EXECUTIVE SUMMARY

AMERICAS: U.S. BUSINESS ACTIVITY EXPANDED AT ITS SLOWEST PACE IN A YEAR IN SEPTEMBER amid relentless supply constraints and peaking demand. **Consumer confidence** fell to a seven-month low last month as the rise in COVID cases deepened concerns about the economy's near-term prospects. **American consumer spending** rebounded in August, boosted by increases for food and household supplies, offsetting a drop in auto outlays. **Factory activity** gained strength in September, but manufactures had longer delays getting raw materials and paid higher prices. **Durable goods orders** increased 1.8% in August, boosted by a 5.5% rebound in transportation equipment orders, but motor vehicles and parts orders fell 3.1%. **August producer prices** accelerated their upward trajectory, leading to the biggest annual gain in nearly 11 years, but there are signs that inflation could be nearing its peak. **The federal budget deficit** for August was 15% lower vs. a year ago; recovery-driven tax receipts grew faster than outlays for pandemic relief.

OVERSEAS: THE EURO ZONE RECORDED SHARPLY SLOWER GROWTH IN SEPTEMBER in both manufacturing and services, extending a slowdown that began in August after business activity in July hit a 21-year high. **A carbon dioxide shortage in the UK** that is threatening industries from steel to food and beverages is spilling over to Continental Europe. **China's manufacturing activity** dipped into negative territory in September, the first time since the pandemic began. Power outages have swept across many Chinese provinces, as the government ramps up efforts to curb energy consumption and reduce carbon emissions.

STEEL: STAINLESS DEMAND REMAINS STRONG ALTHOUGH AUTOMOTIVE AND APPLIANCES ARE IN SLOWDOWNS resulting from the microchip shortage. Supply remains tight with only three domestic mills making commodity grade flat-rolled. **Nucor** is looking for a location to build a $2.7 billion sheet mill with a 3 million ton annual capacity. **U.S. Steel** is also looking for a site to construct a mini mill for an estimated cost of $3 billion. The planned USS mini mill will combine two electric arc furnaces with steelmaking and finishing technology. **Steel service center inventories** recovered slightly in the 3rdQtr but remain well below adequate historical levels.

AUTOMOTIVE: FORD AND GENERAL MOTORS ARE FIGHTING IT OUT TO ELECTRIFY THEIR FLEETS, especially pickups, the biggest source of profits for both companies. As part of this campaign, GM will build four battery factories by 2025 with its partner, LG Chem, a South Korean battery-maker. Ford and its South Korean battery partner, SK Innovation, announced an investment of $11 billion for three battery factories and an assembly plant for electric F-Series pickups. **General Motors** said the semiconductor chip shortage that has hit production at automakers worldwide was lessening, while reporting its first quarterly sales drop in a year.

ENERGY: GAZPROM HAS LIMITED NATURAL GAS SALES IN THE EUROPEAN SPOT MARKET, fueling a surge in prices that is threatening industries across the Continent. **Royal Dutch Shell and Scottish Power** submitted proposals to UK authorities to build the first large-scale set of floating wind farms in the world off Scotland's coast. **Siemens Gamesa** has developed the first offshore wind turbine blades that can be fully recycled, potentially saving hundreds of thousands from landfill and resolving an issue highlighted by critics.

MEDICAL: DEVICES MADE OF BIOACTIVE GLASS AND METALS THAT DISSOLVE at the end of their operational lifespan could replace other types of implants and eliminate the need for invasive removal once they have served their purpose. **America's COVID-testing infrastructure** is bracing for a surge in demand as most large U.S. companies mandate their workers get vaccinated or be screened weekly. **Medical device makers** seek priority amid the chip shortage by highlighting their life-saving products to secure supply.

INNOVATION: A LONGER-LASTING, LIGHTER AND MORE SUSTAINABLE RIVAL TO THE LITHIUM-ION BATTERIES has been created by researchers. A glucose-based additive applied to the positive electrode stabilizes lithium-sulfur battery technology, long touted as the basis for the next generation of batteries**.** In less than a decade, this technology could lead to vehicles that can travel more than 500 miles without recharging. It could also enable innovation in delivery and agricultural drones where lightweight is paramount.

AEROSPACE: HYDROGEN'S MOMENT IS FAST APPROACHING, according to Airbus' CEO, who said Airbus is ready to start building a hydrogen-powered commercial airliner before the end of this decade. **Lockheed Martin Aeronautics** was awarded a $2 billion contract to provide logistics support for delivered F-35 Lightning II Joint Strike Fighter air systems. **NASA's Perseverance Mars rover** collected two rock samples, showing signs they were in contact with water for a long time, boosting the case for ancient life on Mars.

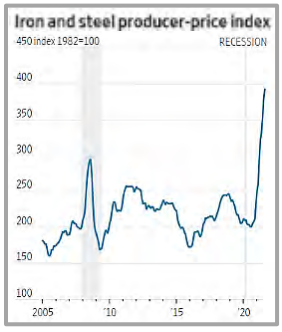
COMMODITIES: IRON ORE PRICES EXTENDED THEIR SLUMP BELOW $100 A TON as China stepped up restrictions on steel production. Prices have collapsed about 60% since a record high in May, as Chinese demand for iron ore wanes. China is intensifying steel production curbs to meet a target for lower volumes this year, as it works toward carbon neutrality by 2060. More recently, restrictions have focused on improving air quality for the Winter Olympics next year. **Aluminum prices** continued to rally in September, with the spot price on the London Metal Exchange hitting $3,000 per metric ton for the first time in more than a decade on supply conern issues.

THE AMERICAS

- **U.S. business activity** expanded at its slowest pace in a year in September amid relentless supply constraints and peaking demand, according to ISM's flash Composite PMI Output Index and in line with expectations for a sharp slowdown in economic growth in the third quarter.
  Key Update: *The Delta variant has worsened the scarcity of some raw materials, produced primarily in Southeast Asia. Congestion at ports in China and the U.S. is also contributing to keeping the supply chains tight.*
- **August durable goods orders** increased 1.8% to a record $263.5 billion, boosted by a 5.5% rebound in orders for transportation equipment. Orders for motor vehicles and parts fell 3.1%. GM and Ford announced further production cuts as they adjust their schedules to manage their chip supply. Orders for civilian aircraft soared 77.9%. Boeing received 53 aircraft orders in August compared to 31 in July. Depleted business and retail inventories have translated into increased demand for manufacturers.
- **The U.S. government** posted a $171 billion budget deficit for August, 15% lower than the gap a year ago, as recovery-driven tax receipts grew faster than outlays for COVID-19 pandemic relief programs. For the first 11 months of the 2021 fiscal year, the deficit totaled $2.711 trillion, down 10% vs. a year ago, as tax revenues have improved.
- **The Index of Leading Economic Indicators** climbed 0.9% to 117.1 in August. The Conference Board said that while the Delta variant and rising inflation fears could create headwinds for labor markets and the consumer spending outlook in the near term, the trend in the LEI is consistent with robust economic growth in the reminder of the year.
- **U.S. import prices** dropped 0.3% in August. This first decrease since October 2020 lowered the YOY increase to 9.0% from 10.3% in July. Imported fuel prices tumbled 2.3%. Oil prices dropped 2.4%; the cost of imported food rose 0.6%. Excluding fuel and food, import prices fell 0.2%. There were small gains in the prices of imported capital goods and consumer goods, excluding automobiles.
- **The U.S. trade deficit** surged 4.2% to $73.3 billion in August, the highest since the government started tracking the series. Imports of motor vehicles, parts and engines decreased $1.5 billion. Goods exports rose 0.7% to a record $149.7 billion; services exports fell $1 million.
- **The U.S. economy** added 194,000 jobs in September, the smallest gain since December 2020. The jobless rate fell to 4.8% from 5.2% a month earlier. The rate fell largely because many workers exited the labor force.
- **Inflation** cooled slightly in August but remained strong, as a surge in COVID infections slowed economic growth and pandemic-related shortages of labor and supplies continued to drive up prices. August's CPI rose 0.3%. Prices eased for autos, with used vehicle prices dropping sharply. Airline fare prices declined 9.1%, while rental cars and trucks dropped 8.5%. The CPI excluding the food and energy components edged up 0.1 percent.

- **Consumer confidence** fell to a 7-month low in September as the rise in COVID-19 cases deepened concerns about the economy's near-term prospects, fitting in with expectations for a slowdown in growth in the 3rdQtr. The Conference Board survey showed consumers are less interested in buying a home and big-ticket items such as motor vehicles and major household appliances over the next six months.
  Key Update: *Economic activity has cooled in recent months as the boost from pandemic relief money faded and infections flared up, driven by the Delta variant. Labor and raw material shortages have also chipped away at growth.*
- **U.S. retail sales** unexpectedly increased 0.7% in August, boosted by back-to-school shopping and child tax credit payments, which could temper expectations for a sharp slowdown in economic growth in the 3rdQtr. Sales at auto dealerships tumbled 3.6% after declining 4.6% in July. An ongoing global shortage of microchips is forcing automakers to cut production. Sales increased 15.1% from a year ago and are 17.7% above their pre-pandemic level.
- **Production at U.S. factories** slowed in August amid disruptions from Hurricane Ida and shortages of raw materials and labor as the pandemic drags on. Manufacturing output increased 0.2% in August and is now is 1.0% above its pre-pandemic level. Output at auto plants edged up 0.1%. August's gain in manufacturing output and a 3.3% rebound in utilities raised industrial output by 0.4%. Mining production fell 0.6%, reflecting hurricane-induced disruptions to oil and gas extraction in the Gulf of Mexico.
- **The ISM index of factory activity** gained strength in September, but factories experienced longer delays getting raw materials delivered and paid higher prices for inputs. Some of the improvement was due to a lengthening in supplier delivery times, normally associated with a strong economy and increased demand, which would be a positive, but in this case slower supplier deliveries indicate persistent supply shortages related to the pandemic.

- **U.S. factory orders** rose 1.2% in August, led by computers and electronic products, fabricated metal products, transportation equipment as well as electrical equipment, appliances and components. However, there were decreases in machinery and primary metals orders.
- **U.S. services industry activity** nudged up in September, but growth is being restrained. The services sector is grappling with shortages of raw materials and labor, with few signs that these headwinds will recede anytime soon.
- **U.S. producer prices** increased solidly in August, leading to the biggest annual gain in nearly 11 years, but there are signs that inflation could be nearing its peak as underlying producer prices rose at their slowest pace in nine months. The August PPI for final demand rose 0.7% after two straight monthly increases of 1.0%. The gain was led by a 0.7% advance in services following a 1.1% jump in July.
- **U.S. consumer spending** rebounded 0.8% in August. Consumption was boosted by a 1.2% rise in purchases of goods, reflecting increases in spending on food and household supplies, which offset a drop in motor vehicle outlays. Spending on services rose 0.6%. Personal income gained 0.1%. Wages continued to rise as companies compete for scarce workers, increasing 0.5% in August.
- **U.S. construction spending** was flat in August as an increase in public sector projects was offset by weakness in the private sector. Single-family homebuilding spending fell 0.7%. Homebuilding is being hampered by expensive building materials as well as land and labor shortages.
- **The rising cost of steel, aluminum and other metals** presents challenges for the $5.9 trillion U.S. manufacturing sector. Manufacturers and trade groups that represent them say steel prices are rising because of high demand for manufactured goods and tariffs on imported steel. U.S. Steel and Cleveland-Cliffs have taken seven million tons of steel production capacity out of service since the pandemic started, about 12% of domestic steel consumption, further pressuring prices.



Key Update: *The U.S. made an initial offer to the EU to resolve a 3-year dispute over steel (but not aluminum) imported from the bloc, paving the way for a solution by the year-end deadline. The proposal involves a tariff-rate-quota system, allowing EU countries to export specified quantities of a steel product at lower duty rates, but subjects shipments above a pre-determined threshold to a higher duty.*

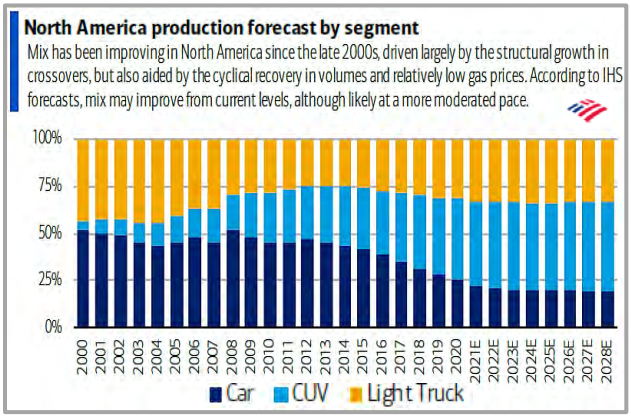
- **Existing home sales** dropped 2.0% to an annual rate of 5.88 million units in August. Supply remained tight, but there are signs the surge in house prices and pandemic-fueled demand have run their course. New home sales rose 1.5% for a second-straight month. Housing starts advanced 3.9%. Homebuilding permits rose 6.0%. Confidence among single-family homebuilders edged up, reversing a three-month decline, as elevated costs eased for some building materials including softwood lumber.
- **Steel service center inventories** recovered slightly in the 3rdQtr but remain well below adequate historical levels.

- **Steel mills** in the U.S. shipped 8.278 million tons of steel in July, a 3.1% improvement from the prior month and up 37.2% from July 2020. Shipments YTD through July were 54.248 million tons, a 14.8% increase vs. the same seven month period in 2020. (See **Appendix: Steel**, page 11)

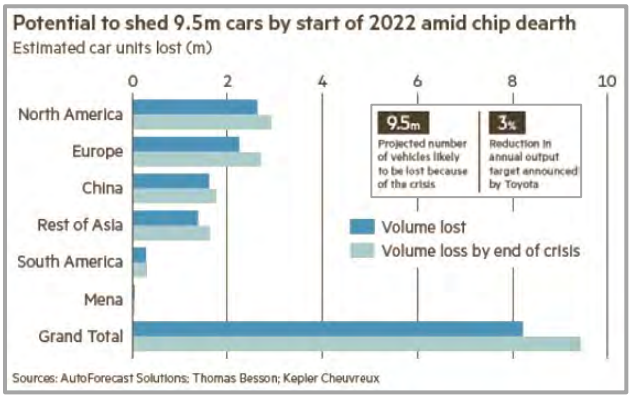
  Key Update: *Mills still control the market overall with extended lead times and a broad slate of seasonal maintenance outages that will reduce output. The mills appear to feel little pressure to fill the balance of 2021 production schedules and haven't opened 2022 order books.*
- **Nucor Corp.** is looking for a location in Pennsylvania, Ohio or W. Virginia to build a $2.7 billion sheet mill with a 3 million ton annual capacity. The new mill would be geographically situated to serve customers in the Midwest and Northeast, and have a lower carbon footprint than nearby competitors. "This mill will allow us to competitively meet the growing need that many of our customers, particularly in the automotive market, have for high quality steel with a lower carbon footprint," Nucor CEO Leon Topalian said.
- **U.S. Steel** is looking for a site in the U.S. to build a mini mill at an estimated cost of $3 billion. USS said the investment would be a significant step toward reducing its global greenhouse gas emissions and would help meet its target of net zero carbon emissions by 2050. The planned mini mill will combine two electric arc furnaces with steelmaking and finishing technology. Electric arc furnaces are cleaner and more flexible than blast furnaces. Construction is expected to start in the 1st-half of 2022, with production in 2024.

- **Steel imports into the U.S.** were 2.767 million tons (MT) in August, including 2.102MT of finished steel. Total steel imports YTD through August increased 25.5% to 20.564MT; finished steel imports rose 20.6% to 14.209MT compared to last year. Finished steel import market share in the U.S. over the first 8 months of 2021 was estimated at 20%.
- **Primary aluminum prices** in September climbed about 11¢/lb boosted by economic growth and constricted supply. The Midwest premium has trended historically high for several months due to rising freight costs and speculation that the Kitimat smelter strike will tighten supply further. The premium averaged 35¢/lb. in September, up by one cent from August.
- **Domestic stainless steel mills** applied a base price increase of 2¢/lb on 300 series cold-rolled coil. The September surcharge for grade 304 increased 4¢/lb, which covered the jump in nickel, while the 5¢/lb hike for grade 316 reflected nickel and molydenum. Surcharges are expected to edge down slightly in October due to the decline in ferrous scrap. Demand remains strong although automotive and appliances are in slowdowns resulting from the microchip shortage. Supply remains tight with only three domestic mills making commodity grade flat-rolled.

  Key Update: *Stainless imports are rising. Cold-rolled coil shipments in the June-August period increased 44% from the prior three months. Service center shipments in August were up 29% over August 2020 at 154,000 tons and YTD up 15%.*
- **Ford Motor Company** plans to team with South Korean battery maker SK Innovation to spend $11.4 billion in the U.S. to build an electric F-150 assembly plant and three battery plants. Ford will build two battery factories in Glendale, KY, and a third in Stanton, TN, alongside a new truck factory set to begin producing electric F-series pickups by 2025, creating 11,000 jobs. Ford said the planned $5.8 billion Blue Oval City complex in Tennessee "will usher in a new era for American manufacturing," comparing it to the Rouge complex in Michigan a century ago.



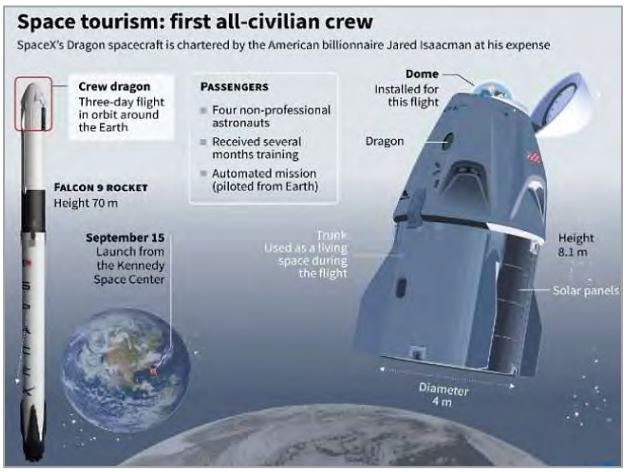
- **Ford sales of new vehicles** in the U.S. fell 27% in the 2nd Qtr vs. a year earlier. The drop was in line with the rest of the auto industry, which has been hampered by a global shortage of computer chips. However, Ford said the supply of parts was improving, as was its inventory of new cars and trucks. (See **Appendix: Automotive**, page 13)



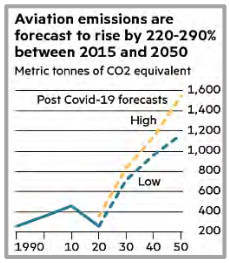
- **General Motors** reported its first quarterly sales drop in a year. The company said that its 3rd Qtr U.S. sales fell 33%. Honda's sales fell 11% and Chrysler's 19%. Toyota reported its sales rose slightly during the quarter, but its total for September declined 22%.
- **Mitsui OSK Lines,** part of Ocean Network Express, one of the world's biggest shipping alliances, said the industry had miscalculated how long the disorder of the pandemic would last. Some shipping companies predicted normalization early next year, but Mitsui recently extended its forecast to late 2022. Port closures caused by outbreaks of new COVID variants, supply bottlenecks and driver shortages have contributed to a tight operating environment. Container rates hit an all-time high of $11,109 in mid-September, after falling below $1,500 at the start of the pandemic.

  Key Update: *Opinions within the shipping industry vary on whether greater government intervention is warranted and the form it might take. Many executives are strongly opposed to the idea, but Mitsui said that the severity of the situation meant that some form of assistance or co-ordination might be necessary to bring an end to the shipping crisis.*
- **Airlines** warned of another pandemic-driven hit to profits in the months ahead, as the Delta variant interrupts a rebound in air travel. New travel bookings slowed in September and cancellations have increased. Some carriers said they still expect 3rd Qtr profits despite lower-than-expected revenue. Others, including United and Southwest, said they anticipate losses during the period. In response, airlines are paring flight schedules and some are warning of more financial losses in the months ahead, though executives said the setback will be short-lived.

- **SpaceX** cemented its position as a leading space enterprise with a mission that delivered four civilians to orbit for several days and then returned them to Earth. The *Inspiration4* flight was a more ambitious and technically difficult one than those conducted over the summer by space companies founded by Jeff Bezos and Richard Branson. It was the first flight taking only commercial astronauts, or those flying without government backing, to orbit. (See **Appendix: Aerospace**, page 10)

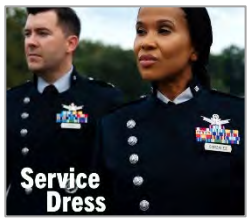


- **Aerospace companies** are urging the U.S. to speed up a review of rule changes for airplane engines, warning delays in implementing planned global emissions standards could trigger industrial delays. The standards would curb the flow of potentially damaging soot particles and do not take effect until the start of 2023, but executives warn an already overstretched supply chain needs clarity long before then to avoid disruption. They complain that a process involving the EPA and the FAA is moving too slowly, while Europe has already taken action. The U.S. is home to two of the world's three biggest engine makers, GE and Pratt & Whitney.
- **Hydrogen's moment** is fast approaching, according to Guillaume Faury, Airbus CEO, who now says Airbus is ready to start building a hydrogen-powered commercial airliner before the end of the decade. Europe's aerospace champion is increasingly confident that 2035 is a "realistic perspective" for a hydrogen aircraft to enter service, despite scepticism among other industry leaders about how quickly the gas might make an impact on aviation emissions.



Key Update: *Faury's remarks underline the urgency in the aviation industry as it strives to meet zero-emission by 2050. Before the pandemic grounded much of the world's aircraft fleet, aviation accounted for 2.4% of global emissions.*

- **U.S. oil prices** rose to their highest level in seven years after OPEC and its allies refused to increase crude production, resisting calls to help tackle a global energy crunch. Europe and Asia are gripped by tight energy supplies that have pushed natural gas and coal prices to record highs, while oil prices have been increasing steadily as the world economy rebounds from the depths of the coronavirus pandemic.
- **Lockheed Martin Aeronautics** was awarded a $2 billion contract to provide logistics support for delivered F-35 Lightning II Joint Strike Fighter air systems for the Navy, Marine Corps, Air Force, Foreign Military Sales customers and non-U.S. Department of Defense participants. Work is expected to be completed in December 2021. The company also bagged a not-to-exceed $412 million contract for deployment spares packages and afloat spares packages in support of F-35 Lightning II Joint Strike Fighter. Work is expected to be completed in September 2026.
- **The Space Force** unveiled its dress uniform, worthy of Star Trek, prompting on-line sharing of images and jokes. The uniform is a marked departure from the dress blues of the Air Force. It has a dark navy coat that buttons on the right-hand side and gray pants. The coat's six buttons, bearing the Space Force emblem, represent its status as the military's sixth service.



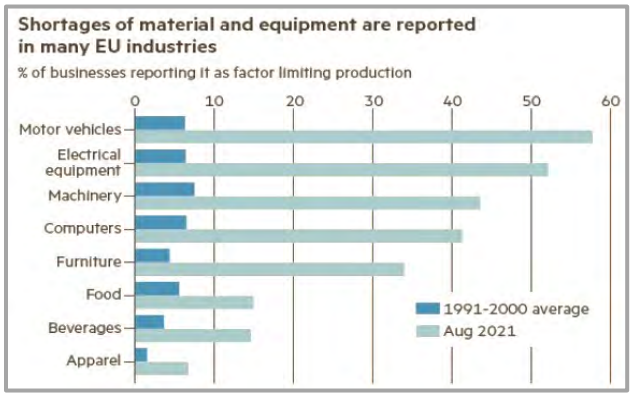
- **America's COVID-testing infrastructure,** from drugstores to diagnostics manufacturers, is bracing for a surge in demand following the administration's order that most large U.S. companies mandate their workers get vaccinated or be screened weekly for the virus. Makers of over-the-counter COVID-19 tests are boosting production, while laboratories and companies are ramping up operations that some had scaled back after the virus largely retreated earlier this year. (See **Appendix: Medical**, page 12)

Key Update: *Employers already are having a tougher time securing bulk tests to screen employees as retail pharmacies and other testing providers ration supplies.*

- **Medical device makers** are seeking priority amid the chip shortage by highlighting their life-saving products to secure supply: 'Every single chip you give me gives the gift of breath to a person suffocating'. Only a tiny fraction of the world's chips end up in medical equipment vs. cars and consumer electronics, but they are key to a range of vital devices like MRI machines, pacemakers and blood-sugar monitors for diabetes. To win priority over larger buyers, medical device makers say their most effective tactic is to raise awareness with executives at chip suppliers.

EUROPE, AFRICA & THE MIDDLE EAST

- **European economies** slowed in September as supply-chain bottlenecks and worries over the Delta variant weighed on businesses, purchasing managers' surveys showed. Gauges of business activity in the 19-nation euro zone recorded sharply slower growth in September in both manufacturing and services, extending a slowdown that began in August after activity in July hit a 21-year high.



- **The UK carbon dioxide shortage** threatening industries from steel to food is spilling over into Europe. Nippon Gases, which sold almost $1.5 billion of industrial gases on the continent last year, said other countries in Europe will also suffer shortages of CO_2, estimating that its supplies had fallen 50% across the region. Soaring natural gas prices have forced closures of fertilizer plants, the UK's main source of CO_2 used to make drinks fizzy, stun animals for slaughter and cool nuclear power plants.

  Key Update: *Jennifer Willis-Jones, commodity analyst at CRU, said, "The impact is massive. We expect more and more shutdowns in Western and Eastern Europe and Ukraine."*

- **Inflation for most G20 countries** will continue to rise over the next two years, according to revised OECD projections, which expect price increases to be significantly higher in 2021 and 2022 than previously forecast. The OECD expects that the average inflation rate across the G20 leading economies will hit 4.5% in the 4thQtr, with 1.5 points of that caused by higher shipping costs and commodity prices.
- **ArcelorMittal's steel plant in Hamburg** received a pledge of Federal Government support for the construction of Germany's first industrial scale hydrogen-based direct reduced iron (DRI) plant. The government will provide €55 million of funding support for construction, half of the €110 million total capital expenditure required. The next step is for the European Commission to approve the funding before the installation of the new plant can begin. Production is scheduled to start in 2025.
- **U.S. aircraft parts maker TransDigm** bowed out of a potential bidding war for the UK aerospace and defense group Meggitt, paving the way for U.S. rival Parker Hannifin to seal its agreed £6.3 billion takeover.
- **The International Energy Agency** urged Russia to send more natural gas to Europe to help alleviate the energy crisis. Officials and traders question why Gazprom limits top-up sales in the spot market to Europe, saying this has fuelled a surge in prices that is threatening industries across the continent. The IEA said that while Russia was fulfilling long-term contracts, it was supplying less gas to Europe than before the pandemic. (See **Appendix: Energy**, page 8)

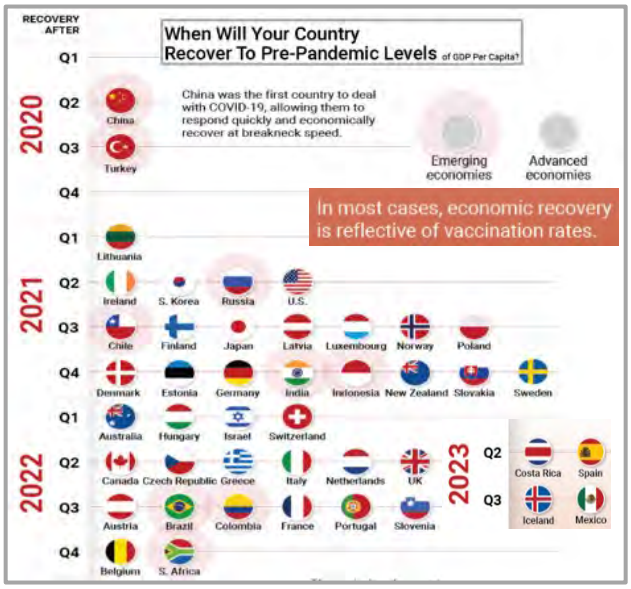
- **A minority stake in a new nuclear power station** on England's East coast will be sold to institutional investors or floated on the stock market under UK government plans to oust China's CGN from the project. The government is nearing a deal to force state-owned CGN to give up its 20% stake in the proposed Sizewell C nuclear plant in Suffolk.
- **Wind-driven electricity production** off the UK coast slowed recently, roiling regional energy markets. Gas and coal-fired electricity plants were called in to make up the shortfall. Natural gas prices hit all-time highs. Thermal coal has emerged from a long price slump as utilities are forced to turn on backup power sources. The episode underscored the precarious state the region's energy markets.
- **Demand for Tesla mid-sized models** helped push up electric car sales in Norway to nearly 80% of September total car sales. The country has been a global leader in switching to electric vehicles and seeks to become the first to end the sale of petrol and diesel engines by 2025.
- **Mercedes-Benz** will take a 33% stake in Automotive Cells Co., a European battery startup that previously received backing from French energy giant Total, trans-Atlantic car giant Stellantis and the EU. Total, Stellantis and Mercedes-Benz will end up with a third each of a venture that plans to spend at least €7 billion through 2030 to build European cell-manufacturing plants, or "gigafactories".
- **Intel Corp** reserved capacity at its Irish semiconductor plant for automakers and created a program to help them transition to making chips in its factories, using Intel chip manufacturing technologies that are far more advanced than the processes used in the auto industry. BMW, VW, Daimler and Bosch expressed support for its program.

  Key Update: *Intel views automakers as a key strategic priority and believes chips will make up 20% of the cost of vehicles by 2030, a five-fold increase from 4% in 2019.*

ASIA/PACIFIC, JAPAN, AUSTRALIA & INDIA

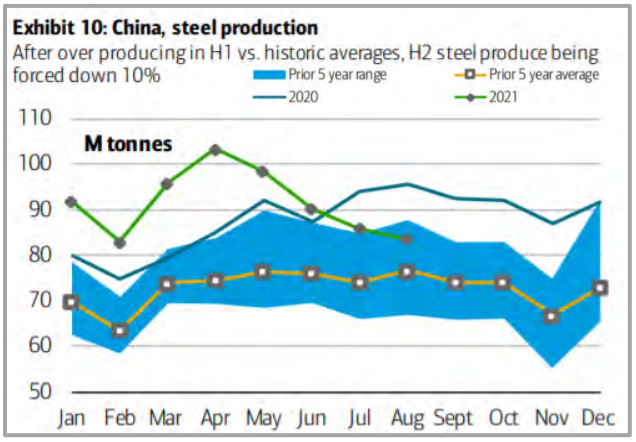
- **Manufacturing activity in China** dipped into negative territory in September, the first time since the pandemic began. China's purchasing managers' index fell to 49.6, crossing the 50-point threshold that separates expansion from contraction. Power shortages and sporadic outbreaks of COVID-19 are risking China's growth outlook.

  Key Update: *Power outages have swept across many Chinese provinces, as the government ramps up efforts to curb energy consumption and reduce carbon emissions.*



- **Metallurgical coal prices** for Chinese importers surged to US$410/tonne in the last week of September, more than triple the price in early 2020. Coking coal is now overtaking iron ore as the largest input cost for many of the world's steel mills. Coking coal has soared despite declines in iron ore attributed to Chinese steel-makers abiding by a government directive to avoid buying from Australia.
- **China's domestic stainless steel prices** surged to a 10-year high in September amid tight supply and steady demand. Local auhorities in Jiangsu province, a major stainless steel production hub, told industries that electricity consumption in the month must not exceed that of last year.
- **Toyota Motors** expects to spend more than $13.5 billion by 2030 to develop batteries and its battery supply system, in a bid to take a lead in the key automotive technology over the next decade. The world's largest automaker by volume is moving rapidly to deliver its first all-electric line-up next year. The company aims to slash the cost of its batteries by 30% by working on the materials used and the way the cells are structured and to improve power consumption or the amount of electricity used per kilometer by 30%.
- **Ford Motors** will stop making cars at two plants in India, ending a long and costly effort to build a presence in one of the world's largest emerging auto markets. Ford lost more than $2 billion in the past 10 years in India. The withdrawal from India is Ford's latest move to pare losses from its international operations. Earlier, Ford said it would close its three plants in Brazil. Previously, it closed several plants and eliminated several thousand jobs in Europe.

  Key Update: *Other major automakers have also struggled to gain a foothold in India, where people tend to buy smaller, more affordable cars than in the U.S. and Europe. General Motors stopped selling cars in the country in 2017.*
- **Iron ore** extended its slump below $100 a ton as China stepped up restrictions on steel production. Prices have collapsed about 60% since a record high in May, as Chinese demand for iron ore wanes. The world's biggest steelmaker is intensifying steel production curbs to meet a target for lower volumes this year, as it works toward carbon neutrality by 2060. More recently, restrictions have focused on improving air quality for the Winter Olympics next year.

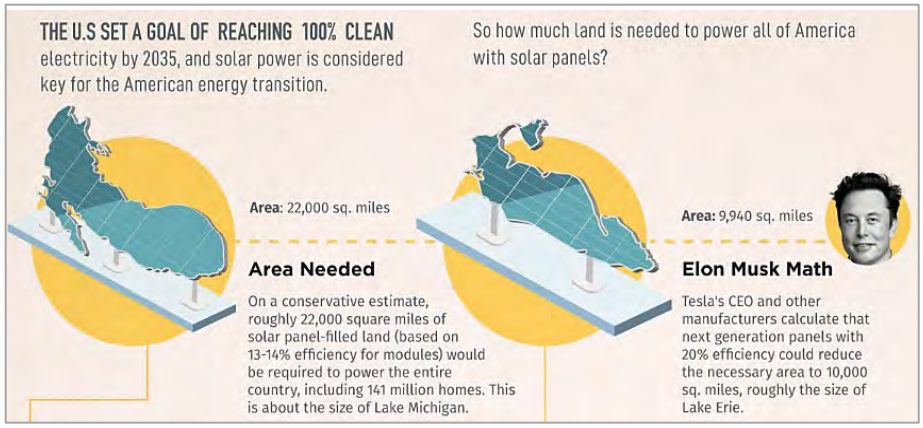


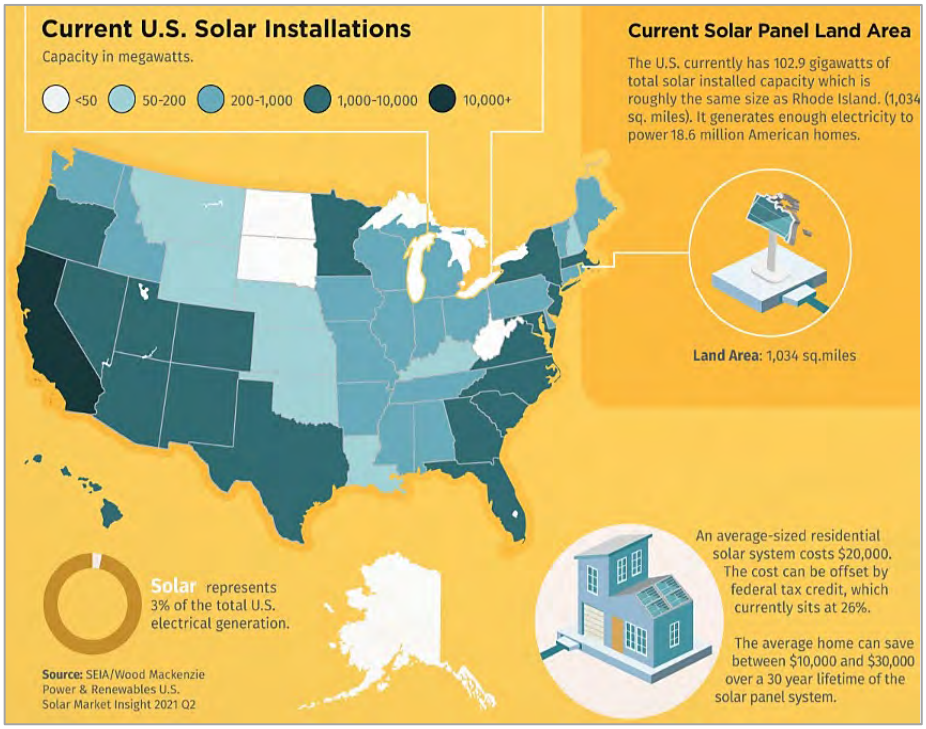
- **Global crude steel output** dropped 1.4% in August on a slump in output from top producer China to a 17-month low due to government actions to control production to reduce carbon emissions. Production rose across other major steel-producing countries for the reported month with the U.S. and Japan racking up the biggest gains.
- **Aluminum prices** continued to rally in September, with the spot price on the LME hitting $3,000 per metric ton for the first time in more than a decade on supply issues. A coup in Guinea, a major producer of bauxite, has hit supply. "The increased uncertainty around the new political regime in one of the world's largest bauxite-producing countries may disrupt global commodity export flows and also raises the likelihood of export contracts renegotiation, which may put upside pressure on alumina and aluminum prices," J.P. Morgan said. (See **Appendix:Commodities**, page 15)

ECONOMIC UPDATE: APPENDIX TO THE OCTOBER 2021 ISSUE

ENERGY: A SOLAR POWERED UNITED STATES — HOW MUCH LAND IS REQUIRED?

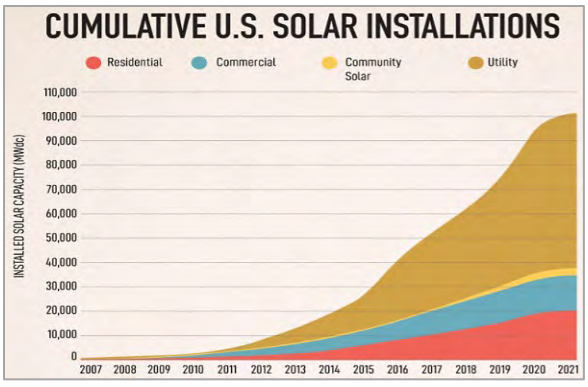
How Much Land is Needed to Power the U.S. with Solar? The administration has set a goal of reaching 100% clean electricity throughout the U.S. by 2035, and solar power is a key for this energy transition. In the last decade, solar has experienced an average annual growth rate of 42% due to federal tax credits, declining costs and increasing demand. It is projected that more than one in seven American homes will have a solar power system by 2030. To put this trend into perspective, these graphics use data from the Department of Energy to show how much land would be needed to power the entire country with solar panels.





Solar Panels Across the Ocean State: The U.S. has 102.9 gigawatts of total solar installed capacity which is equivalent to 965 square miles, roughly the size of the country's smallest state, Rhode Island. This current solar capacity generates enough electricity to power 18.6 million American homes, which is nearly 13% of the nation's households. According to the National Renewable Energy Laboratory, roughly 22,000 square miles of solar panel-filled land (about the size of Lake Michigan) would be required to power the entire country, including all 141 million households and businesses, based on 13-14% efficiency for solar modules. However, many solar panels reach 20% efficiency, which could reduce the necessary area to just about 10,000 square miles, equivalent to the size of Lake Erie.

Solar Installations Spreading Across the States: Today, solar represents only 3% of the total U.S. electrical generation. While California has traditionally dominated the market, other states like Florida and Texas are expanding rapidly, boosted by the residential market. Large companies with clean energy goals such as Walmart, Apple, Target and Amazon have also helped push solar adoption to near-record levels in 2021. Despite having a high installation cost, the technology tends to bring savings in the long term. An average-sized residential system has dropped from a price of $40,000 in 2010 to roughly $20,000 in 2020. Solar panels can save between $10,000-$30,000 over a 30-year lifetime. Between land and rooftops, the U.S. has more than enough space to build all the solar panels necessary to power the country. Until then, the future of clean electricity will also depend on hydro, nuclear, geothermal and wind energy.

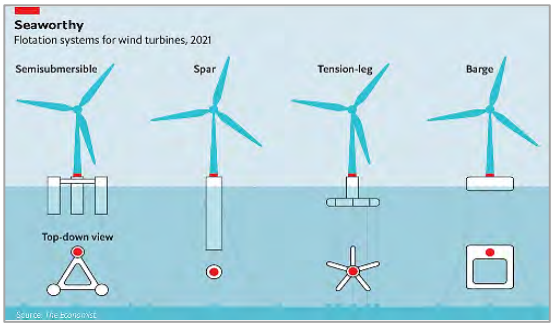


ENERGY: SIEMENS GAMESA BUILDS FIRST RECYCLABLE BLADES FOR WIND TURBINES

Siemens Gamesa has developed the first offshore wind turbine blades that can be fully recycled, potentially saving hundreds of thousands from landfill and resolving an issue long highlighted by industry critics. Blades, which can be longer than a football field and are made of materials including balsa wood, glass and carbon fiber, are difficult and costly to reuse. Renewable energy sceptics have used images of blades piled in landfills to question the green credentials of wind power, which produces no emissions but requires materials such as steel and copper whose production remains carbon-intensive. **About 85% of a turbine, including the steel towers, can be recycled but the blades have proved more challenging. The materials are bound with a resin that ensures they are stiff enough to withstand typhoon conditions but makes it difficult to separate the parts.** Although some blades have been used in alternatives such as in playgrounds, Siemens Gamesa said the majority go to landfill, typically after 25 years. As many early projects are reaching the end of their lives or are "re-powered" with new, more powerful turbines, about 6,650 blades will be removed each year in Europe until 2025. About 1,400 blades will be removed annually in the U.S. over the same period. Siemens Gamesa has produced its first six recyclable blades at a factory in Aalborg in Denmark using a resin whose chemical structure ensures it can be more easily separated from the other components when heated in a mild acidic solution. The turbine maker is also evaluating the technology for use in onshore projects. Marc Becker, global offshore chief executive, said although the separated materials would not be suitable for new blades as they would no longer withstand typhoon conditions, they could be used "in boats or a lot of other applications where you don't need this ultra strength any more". He declined to detail how much the recyclable blades would cost compared with standard ones but insisted they were not "prohibitively expensive" and that prices would decline as greater volumes were produced. "It's not something we will do in 2030 or 2050, we can do it now," he added. Siemens Gamesa is committed with RWE to install and monitor the world's first wind turbines with recyclable blades at the Kaskasi offshore wind power plant in Germany. Current plans are for the project to be producing energy from 2022 onwards. The company pledged to develop fully recyclable wind turbines by 2040 as many European countries introduce tighter restrictions on what materials can be sent to landfill. With the new blades, only 5-7% of a turbine could not be recycled at present, including hydraulic fluids. Siemens Gamesa estimates that the recyclable blades, if taken up by offshore wind developers, could save as many as 200,000 from ending up in landfill sites as more are expected to be deployed globally.

ENERGY: FLOATING WIND TURBINES COULD RISE TO GREAT HEIGHTS

Royal Dutch Shell and Scottish Power have jointly submitting proposals to British authorities to build off the coast of Scotland the first large-scale set of floating wind farms in the world. At the moment, the largest floating farm is a six-turbine, 50MW array which was completed in the North Sea in August, 15km from Aberdeen. The consortium, by contrast, has said it is thinking in gigawatts. Offshore wind farms with foundations in the seabed are of limited deployability, being restricted to waters shallower than about 60 metres. Unfortunately, 80% of the world's offshore wind blows over places deeper than that. **Making these winds accessible, according to the International Energy Agency, would unlock enough power to meet the world's probable electrical needs in 2040 eleven times over.** The trick is to build turbines which, though moored to the seabed, will float. A decade of development has yielded two things: proof that turbines can float and clarity as to how these floating units might look. Engineers achieved this through patient prototyping and consider the flotation problem solved. Four approaches to flotation have emerged (see diagram). The commonest is a semisubmersible. Semisubmersibles come in various designs. One uses a buoyant steel triangle that has water-filled cans at two of the vertices. These ballast tanks balance the weight of a turbine at the third vertex, with water pumped around inside the triangle to trim its stability. A second tack is to stick a turbine on a bottle called a spar that is filled with heavy ballast, to make it float upright. Two other approaches are less developed, but may prove useful. Glosten, an American engineering firm that has formed a partnership with General Electric, uses a tension-leg platform. This is a starfish-shaped steel structure with a turbine at its hub. The starfish is submerged and yoked to the ocean floor with cables. This arrangement, similar to that for the ultra-deep-water Magnolia rig drilling in the Gulf of Mexico, holds the turbine upright. BW Ideol, a Norwegian firm, erects the turbine on a flat concrete or steel barge that resembles an empty picture frame. When the turbine sways, water sloshes within the frame, dampening its movement. The company claims its prototype, off the coast of Japan, has already survived three typhoons.



AEROSPACE: MARS ROCKS COLLECTED BY PERSEVERANCE BOOST CASE FOR ANCIENT LIFE

NASA's Perseverance Mars rover has now collected two rock samples, with signs that they were in contact with water for a long period of time, boosting the case for ancient life on the Red Planet. "It looks like our first rocks reveal a potentially habitable sustained environment," said Ken Farley, project scientist for the mission. "It's a big deal that the water was there for a long time." The six-wheeled robot collected its first sample, dubbed "Montdenier" on September 6 and its second ("Montagnac") from the same rock on September 8. Both samples, slightly wider than a pencil in diameter and about six centimeters long, are now stored in sealed tubes in the rover's interior. A first attempt at collecting a sample in early August failed after the rock proved too crumbly to withstand Perseverance's drill. The rover has been operating in a region known as the Jezero Crater, just north of the equator and home to a lake 3.5 billion years ago, when conditions on Mars were much warmer and wetter than today. The rock that provided the first samples was found to be basaltic in composition and likely the product of lava flows. **Volcanic rocks contain crystalline minerals that are helpful in radiometric dating. This in turn could help scientists build up a picture of the area's geological history, such as when the crater formed, when the lake appeared and disappeared and how climate changed over time.** "An interesting thing about these rocks is that they show signs for sustained interaction with groundwater," NASA geologist Katie Stack Morgan told a press conference. The scientists already knew the crater was home to a lake, but couldn't rule out the possibility that it had been a "flash in the pan" with floodwaters filling up the crater for as little as 50 years. Now they are more certain groundwater was present for much longer. "If these rocks experienced water for long periods of time, there may be habitable niches within these rocks that could have supported ancient microbial life," added Stack Morgan. The salt minerals in the rock cores may have trapped tiny bubbles of ancient Martian water. "Salts are great minerals for preserving signs of ancient life here on Earth, and we expect the same may be true for rocks on Mars," added Stack Morgan. NASA is hoping to return the samples to Earth for in depth lab analysis in a joint mission with the European Space Agency sometime in the 2030s.

AEROSPACE: ASTRONAUTS SMELL SMOKE, BURNING ON RUSSIA'S ISS MODULE

A smoke alarm sounded in Russia's segment of the International Space Station (ISS) and astronauts smelled "burning" on board, Russia's space agency and NASA reported in September. **The incident, which the Russian space agency Roscosmos said happened ahead of a scheduled spacewalk, is the latest in a string of problems to spur safety concerns over conditions on the Russian segment.** "A smoke detector was triggered in the Zvezda service module of the Russian segment of the International Space Station during automatic battery charging and an alarm went off," Roscosmos said. French astronaut Thomas Pesquet said "the smell of burning plastic or electronic equipment" wafted to the U.S. segment of the station, Russian state news agency RIA Novosti reported, citing a NASA broadcast. The Russian crew turned on a filter and after the air was cleaned up the astronauts went back to sleep, Roscosmos said. The space agency said that a planned spacewalk would go ahead as scheduled. Russia's Oleg Novitsky and Pyotr Dubrov were scheduled to leave the station to continue work on the Nauka science module that docked in July. "All systems are operating normally," Roscosmos said. **The Russian segment of the ISS has experienced several problems recently and a space official warned in August that out of date software could lead to "irreparable failures".** The Zvezda service module, part of the Russian segment, has experienced several air leaks, including earlier this year and in 2019. Citing concerns stemming from ageing hardware, Russia has previously indicated that it plans to leave the ISS after 2025 and launch its own orbital station. In July, the entire ISS tilted out of orbit after the thrusters of the Nauka module reignited several hours after docking.

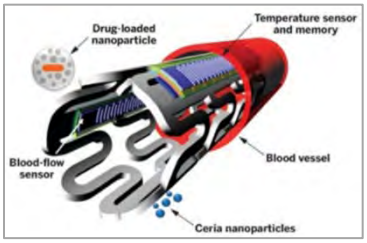
STEEL: DECARBONIZATION OF PRIMARY STEELMAKING NEEDED TO MEET PARIS GOALS

STEEL: INDUSTRY'S INNOVATIVE USE OF STEEL BY-PRODUCTS SUPPORTS MARINE REGENERATION

Artificial reefs made of steel slag have been used to create sea forests off the coast of South Korea, providing a new habitat and breeding ground for fish populations. The sea floor environment around South Korea's coastline has been degrading steadily due to desertification, a process which destroys ocean life and has been linked to climate change and pollution. The situation had led to the destruction of over 60% of marine plants along a 220/km stretch of the country's eastern coast. The desertification of sea forest algae, including seaweed and kelp, is devastating to ecosystems and impacts heavily on fish populations. A by-product of necessity: In the year 2000, the research unit of POSCO, South Korea's largest steel company, was working with the Research Institute of Industrial Science & Technology on an artificial reef based on steel slag, a by-product of the steel manufacturing process. Produced during the separation of molten steel from impurities, slag is a dense, rock-like material that has traditionally been used as ballast, or as a construction aggregate or addition to agricultural soil**. POSCO's research team realized that steel slag's high mineral content, including calcium and iron, made it highly supportive for the growth of marine plant life. This led to the creation of the Triton, an artificial reef that has since been installed in 30 different sea forests across South Korea.** Made up of 85% slag aggregates, 15% slag cement and water, more than 29,000 Triton blocks have been installed in over 7,500 reefs since 2007. The blocks, which are heavy enough to resist being moved by typhoon or tsunami activity, are planted with marine algae before they are installed on the sea floor, helping regenerate previously barren stretches of coastline. POSCO is committed to sustainability so local reef manufacturers are provided with steel slag entirely free of charge so that costs can be kept low. The steel company can process 13,500 tonnes of slag every year, ensuring a steady supply of new reefs for coastal areas in need. In addition to being a sustainable reuse of a steel-making by-product and providing an environment for marine algae to thrive, Triton sea forests also sequestrate and store carbon from the ocean and atmosphere. A single hectare of Triton sea forest captures around 16 tonnes of CO_2 annually. With the 29,000 blocks covering nearly 38 hectares, this totals more than 600 tonnes of CO_2 uptake per year. The sea forests' increased seaweed and kelp also helps boost fish populations, with increased fish catches seen in areas with Triton reefs. It is estimated that the total economic value of existing sea forests to local communities is over $1 million. **The steel industry is continuing to improve the sustainability of its processes. Its research teams are reducing emissions and discovering innovative new ways to use steel manufacturing by-products.**

MEDICAL: BIOACTIVE GLASS AND METALS MAY ELIMINATE THE NEED FOR INVASIVE IMPLANT REMOVAL

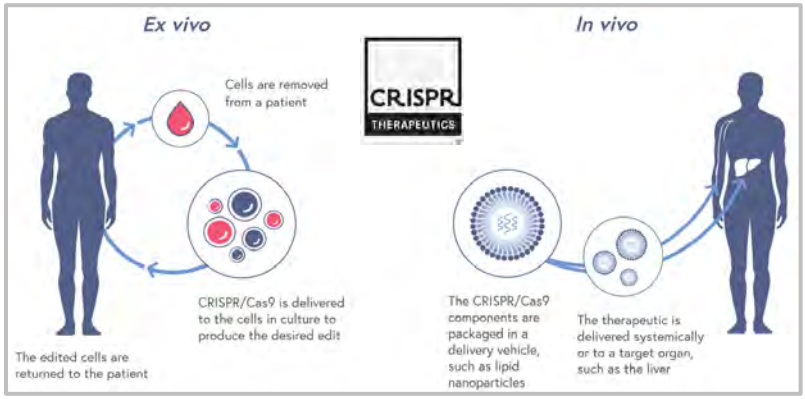
Medical devices made of bioactive glass and metals that dissolve at the end of their operational lifespan could replace other types of implants and eliminate the need for invasive removal once they have served their purpose, according to researchers at Missouri University of Science and Technology. The researchers recently received a patent for their implant. "Glass is an excellent material for packaging and substrate layers in implanted solid-state devices including sensors and actuators," said Chang-Soo Kim, PhD professor and graduate coordinator of electrical engineering at Missouri S&T. "Depending on the combination of materials, you can develop a bioactive glass that degrades very slowly or very quickly, based on the required operational time for the device." As lead researcher on the project, Kim worked with Richard Brow, PhD, Curators' distinguished professor of ceramic engineering at Missouri S&T; and Delbert Day, PhD, Curators' distinguished professor emeritus of ceramic engineering and inventor of bioactive glasses for cancer treatment, bone tissue regeneration and wound healing. Kim designed the electrical functions of the devices, and Brow and Day designed the glasses used in the implants. **The resorbable implants eliminate the need for additional surgery to remove a sensor or other functional device after it is no longer needed.** That is especially important because biodegradable devices are designed to be implanted in the brain or other organs deep inside the body. The implants can also be used for drug delivery or tissue healing. Implantable medical devices have been used for real-time monitoring of physical parameters (temperature, pressure and biopotentials), sustained drug release, cardiovascular and pulmonary stents and other clinical applications for some time. Several biocompatible materials (titanium and its alloys, aluminum, cobalt-alloys, stainless steel, polyethylene, polyurethanes, polyglycolide and polylactides) have been commercially used for fabricating implantable devices. However, these devices require retrieval operations after a certain period. Bioresorbable materials disintegrate gradually in vivo and their derivatives get absorbed completely in the body fluid with no residue and with minimal toxic effects. Bioresorbable materials include magnesium, molybdenum, tungsten, silicon, germanium, silicon dioxide, silicon nitride, silk and synthetic polymers.



MEDICAL: GENE EDITING STOCKS PROMISING TO CHANGE OUR DNA

Gene editing stocks are ready to take off as the underlying technology moves from fiction to fact. In the 1980s, the field of genetics surged in popularity. At the time, there were many articles promising investors that genetics stocks were on the cusp of spectacular gains.

Investors who were looking for short-term payoffs then were disappointed, but now, gene editing stocks look far more promising. Researching the genetic origin behind certain diseases and conditions has led to truly breakthrough treatments. Almost everyone knows a cancer survivor or someone with a chronic condition who is living a longer, more fulfilling life than was ever thought possible. A deeper understanding of genetics has a lot to do with that. Once scientists identified problematic gene sequences, they began searching for a way to selectively delete or change certain parts of them. That's where CRISPR technology comes in. Currently, gene editing with CRISPR is encumbered by enormous amounts of data that researchers have struggled to comb through. However, that is changing quickly. **The key today is the convergence of artificial intelligence and gene editing, which gives companies the ability to comb through and understand the voluminous data.** That means ideas that were once the stuff of science fiction are becoming scientific fact and that's why investors are looking at companies that are on the forefront of this movement. These companies are not yet profitable, as many are in the pre-revenue stage, but that's to be expected. This is a multi-year event that's unfolding**.** Crispr Therapeutics is a pioneer of the CRISPR/Cas9 gene editing platform. Like other companies in the sector, it illustrates what investors are dealing with in this growing space. Crispr has four products in its pipeline, but is probably several years away from bringing any of them to market. The one that is closest to approval is being co-developed and co-commercialized with Vertex Pharmaceuticals. The company recently made a $900 million pledge to Crispr. That is one of the challenges of investing in gene editing stocks. Bringing products to market requires resources that many companies like Crispr lack. While the support of Vertex will help a great deal, Vertex will get 60% of the profits from future sales.



AUTOMOTIVE: EV BATTERIES MAY BE THE NEXT VICTIM OF HIGH COMMODITY PRICES

Ever-cheaper batteries over the past decade have made electric vehicles more price-competitive, but rising demand for EVs could now disrupt that trend. The race to secure key materials will become more crucial. **Prices of battery materials have skyrocketed this year as electric vehicle demand jumps. Prices of lithium carbonate, used in cathodes, have doubled year-to-date,** according to research firm Benchmark Mineral Intelligence. Prices for cobalt hydroxide, which boosts energy density and battery life, have risen more than 40%. The pandemic has brought disruption, but the real problem is more fundamental, especially in lithium. The oversupply that crashed prices from 2018 to 2020 caused multiple projects to be put on hold and maintenance of other newer projects stalled. Analysts expect most battery raw-material markets to remain tight this decade and that the lithium market will fall into deficit in 2022. Most supply-chain contracts are cost pass through, which means EV manufacturers have to bear cost increases, but battery makers still face margin pressure. Auto makers will push back when they can by playing different battery suppliers off one another. Battery stocks, which have been on a tear since last year, might need to take a breather. Leading firms, such as China's Contemporary Amperex Technology and Korea's LG Energy Solution, may have better bargaining power with auto makers. In the first five months of the year, they were neck-and-neck—each having slightly more than a quarter of the battery market for passenger EVs. After a decade of price declines driven by economies of scale, new savings may become tougher. Raw materials now account for most of the cost of a battery. Cathode materials such as lithium, nickel and cobalt make up around 30% to 45% of the total. New technologies can help, but securing upstream supply is also becoming more important. Tesla has inked a nickel-supply deal with Australia's BHP. Auto makers BMW and General Motors have signed lithium sourcing agreements with miners. CATL recently took a stake in a copper-cobalt mine. Longer-term supply contracts have also become more common. Chinese battery makers benefit from a strong EV supply chain. While most mining isn't done at home, China dominates the processing of chemical materials that go into batteries. It accounts for 65% of the production of anode materials and electrolytes and 42% of cathode materials. China has a stronger grip on supply chains than anyone else, so they should be better positioned. That advantagre could translate into cost savings for China's favored EV manufacturers, although it also creates strong incentives for other countries to develop their own processing capacity.

AUTOMOTIVE: FORD AND GENERAL MOTORS FIGHT IT OUT TO ELECTRIFY

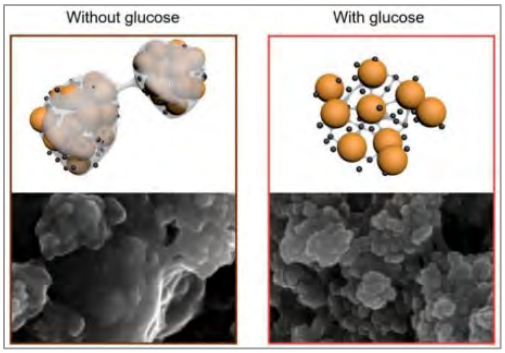
A new contest is brewing between America's two mightiest carmakers that may be the most momentous in a century. It is the race to electrify their fleets, and especially pickups, the biggest source of profits for both companies. As part of this campaign, GM has said it will build four battery factories by 2025 with its partner, LG Chem, a South Korean battery-maker. In September, Ford and its South Korean battery partner, SK Innovation, announced an investment of $11bn in three battery factories and an assembly plant for electric F-Series pickups. **Ford reckons that 40% of its global sales will be electric by 2030. GM wants all its vehicles to be emissions-free by 2035.** The ultimate result of this competition will determine which of Detroit's giants will have the upper hand in the market for EVs and autonomous driving. It will also help shape the future of both motoring and carbon emissions in the country that invented the gas-guzzler and car culture. The reason for this newfound ambition is the firms' painful decline in their home market. America "defines both companies", says Dan Levy of Credit Suisse. In 2020, 65% of Ford's revenues and over 80% of GM's, along with most of their profits, came courtesy of domestic buyers. Although America defines both of them, they no longer define America (see chart). Hubris, bred from decades of effortless success, ran up against smaller, cheaper and better vehicles made by foreign firms. Ford's and GM's combined market share of 30% is a shadow of the combined 50% they commanded 20 years ago, let alone the 70% in the 1970s.

INNOVATION/ROBOTICS: THE LAST PIECES OF WAREHOUSE AUTOMATION WILL SOON BE IN PLACE

Unloading trucks is wearisome for people, but hardly an intellectual challenge. For robots it is the reverse. Robots never tire, but they have problems interpreting the data streaming in from the cameras and laser scanners that are their eyes. Seeing where one box in the back of a crowded truck ends and another begins is second nature to a human being, but even the best artificial-vision systems struggle to cope. The next question is what the robot should do with what it sees. The less tidy the contents, the greater the problem. Shrink-wrapped pallets of packages are one thing, the miscellaneous jumbles of objects handled by parcel-delivery businesses quite another. Cases may get wedged, or the robot may need to work out how to lift an irregular consignment like a set of skis. People learn how to do such things gradually, as they grow up and machines have to learn too and that takes time and a lot of training. **Unloading trucks is therefore one of the few parts of operating a warehouse that has resisted automation, but not for much longer. A new generation of cargo-handling robots is poised to take on the task.** The robotics division of Honeywell has come up with a vehicle-sized unit (see picture) that fits onto the back of a truck. It has a large arm fitted with suction cups which can pick up several boxes at a time and then feed them onto a conveyor belt, or knock down a wall of boxes and sweep them onto the conveyor. An individual human worker can unload between 600 and 1,200 boxes an hour. Honeywell hopes that once its robot is perfected, a single crew chief will be able to supervise the simultaneous unloading of three or four trucks, each at rates of up to 1,500 boxes an hour. The robot does not need to be as precise as the pick-and-place robots that work on assembly lines. However, it is still a challenge for it to distinguish between individual boxes and to recognize and identify anomalous objects such as loose pallets and the pallet jacks used to move stacked pallets around. At the moment, it works best with boxes of uniform size and shape. Changing that will need a lot of training, which means designing and assembling a variety of dummy loads inside a variety of vehicles. This is both time-consuming and labor-intensive. Honeywell is negotiating with one of the potential customers for the robot to do the training there. The next task is to run the unloading process in reverse by using robots to load trucks in the first place. Besides simply lugging boxes around, this also involves working out how to stack them efficiently. Solving that problem, and doing so at the speed which commerce requires, would allow warehouses to be almost completely automated.

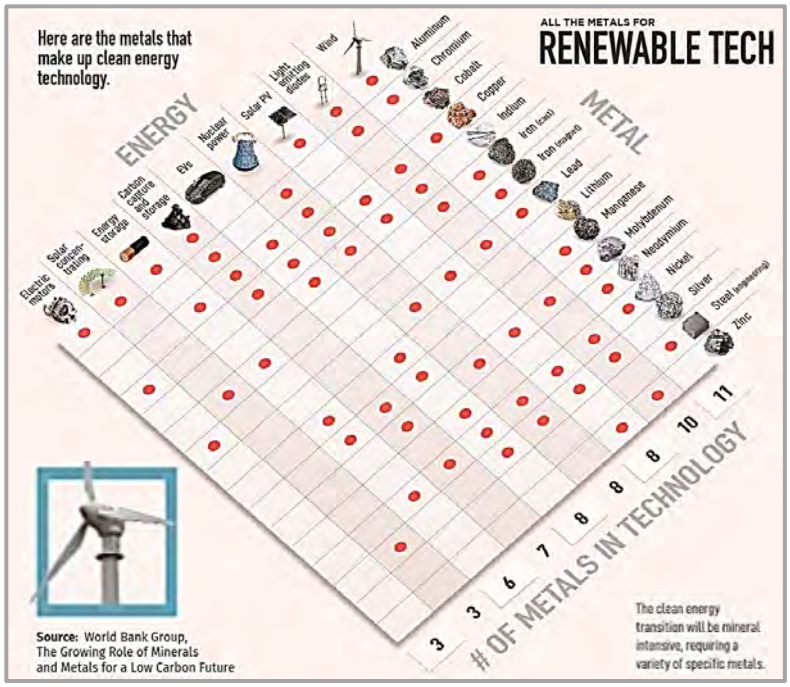
INNOVATION/ENERGY: A SPOONFUL OF SUGAR LEADS TO LONGER LASTING LITHIUM SULFUR BATTERIES

Simply by adding sugar, researchers from the Monash Energy Institute (Melbourne) have created a longer-lasting, lighter and more sustainable rival to the lithium-ion batteries that are essential for aviation, electric vehicles and submarines. Using a glucose-based additive on the positive electrode, they have managed to stabilize lithium-sulfur battery technology, long touted as the basis for the next generation of batteries**. "In less than a decade, this technology could lead to vehicles, including electric buses and trucks, that can travel from Melbourne to Sydney (542 miles) without recharging.** It could also enable innovation in delivery and agricultural drones where light weight is paramount," said lead author Professor Mainak Majumder, Associate Director of the Monash Energy Institute. In theory, lithium-sulfur batteries could store two to five times more energy than lithium-ion batteries of the same weight. The problem has been that the electrodes deteriorated rapidly in use, and the batteries broke down. There were two reasons for this—the positive sulfur electrode suffered from substantial expansion and contraction, weakening it and making it inaccessible to lithium, and the negative lithium electrode became contaminated by sulfur compounds. Last year, the Monash team demonstrated they could open the structure of the sulfur electrode to accommodate expansion and make it more accessible to lithium. Now, by incorporating sugar into the web-like architecture of the electrode, they have stabilized the sulfur, preventing it from moving and blanketing the lithium electrode. Test-cell prototypes constructed by the team have been shown to have a charge-discharge life of at least 1000 cycles, while still holding far more capacity than equivalent lithium-ion batteries. Each charge lasts longer, extending the battery's life. Manufacturing the batteries doesn't require exotic, toxic or expensive materials. While many of the challenges on the cathode side of the battery has been solved, there is still need for further innovation into the protection of the lithium metal anode to enable large-scale uptake of this promising technology—innovations that may be right around the corner. Enserv Australia hopes to develop and manufacture the batteries in Australia, the world's largest producer of lithium. "We would be looking to use the technology to enter the growing market for electric vehicles and electronic devices," says Mark Gustowski, Managing Director of Enserv Australia. "We plan to make the first lithium-sulfur batteries in Australia using Australian lithium within about five years."



COMMODITIES: THE CRITICAL METALS NEEDED FOR RENEWABLE TECHNOLOGY

The energy transition will be mineral intensive and create massive demand for all the metals in renewable tech. Electricity from renewable technology grew at the fastest rate in two decades in 2020, according to a report from the International Energy Agency (IEA). Consequently, as the pace of the energy transition gains further momentum, the demand for metals will increase. The graphic takes data from the World Bank's *Climate Smart Report* which outlines what metals each renewable technology will require and their overlapping uses. **The number and amount of metals used vary by technology.** Lithium, nickel, cobalt, manganese and graphite are important for battery performance, durability and energy density. Rare earth elements are in the permanent magnets that help spin wind turbines and EV motors. A typical electric car requires six times the minerals of a conventional car and an onshore wind farm requires nine times more minerals than a gas-fired power plant with a similar output. Electricity grids need massive amounts of copper and aluminum, with copper being a keystone for all electricity-related technologies. Inevitably, more mining must happen to provide the minerals for a renewable energy transition. According to the IEA, reaching the goals of the Paris Agreement would quadruple mineral demand by 2040.



Expect limited resources and high prices. Eventually, a rapid increase in demand for minerals will create opportunities and challenges in meeting sustainability goals. There has been a lack of investment in new mine supply which could substantially raise the costs of clean energy technologies. The mining industry needs to invest $1.7 trillion over the next 15 years to supply enough metals for renewable tech, according to Wood Mackenzie, but the mining industry is not ready to support an accelerated energy transition. While there are a host of projects at varying stages of development, there are many risks that could increase supply constraints and price volatility: (1) Very high geographical concentration of production; (2) Long project development lead times; (3) Declining resource quality; (4) Growing scrutiny of environmental and social performance; and (5) Higher exposure to climate risks. Some nations are better positioned to secure the metals. Attaining these new sources will be vital and valuable for a clean energy future.

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

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