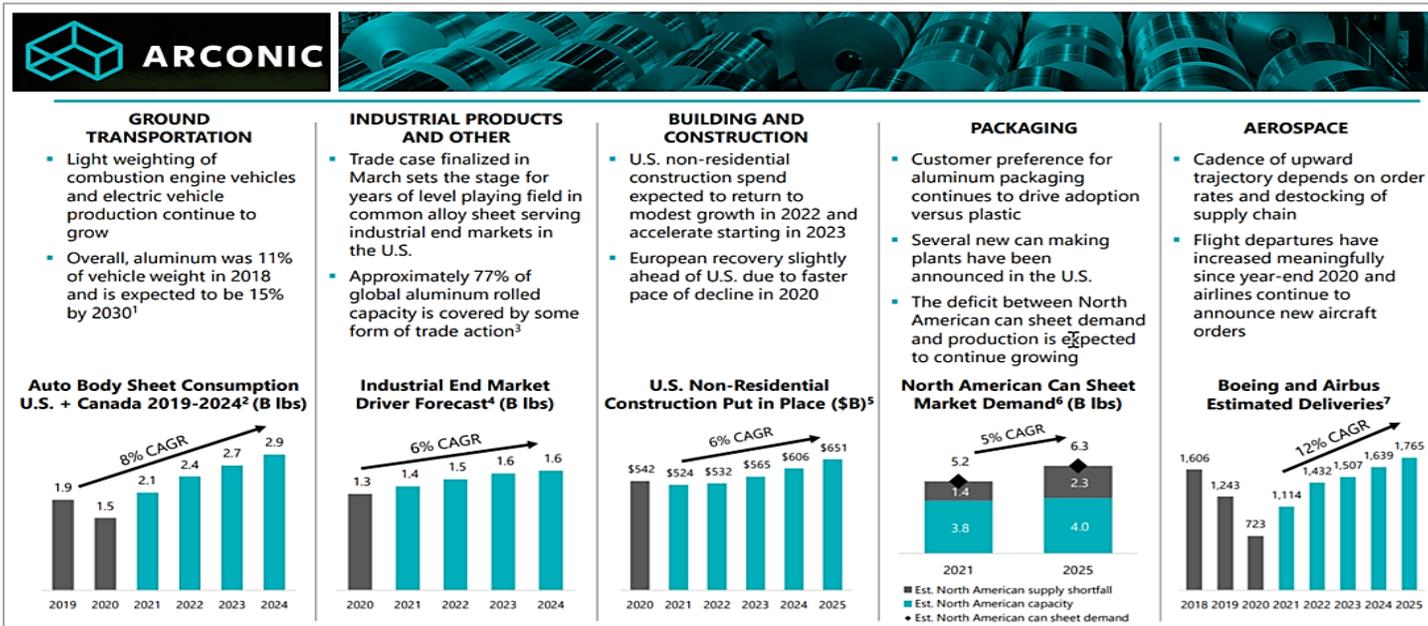
The London Metal Exchange launched a new contract for battery metal lithium, setting up a transatlantic battle with U.S. rival CME Group, as exchanges look to capture rapid growth in demand for commodities tied to the electric car industry. **The LME said the lithium contract**



was "designed to bridge" the need for battery and car manufacturers to hedge their exposure to volatile lithium prices. The move comes after the CME launched a similar contract in May. The two exchanges also compete in cobalt, another key battery metal. Demand for lithium is set to grow sevenfold by 2030 as sales of electric vehicles increase, according to consultancy Benchmark Mineral Intelligence. Prices for lithium hydroxide in China, the largest electric car market, have surged 86% this year. All electric cars use lithium-ion batteries, which rely on the metal to store energy. Lithium hydroxide is the compound favored by many battery producers and carmakers such as Tesla because it allows the use of more powerful nickel-based batteries. Many lithium miners were initially hostile to the LME's plan, since a futures contract would standardize a product that is produced to different qualities and grades, but the LME said it had spent three years working with the industry on the cash-settled futures contract. The exchange's lithium committee includes members from Albemarle, the world's largest lithium producer, and carmakers including Tesla. "The launch of the lithium hydroxide cash-settled futures contract represents a significant milestone not only for the LME but also for the global lithium industry," said Ron Mitchell, sales director at Tianqi Lithium, a Chinese lithium producer. "The contract offers the industry an important price risk management tool and comes at a critical time to support the future electrification goals of many nations." Most lithium supply deals between carmakers and miners are long-term deals based on assessments by pricing agencies. For car companies, a futures contract will provide greater visibility on prices into the future, enabling them to hedge their exposure. "One of the most commonly asked questions in lithium is where the prices will go tomorrow," Martim Facada, a broker at SCB Group, said. "Having a forward curve helps to solve that issue and enables you to better predict, better control costs and better hedge." The lithium launch is part of a broader sustainability drive. The LME also said it had launched a scrap aluminum contract focused on the U.S. used beverage can market.

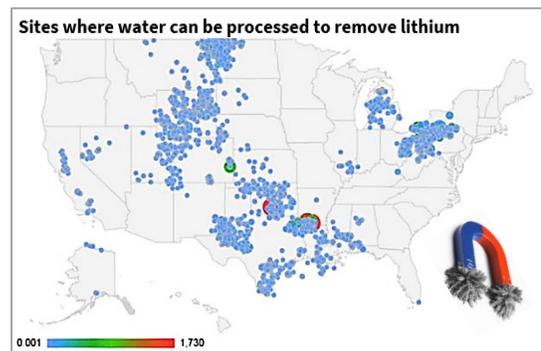


ALUMINUM: ARCONIC'S FORECAST OF ALUMINUM ROLLED PRODUCTS MARKET DEMAND BY SECTOR



INNOVATION: MAGNETS EXTRACT VALUABLE RESOURCES AND RARE EARTH ELEMENTS FROM BRINE

Oil and gas extraction companies in the U.S. and Canada pump subsurface water (brine) containing significant amounts of lithium to the surface. Just a quarter of the lithium in that water would equal the current annual worldwide production, according to scientists at the Pacific Northwest National Laboratory (PNNL). **Current approaches for extracting lithium require pumping large volumes of water (thousands of gallons a minute) through an ion exchange filter, making them energy intensive and expensive.** A team of PNNL



researchers tackling the problem of finding an economic way to get valuable rare earth elements out of brine water from mining/drilling fluids, geothermal plants and seawater looked at the problem on the nanoscale. They developed a nanotech process that miniaturizes most of the extraction and eliminates the need for ion exchange separators. Iron-oxide nanoparticles coated with engineered coatings can be easily collected by their attraction to a magnet, just as iron filings are attracted to a simple magnet. The process starts with nanoparticles of iron oxide (magnetite). An absorbent shell that selectively binds to the compound being extracted is attached to each nanoparticle. Coated nanoparticles are put in containers with the brine and mixed. As they float around in the brine, particles of the targeted compound come into contact with them and attach themselves. A magnet is then used to reel in the magnetite-rich nanoparticles along with the critical material, which is filtered and recovered. PNNL has several pilot projects lined up to test and refine the technology. In one, they are working with DOE's Office of Fossil Energy, as well as the oil and gas industries, to harvest lithium from water generated by mineral extraction. "By using the magnetic nanoparticles to attach to the lithium particles in solution, we expect the resulting lithium to be purer, reducing the cost of further processing," said Jerry Mills, CEO of Moselle Technologies, a start-up business that is piloting the technology in several global locations and has exclusive licensing on it. He added that this will take out more than half the cost of lithium. **The map above shows sites where water used in mining and petroleum operations can be processed to remove lithium. The concentrations of lithium (expressed as parts per million) in the water at the sites are indicated by their colors.** Another project will investigate using the non-polluting technology to recover other critical materials and a third cooperative research project will explore that possibility. It will be carried out in New Zealand, where geologists have found cesium in its brines. **If these programs are successful, it could help the U.S. become a source of the critical minerals needed in electronics and energy production.** Today, most of these minerals come from international sources and high-conflict regions. Of the 35 materials deemed critical by the DOE, the U.S imports 100% of its need for 14 of them and more than 50% of 17 of them from high-conflict regions.



COMMODITIES/METALS: VISUALIZING THE CRITICAL METALS IN A SMARTPHONE

In an increasingly connected world, smartphones have become an inseparable part of life. Over 60% of the world’s population owns a mobile phone and smartphone adoption continues to rise in developing countries around the world. **Most smartphones carry roughly 80% of the stable elements on the periodic table.** Some of the vital metals to build these devices are considered at risk due to scarcity and geopolitical issues. **What’s in Your Pocket?—Touch Screen:** Screens are made up of multiple layers of glass and plastic, coated with a conductor material called indium which is highly conductive and transparent. Indium responds when contacted by another electrical conductor, like our fingers. When we touch the screen, an electric circuit is completed where the finger makes contact with the screen, changing the electrical charge at this location. The device registers this electrical charge as a “touch event”, then prompting a response. **Display:** Smartphones screens display images on a liquid crystal display (LCD). Just as in most TVs and computer monitors, a phone LCD uses an electrical current to adjust the color of each pixel. Several rare earth elements are used to produce the colors on screen. **Electronics:** Smartphones employ multiple antenna systems, such as Bluetooth, GPS and WiFi. The distance between these antenna systems is usually small making it extremely difficult to achieve flawless performance. Capacitors made of the rare, hard, blue-gray metal tantalum are used for filtering and frequency tuning. Nickel is also used in capacitors and in mobile phone electrical connections. Another silvery metal, gallium, is used in semiconductors. **Microphone, Speakers, Vibration Unit:** Nickel is used in the microphone diaphragm (that vibrates in response to sound waves). Alloys containing rare earths neodymium, praseodymium and gadolinium are used in the magnets contained in the speaker and microphone. Neodymium, terbium and dysprosium are also used in the vibration unit. **Casing:** There are many materials used to make phone cases, such as plastic, aluminum, carbon fiber and even gold. Usually, the cases have nickel to reduce electromagnetic interference (EMI) and magnesium alloys for EMI shielding. **Battery:** Most devices have a lithium-ion battery, which is charged and discharged by lithium ions moving between the negative (anode) and positive (cathode) electrodes.

A BREAKDOWN OF THE CRITICAL METALS IN A SMARTPHONE

Some vital metals used to build these devices are considered at risk due to geological scarcity, geopolitical issues or trade policy. This infographic details the critical metals that you carry in your pocket.

TOUCH SCREEN
It contains a thin layer of **indium** tin oxide, highly conductive and transparent, allowing the screen to function as a touch screen.

DISPLAY
The display contains several **rare earth elements**. Small quantities are used to produce the colors on the liquid crystal display. Some give the screen its glow.

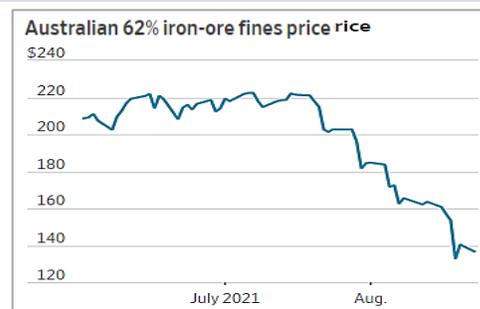
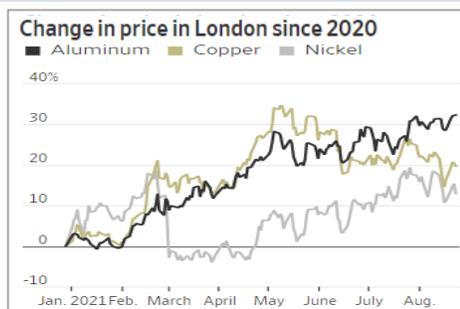
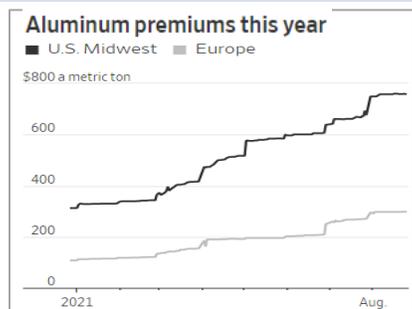
MICROPHONE, SPEAKERS, VIBRATION UNIT
Nickel is used in the microphone diaphragm (that vibrates in response to sound waves). Alloys containing **neodymium, praseodymium and gadolinium** are used in the magnets contained in the speaker and microphone. **Neodymium, terbium and dysprosium** are used in the vibration unit.

ELECTRONICS
Nickel is used in electrical connections. **Gallium** is used in semiconductors. **Tantalum** is the major component of micro capacitors, used for filtering and frequency tuning.

CASING
Nickel reduces electromagnetic interference. **Magnesium** alloys are superior at electromagnetic interference (EMI) shielding.

BATTERY
The majority of smartphones use **lithium-ion** batteries.

COMMODITIES: IRON-ORE PRICES CONTINUE TO FADE; ALUMINUM FUTURES AND PREMIUMS SOAR



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