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ECONOMIC UPDATE

Number 11 • APRIL 2021

EXECUTIVE SUMMARY

AMERICAS: U.S. MANUFACTURING ACTIVITY soared to its highest level in more than 37 years in March, driven by strong growth in new orders, the clearest sign yet that a much-anticipated economic boom is underway. **The unemployment rate** dropped to 6.0% in March as employers added 916,000 new jobs to payrolls. Temporary help and auto manufacturing were weak spots. **Factory orders** fell 0.8%, impacted by unseasonably cold weather, including winter storms in Texas and other parts of the densely populated South. **Industrial production** in the U.S. fell 2.2%, pulled down by manufacturing production (-3.1%) and mining production (-5.4%). **Activity in the service sector** soared in March. It was the strongest expansion in the service sector in eleven years. **Household net worth** in America finished 2020 at the highest level on record, as soaring prices for stocks, real estate and other assets erased losses inflicted by the effects of the coronavirus pandemic. **U.S. consumer confidence** rose in March to its highest level since the pandemic started, with Americans expressing more optimism about business and labor-market conditions in the coming months**. Logjams at U.S. ports** are spreading beyond Southern California's choked gateways and shipping officials are projecting the backups will continue into the summer.

OVERSEAS: RISING RAW-MATERIALS COSTS AND UNRELENTING SUPPLY-CHAIN CONSTRAINTS are prompting many Chinese exporters to increase prices for the goods they export, raising fears it may add to global inflationary pressures. **Eurozone manufacturing PMI** vaulted to its highest level since data collection started 24 years ago. The **UK manufacturing PMI** grew for a tenth consecutive month. **OPEC and a group of other big oil producers** agreed to add about 350,000/bbls. a day in production starting in May.

STEEL: DEMAND FOR STAINLESS STEEL CONTINUED STRONG in March led by the automotive and appliance sectors which, along with low inventories and extended lead times, has supported two mill base price increases since December. The market expects a third increase soon. **The Metal Service Center Institute** reported inventories going into March were 12.7% below February 2020 levels. Although the LME nickel price has recently declined, the drop's effect on the April surcharge was offset by higher chrome and scrap prices.

COMMODITIES/METALS: BOOMING ELECTRIC-VEHICLE DEMAND SUPERCHARGES LITHIUM PRICES. Lithium prices are surging, sparking concerns about limited supplies of the battery metal that is crucial to the electric-vehicle boom. Chinese prices for lithium, considered a bellwether, have soared since the start of the year. **Platinum demand** has been boosted by renewed efforts around the world to reduce carbon-dioxide emissions**. Australian iron ore exports** are expected to hit US$104 billion this year.

AEROSPACE: AIRLINES PUSH TO REDUCE CARBON FOOTPRINT WITH GREENER FUELS. Air traffic, the second biggest source of transport emissions after roads, is expected to grow more than threefold by 2045. Under pressure to reach net-zero greenhouse gas emissions by 2050, airlines are experimenting with sustainable aviation fuels (SAF). Only biofuel is in use today, but a promising new technology is **e-fuels, or power-to-liquid fuels**, which use renewable energy such as solar and wind to split water into hydrogen and oxygen (electrolysis). To make fuel, the hydrogen is then combined with carbon monoxide created from captured carbon dioxide**.**

AUTOMOTIVE: VW EXPANDS EV OFFENSIVE WITH PLANS FOR SIX BATTERY FACTORIES. The automaker revealed the latest part of its plan to lead in electrification: building **six new battery factories** across Europe to be in operation by 2030. Each factory will have a capacity of 40 gigawatt-hours. VW also plans to invest in its charging networks around the world, including building another **3500 Electrify America fast chargers** in North America in 2021, along with increasing the number of charging stations from 560 to 800.

STAINLESS STEEL/MEDICAL: ONE GRAM OF NICKEL CAN KEEP YOUR GLASSES FROM FOGGING UP. Using a fine nickel containing stainless steel strip keeps masks fitting snugly on medical professionals and frontline workers who wear glasses and need to see clearly at all times. In addition to its ease of sourcing and the absence of any allergic reactions, the stainless steel strip can be recycled along with the other materials that constitute the mask. Quite an achievement for barely **one gram of nickel containing stainless steel!**

SPECIALTY MATERIALS: NITINOL+ TIRES THAT ARE SUPERELASTIC, AIRLESS AND NEVER GO FLAT. The startup SMART Tire Company, in partnership with NASA, has developed a superelastic tire technology that uses a shape memory alloy (SMA). The airless, non-pneumatic tire design was originally envisioned for Martian and lunar rovers. Made from a special advanced material, **NiTinol+**, the METL tires can travel safely over rocky and sandy terrain. Shape memory alloys are capable of undergoing significant reversible strain (up to 10%), enabling the tires to withstand an order of magnitude more deformation than other non-pneumatic tires.

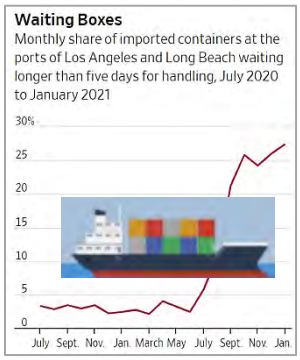
INNOVATION/ENERGY: STARTUP JOINS RACE TO MAKE GREEN HYDROGEN CHEAPER. An Israeli startup joined the race to make cheap green hydrogen after securing investments from funds backed by Microsoft founder Bill Gates and Hong Kong billionaire Li Ka-shing. As governments and industries get serious about cutting greenhouse gas emissions, demand has grown for **hydrogen produced by splitting water using renewable electricity** as a potential carbon-free fuel to replace coal, oil and natural gas.

THE AMERICAS

- **U.S. employers** added 916,000 jobs in March. Hiring was led by a gain of 280,000 in the category that includes restaurants and hotels. Employment also rose sharply in construction, manufacturing and government. Temporary help and auto manufacturing were weak spots. The unemployment rate fell to 6.0% from 6.2%. Considerably more job seekers entered the labor market in March.
- **U.S. consumer confidence** rose in March to its highest level since the pandemic started, with Americans expressing more optimism about business and labor-market conditions in the coming months. The Conference Board consumer confidence index increased to 109.7 in March from 90.4 in February. The reading marked the third-consecutive monthly increase. Despite recent gains, the index remains below the pre-pandemic level.
- **U.S. retail sales** fell more than expected in February amid bitterly cold weather across the country, but a rebound is likely as the government disburses another round of pandemic relief money to mostly lower and middle-income households. Retail sales dropped 3.0% in February. The decrease was led by motor vehicles, with receipts at auto dealerships dropping 4.2%. Consumers cut back spending at restaurants and bars, leading to a 2.5% drop in receipts.
- **U.S. consumer prices** increased 0.4% in February. Gasoline prices jumped 6.4%, driving more than half of the overall increase, while electricity and natural gas prices rose 3.9%. New-vehicle prices were flat and used-vehicle prices fell for the fourth-straight month. Apparel and medical care costs both fell. The core price index rose 0.1% in February from January and was up 1.3% from the same month in 2020.
- **The U.S. trade deficit** widened 4.8% to $71.1 billion in February, the largest on record. A 2.6% decline in U.S. exports to $187.3 billion caused the trade deficit to balloon. U.S. imports also declined, dropping 0.7% to $258.3 billion. ***Key Update:*** *Economists expect the U.S. trade deficit to remain high as its economy recovers faster than in other parts of the world, boosting American imports. The IMF revised its 2021 growth forecast for the U.S. from 5.1% to 6.4%, a much faster pace than 4.4% for the euro area and 3.3% for Japan.*
- **U.S. import prices** rose 1.3% in February, excluding tariffs. after surging 1.4% in January. For the 12 months through February, import prices accelerated 3.0%. Oil prices have recovered to pre-pandemic levels amid expectations of a pick-up in global economic growth, but the pandemic is causing disruptions to the supply chain and is boosting prices of many commodities, including oil.
- **The U.S. economy** grew at an annual rate of 4.3% in the final three months of 2020, slightly faster than previously estimated. That was a sharp deceleration from the record 33.4% rate logged in the 3rdQtr. After-tax corporate profits were weak in the last quarter of 2020, contracting at a 1.7% rate after accelerating at a 36.1% pace in the third quarter. ***Key Update:*** *In March, economists surveyed by IHS Markit forecast that real GDP in the 4thQtr will reach a rate of 6.3% annualized. Meanwhile, the Federal Reserve projected GDP will reach 6.5% in the final quarter of this year.*
- **Durable goods orders** fell 1.1% in February as U.S. factories faced supply-chain challenges. Most of the major categories of durable goods declined, led by motor vehicles and parts orders which plunged 8.7%. The previous nine months had recorded gains, following sharp declines last March and April early in the pandemic. New durable goods orders have risen 3.2% over the year and nearly 88% of manufacturers were positive about their company's outlook in the latest NAM survey of manufacturers, a two-year high.

- **U.S. manufacturing activity** soared to its highest level in more than 37 years in March, driven by strong growth in new orders, the clearest sign yet that a much-anticipated economic boom is probably underway. The ISM index of national factory activity jumped to a reading of 64.7 in March from 60.8 in February. A reading above 50 indicates expansion in manufacturing, 11.9% of the U.S. economy.
- **Factory orders** fell 0.8% in February, weighed down by unseasonably cold weather, including winter storms in Texas and other parts of the densely populated South. Factory goods orders in February were held down by declines in demand for machinery, computers and primary metals. Orders increased 1.0% on a year over-year basis.
- **U.S. industrial production** fell 2.2% in February, pulled down by manufacturing production (-3.1%) and mining output (-5.4%). Mining, which includes oil and gas extraction, was key here. Utilities production rebounded by 7.4% as the cold weather increased demand for heating. Capacity utilization fell to 73.8% from 75.5% in January.
- **U.S. producer prices** increased 0.5% in February, the biggest advance since December 2009. A 6.0% jump in the cost of energy goods accounted for more than two-thirds of the broad-based rise. In the 12 months through February, the PPI surged 2.8%, while the core PPI increased 2.2%.

- **U.S. service sector activity,** according to IHS Markit's index, rose to 60.4 in March from 59.8 in February, the strongest expansion in the service sector in 11 years. New orders rose sharply. The rate of input price inflation was the sharpest since data collection began in late-2009.
- **The U.S. Leading Economic Index** rose 0.2% in February after a 0.5% increase in January. The Conference Board said that the full impact of widespread vaccinations has not yet been seen in the data and that weather effects in the month were likely temporary, so the leading index is likely to advance in the coming months.
- **A record-low number of homes** on the market was the key reason why existing home sales dropped 6.6% in February from January to an annual rate of 6.22 million. There were 1.03 million homes for sale in the U.S. at the end of February, unchanged from the revised January level, which was the lowest since 1982. The inventory was down 29.5% from February 2020. The median existing home price rose 15.8% from a year earlier to $313,000. New home sales plunged 18.2% to an annual rate of 775,000 units. Housing starts fell 10.3% to an annual rate of 1.421 million units.
- **U.S. household spending** fell 1% in February but is primed to pick up again with the pandemic easing and a new round of stimulus money landing in bank accounts. Spending at retailers fell 3% in February from a month earlier, largely because of the weather disruptions. Household income fell by 7.1%, after government stimulus money caused income to rise 10.1% in January.
- **U.S. household net worth** finished 2020 at the highest level on record, as soaring prices for stocks, real estate and other assets erased losses inflicted by the coronavirus pandemic and related economic downturn. Household net worth ended the 4thQtr at $130.2 trillion, up 5.6% from the 3rdQtr and 10% from the end of 2019.
- **Construction spending** in the U.S. fell 0.8% in February to $1.517 trillion in a month that saw a number of strong snowstorms slam into some regions of the country. Residential construction slipped 0.2% from the month before. Single-family homes ticked up 0.1%, but multifamily building fell 1.4%. Spending on educational public projects fell 3.2%, while highway construction was down 0.6%.
- **Steel imports into the U.S.** were 1.888 million tons in February, including 1.424 million tons of finished steel, down 22% and up 15% respectively vs. February 2020. Total steel and finished steel imports through February were down 7.5% and 11.1% respectively from the same period in 2020. Finished steel import market share was estimated at 17% over the first two months of 2021.
- **Logjams at U.S. ports** are spreading beyond Southern California's choked gateways and shipping officials are projecting the backups will continue into the summer. The delays that started building up late last year have grown during a normally slack period in shipping demand, tying up inventories for weeks as ships wait to reach berths, while offloaded containers sit for long periods at packed freight terminals. Delays have stretched from docks to rail yards, truck terminals and distribution centers, rattling supply chains for companies from big auto manufacturers to small retailers.



- **The American Iron and Steel Institute (AISI)** applauded the Administration's infrastructure revitalization plan, a.k.a. *The American Jobs Plan*. The AISI statement said that every billion dollars in infrastructure spending requires about 50,000 tons of steel, and each trillion dollars invested in infrastructure has the potential to create 11 million jobs in the U.S. economy over the next decade.

  Key Update: *AISI prefers infrastructure funding through a dedicated user fee rather than corporate income tax. AISI advocates for bolstering the user fees to fund the Highway Trust Fund and other infrastructure funding mechanisms to provide the needed certainty in terms of funding for states to implement long-term steel-intensive infrastructure projects.*
- **Stainless steel demand** in March continued strong from the automotive and appliance sectors which, along with low inventories and extended lead times, has supported two mill base price increases since December. The market expects a third increase soon. Surcharges also increased, raising March mill prices by 8¢ to 10¢/lb. Mill lead times are out 3 to 4 months. The Metal Service Center Institute reports inventories going into March were 12.7% below February 2020 levels. Although LME nickel price has declined, the drop's effect on the April surcharge was offset by higher chrome and scrap prices.
- **The ATI strike** continues from March 30th which further causes supply issues for many stainless customers. ATI plans on operating with non-union and salaried personnel shortly. The union charges unfair labor practices. Late last year, ATI announced plans to exit the standard stainless steel sheet market by mid-2021, so stainless buyers already had to develop alternative plans. The current ATI strike presents another serious source of disruption for buyers.

- **What happens to steel service center owners** after they retire? It's fairly common for steel industry retirees to repair to golf courses and vacation homes in Florida or the Carolinas. In the case of Roy Berlin, the former owner of Berlin Metals, he has turned (or more accurately returned) to his first career of photography. Many of Ulbrich's readers may know that Roy developed the monthly *Berlin Global Briefing*, along with this writer. We worked on the monthly report together for almost 20 years. Roy's passion for photography reassures us that, "There is life after steel." Part of his collection of over 50 years of photographs can be seen on his website, www.royberlin.com.

- **Steel mills** in the U.S. shipped 7.420 million tons of steel in January, a 5.3% increase from the previous month but a 13.1% decline from the 8.535 million tons shipped in January 2020. (See **Appendix: Steel**, page 14)
- **Intel Corp.** will more aggressively outsource some chip production while doubling down on its own manufacturing with a $20 billion spending commitment for new plants. To underpin those ambitions, Intel plans to build two new chip factories at existing facilities in Arizona, with production due to start there in 2024. Intel will detail further expansion plans in the U.S., Europe and elsewhere later this year.
- ***Key Update:*** *Concerns about the robustness of the U.S. chip industry have grown in Washington over recent years as semiconductor production shifted to Asia. Those worries intensified in recent months amid a global component shortage. Car makers, in particular, have felt the impact, causing them to idle some of their production capacity.*
- **The Administration's infrastructure proposal,** priced at $2.3 trillion, includes $50 billion for the American semiconductor industry. The industry's lobbying efforts have gained momentum amid a global chip shortage and fears that China might be overtaking the U.S. in a critical technology. Ford recenty said the chip shortage is forcing it to schedule more downtime at several U.S. factories.
- **Volkswagen's U.S. subsidiary** said the unit would rebrand itself as '*Voltswagen* of America' to promote its electric car strategy, but the parent company said, "*Auf keinen Fall*". The name change was originally intended as an early April Fools' Day stunt to get people talking about VW's ambitious electric car strategy. Wolfsburg was not amused.
- **LG Energy Solution** will invest more than $4.5 billion in U.S. battery production by 2025, as more automakers commit to selling electric vehicles sooner than expected. The Korean company, which has a JV with GM, said the investment will help create 10,000 jobs, including subcontractors. GM and LG are building a $2.3 billion battery factory in Lordstown, Ohio, that will employ 1,000 people when completed in 2022. The site is fairly close to GM's two other designated EV plants in Detroit and in Orion Township, Michigan. The companies hope to have a decision on a second site in the first half of 2021. (See **Appendix: Automotive**, page 12)
  Key Update: *The consulting firm LMC Automotive predicts that U.S. battery powered vehicle sales will exceed 1 million annually starting in 2023 and exceed 4 million by 2030.*
- **U.S. auto sales** rose 11.3% in the first quarter. The industry's annualized selling pace in March hit 16.8 million vehicles, a sign that the level of demand is about on par with what it was before the COVID-19 pandemic.
- **Toyota, Honda and GM** complained about supply chain setbacks, saying they would halt production at plants in North America. Toyota cited a shortage of petrochemicals, manufacturing of which has been hobbled by February's Texas freeze. Honda pointed to a combination of port delays, the semiconductor shortage, pandemic-related problems and the crippling U.S. weather. Ford and Stellantis said they would partially assemble and park their large pickups to finish later when chip supplies allow.
- **Southwest Airlines** is buying 100 new Boeing 737 MAX 7 jets, the smallest MAX variant. The order means Boeing will retain its lock on one of its most important airline customers. Southwest's fleet is made up entirely of 737 jets, but the carrier had been re-evaluating that strategy.
- **NASA** completed an 8-minute test of the four RS-25 engines on a Boeing-built rocket for Artemis missions that aims to return U.S. astronauts to the moon by 2024. The hot fire was the final test of the series to ensure the core stage of the SLS rocket is ready to launch missions to the moon. Artemis I is scheduled in November to orbit the moon with an uncrewed spacecraft but that date is likely to change. Elon Musk's SpaceX and Jeff Bezos' Blue Origin are racing to send their own crewed missions to space for the first time.
- **The number of U.S. air passengers** continues to rebound from a pandemic-related drop. TSA screened 1.54 million people on March 21, the highest single day since March of 2020, and the 11th consecutive day of volume exceeding one million per day. U.S. airline passengers screened dropped 60% in 2020. Despite the recovery, volume is still only about half of what it would normally be this time of year.

- **Lockheed Martin and Omnispace** struck a strategic deal to jointly develop 5G network capability from space that has the potential to offer mobile communications regardless of environment or location. The non-terrestrial network will leverage Omnispace's priority 2 GHz S-band spectrum rights to enable direct-to-device connectivity and interoperability. The network would also provide the coverage and capacity to support essential applications requiring seamless global communications. (See **Appendix: Aerospace**, page 8)

- **Lockheed Martin and Northrop Grumman,** instead of Boeing, were selected to compete to provide a new system aimed at downing long-range missiles fired by adversaries, estimated to cost $12 billion. The Pentagon is revamping the Boeing-developed silos in California and Alaska designed to shoot down missiles. The Defense Dept. has already spent more than $50 billion on the long-delayed program, with the next stage including the fielding of 20 Next Generation Interceptors by the end of the decade.

  Key Update: *Boeing has led the Pentagon's domestic missile-defense program for more than two decades. Its elimination from the opportunity to provide a replacement system to intercept and destroy threats highlights the fierce competition for a shrinking band of big programs. Lockheed Martin and Northrop Grumman are both growing at a faster clip, with an expanding pipeline of orders.*

- **Berkshire Hathaway** offered Texas lawmakers a plan to spend $8.3 billion to build power plants that would run during electricity emergencies, a month after the state suffered devastating blackouts. Berkshire Hathaway Energy Infrastructure said it could build 10 large natural-gas plants that would only operate during times of extreme need, and not otherwise compete in the state's power market. The plants could be operational by November 2023. Berkshire hopes to receive a 9.3% ROI, the same as regulated electric companies that operate a portion of the grid.

- **Global solar photovoltaic installations** are expected to grow by 27% this year to a record 181 gigawatts (GW), led by China, the U.S. and India, IHS Markit reported. Even though prices for solar PV modules are higher than last year, along with long delivery times and rising freight costs, demand should grow in the 2ndH of this year. Module prices have increased due to peaks in pricing for some materials such as polysilicon, copper and steel.

- **A priority offshore wind zone** between the South Shore of Long Island and the New Jersey coast will be designated by the Administration to accelerate a burgeoning industry that has long struggled to gain a foothold in the U.S. Officials also announced $3 billion in loan guarantees available to offshore wind projects. Separately, the White House is setting a goal of deploying 30,000 megawatts of offshore wind in the U.S. by 2030 — a goal it claimed will create about 75,000 jobs — and devoting funding already approved by Congress to develop port infrastructure and transmission.

- **The American Petroleum Institute** has indicated it will push Congress for legislation to price carbon emissions across the economy, in a sharp policy turnabout a decade after the industry helped kill a similar effort to address climate change. The API called for a wide-ranging plan to lower the emissions blamed for global warming. It backs increasing government and industry collaboration, seeking to preserve a role for oil companies to solve a problem it says requires "continuous innovation." The plan supports a price on carbon dioxide that every emitter must pay but doesn't back any specific action such as a tax. It also calls for more federal research funding, federal regulation on methane emissions and improved industry efforts to track and reduce emissions.

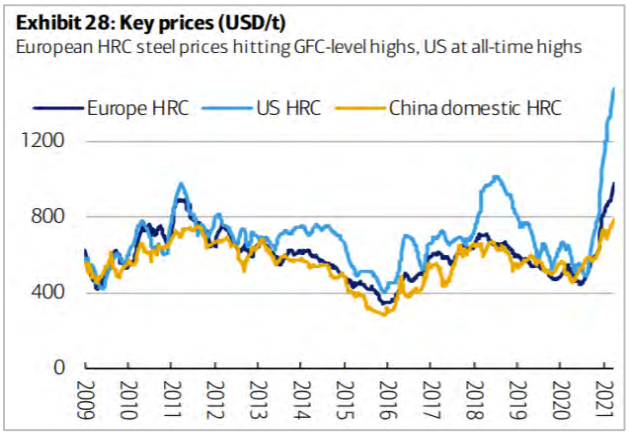
- **The Department of Defense** awarded a $231.8 million to Australia's Ellume to expand U.S. production of a rapid at-home test for COVID-19. Ellume's product, the first over-the-counter self-test for COVID-19 to receive FDA emergency use authorization, was developed with a $30 million contract from the NIH's Rapid Acceleration of Diagnostics (RADx) initiative.
  (See **Appendix: Medical**, page 13)

- **Boston Scientific** will pay $188 million to 47 states and D.C. to settle allegations that it deceptively marketed transvaginal surgical mesh devices to patients by failing to disclose the full extent of risks and complications associated with the products. The settlement follows last year's judgment against J&J for deceptive marketing of mesh devices.

  Key Update: *Surgical mesh is still authorized for use in treating urinary incontinence and for transabdominal procedures to repair pelvic organ prolapse. FDA asserts that the benefit-risk profile of those treatments remains favorable. However, most manufacturers chose to exit the market after FDA began mandating post-market surveillance studies in 2012 to address safety and effectiveness concerns.*

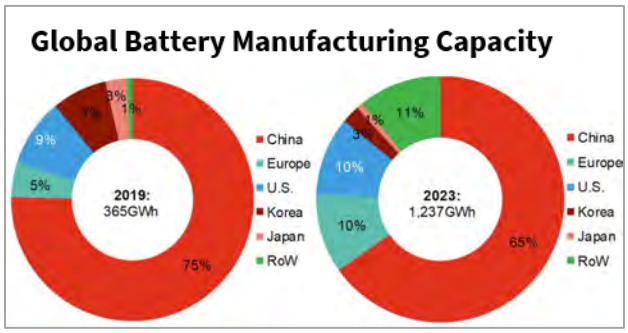
EUROPE, AFRICA & THE MIDDLE EAST

- **Eurozone manufacturing PMI** soared to 62.5 in March from 57.9 in February, the highest level since data collection started nearly 24 years ago. The UK manufacturing PMI index grew for a tenth consecutive month to 58.9 in March.
- **ArcelorMittal** will offer "green certificates" to customers willing to pay a premium for low-carbon steel. MT will launch a fund that aims to invest $100M annually to support breakthrough technologies to curb carbon emissions from steelmaking. The certificates represent emissions savings achieved through projects (e.g., reducing coal use in blast furnaces) compared with the average CO^2 intensity of European steelmaking, allowing customers to report a reduction in their own emissions. The company, which ships 70-80M tonnes/year of steel, expects to certify 600,000 tonnes of available green steel by the end of 2022.
- **ArcelorMittal** increased hot-rolled coil prices to US$1,060/mt across Europe for Sept. and Oct. delivery. The latest increase, the third in March and just one week after the last one, comes on the back of an unprecedented price rally that has seen the Platts daily HRC assessment hitting an all-time high of €830/mt EXW Ruhr March 25.



Key Update: *Lead times continue to be unusually long amid the supply shortage that is gripping Europe. Supply and demand have been out of balance since the 3rd Qtr of 2020. A demand surge after pandemic-related closures outpaced mill ramp ups as they battled technical problems and growing order backlogs. (See* ***Appendix: Steel****, page 14)*

- **The fallout** from one of the world's largest container ships getting stuck in the Suez Canal has disturbed commodity markets and damaged an already distressed global supply chain. Shipping worldwide will be snarled for months, according to logistics experts. About 12% of world trade by volume passes through the Suez Canal, including large volumes of crude oil and natural gas.
- **Volkswagen** announced a shift in strategy that would see it take control of battery production and high-speed charging networks. The first step is increasing its stake in its partnership with Northvolt, the Swedish battery startup in which VW took a 20% stake in 2019. VW will order an additional $14 billion worth of batteries from Northvolt through 2030.
(See **Appendix: Automotive**, page 12)

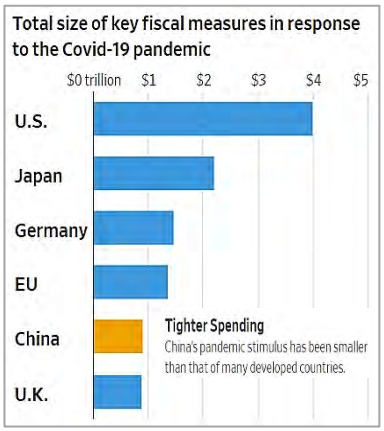


Key Update: *The world's auto industry is pivoting to EVs to meet new emission requirements and rushing to establish the vast infrastructure—from battery factories to charging networks—needed to sustain the growing market.*

- **OPEC and a group of other big producers** led by Russia agreed to add about 350,000/bbls a day in production, starting in May and expand that loosening over the next three months, betting on a return of demand as COVID vaccinations roll out around the world. The agreement was a compromise between Saudi Arabia and Russia. Saudi Arabia sought to maintain current output levels, wary that the pandemic's ebb and flow could still threaten demand.
- **The European Union** wants to produce a fifth of the global output of cutting-edge semiconductors by 2030 and make its first quantum computer in five years as part of efforts to cut its dependence on non-European technologies. The EU plan, *2030 Digital Compass*, calls for investing in quantum technologies for developing new medicines and to speed up genome sequencing. It advocates 10,000 climate-neutral facilities to help Europe develop its own cloud infrastructure and the doubling of €1B valuation firms.
- **German technology group Bosch** will open a €1 billion automotive chip factory in Dresden that will produce sensor chips for electric and hybrid electric vehicles. The plant will not produce all of the kinds of semiconductor chips now in short supply and causing disruptions to the global car industry, but it will make only application-specific integrated circuit microchips.
- **The French government and the EU** are close to an agreement on the terms of a bailout for Air France, which has been hammered by the coronavirus pandemic. The Air France-KLM group recorded a €7.1 billion net loss for 2020.

ASIA/PACIFIC, JAPAN, AUSTRALIA & INDIA

- **Chinese economic activity data** released in March showed industrial production, consumption, investment and home sales in January and February all surging by more than 30% from a year ago, when the Chinese economy was largely shut down to contain the coronavirus. In addition, China's exports have jumped more than 60% in the first two months of 2021. China is now taking the global lead in unwinding its pandemic-driven economic stimulus efforts. China has started restraining credit in some areas of the economy.



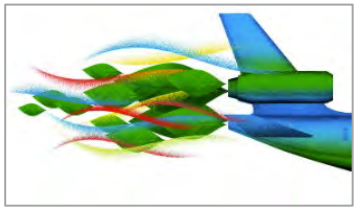
- **Rising raw-materials** costs and unrelenting supply-chain constraints are prompting many Chinese exporters to increase prices for the goods they sell abroad, raising fears it may add to global inflationary pressures. Shipping rates, which soared in recent months amid port bottlenecks and container shortages, are part of the problem. Prices for imports from China to the U.S. rose 1.2% over the past year, the fastest increase since 2012, with most of the increase coming in the three months ending in February. Some economists worry that the trillions of dollars of stimulus unleashed world-wide will ultimately lead to more inflation than policy makers anticipate.
- **Japan's government** in March slashed its assessment of exports for the first time since May, citing a slowdown in car exports, which showed signs of flattening out after manufacturers front-loaded shipments ahead of an expected recovery from the health crisis, especially in the U.S. Analysts expect Japan's economy to shrink sharply in the 1stQtr, as the emergency that ended at the start of April weighed on business activity and consumer spending, followed by a rebound of an annualized 5.3% in the 2ndQtr.
- **Global crude steel production** was 150.2 million tonnes MT) in February, a 4.1% increase compared a year ago. China produced 83 MT of crude steel, an increase of 10.9% on February 2020. The United States cast 6.3 MT of crude steel, a decrease of 10.9% vs. the year prior. India's production was 9.1 MT, down 3.1%. Japan produced 7.5 MT, down 5.6%. South Korea made 5.5 MT, up 1.2% percent.
(See **Appendix: Steel**, page 14)
- **The International Stainless Steel Forum (ISSF)** has released figures for the full year 2020 showing that stainless steel melt shop production decreased by 2.5% YOY to 50.9 million tonnes. China's production was 30.139 million tons or 59% of the world's total stainless output. U.S. production was 2.144 million tons, down -17.3% from 2019.
- **China's auto sales** quadrupled to 1.18 million vehicles in February compared with last year, reflecting the low sales then as many cities were locked down and factories and dealerships were shut. In February 2021, 97,000 electric cars were sold, a sevenfold increase from a year earlier. Since 2020, China has been offering various subsidies and incentives to help boost car sales. In recent months, Chinese regulators have announced more measures, including further relaxing vehicle-purchase restrictions and building more charging facilities for electric cars.
- **A fire at a factory** of one of the world's leading auto chip makers has added to the troubles of car makers that already have slashed production because of a semiconductor shortage. The fire left a swath of charred equipment in the factory owned by a subsidiary of Renesas Electronics in Hitachinaka, northeast of Tokyo. The company said it will take 3-4 months to restart the damaged operations and the impact on global chip supplies will be significant.
- **Mining executives and industry analysts** say that renewed efforts around the world to reduce carbon-dioxide emissions are also boosting demand for platinum. Hydrogen fuel-cell technology relies on platinum, which can withstand higher temperatures than other metals. A fuel cell needs platinum for the catalyst that separates hydrogen into protons and electrons, which then generate the electrical current, making it an alternative to battery-powered vehicles. Hydrogen fuel cells are expected to be an important part of reducing global carbon emissions.

  Key Update: *Japan's Toyota has developed a fuel-cell system in a compact module that could be adapted easily for use in trucks, buses, trains, ships and generators. South Korea's Hyundai said it would join with European chemical giant Ineos to explore opportunities in new hydrogen technologies. Other car makers are also working on incorporating fuel cells in large vehicles.*
- **The Australian government** expects iron ore exports to hit US$104 billion this year as global demand for steel recovers after the COVID-19 slump. Iron ore exports are projected to earn more than US$76 billion for each of the next five years. China has boycotted a range of Australian imports, but it remains reliant on Australia's iron ore.
(See **Appendix: Commodities**, page 15)

ECONOMIC UPDATE: APPENDIX TO THE APRIL 2021 ISSUE

AEROSPACE: AIRLINES PUSH TO REDUCE CARBON FOOTPRINT WITH GREENER FUELS

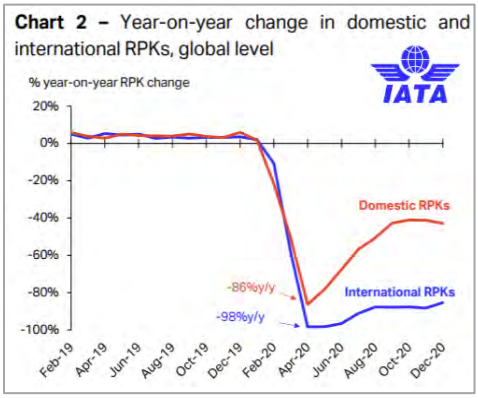
Aviation accounts for 3.5% of the world's human-made greenhouse gas emissions. Air traffic, the second biggest source of transport emissions after roads, is expected to grow more than threefold by 2045. Under pressure to reach net-zero greenhouse gas emissions by 2050, airlines are experimenting with so-called sustainable aviation fuels (SAF). Different types of SAF exist, but only biofuel is in use today. Biofuel reduces emissions by up to 80% versus conventional jet fuel. International standards allow carriers to burn up to 50% biofuel with kerosene. **From 2016 to 2020, roughly 300,000 out of around 188 million total flights world-wide used SAF—less than 0.2%. Still, industry experts say they are key to cutting aviation's environmental footprint.**



United Airlines, which is aiming to get to net-zero emissions by 2050, first used biofuel in 2009 and started using it regularly in 2016. It used only 4 million gallons in the last five years, compared with the 4 billion gallons of conventional fuel the airline uses in an average year. Biofuels cost up to four times more than conventional jet fuel. It is not feasible to replace all kerosene jet fuel with biofuel because of the limited supply of biomass, which comes from crops such as soybeans, solid waste such as leftover food and unused timber such as wood pellets. In the U.S., there are only around 340 million tons of biomass available, but biofuel requires several 100 million tons alone to power planes, as demand for more jet fuel picks up in the coming decades. Still, there is momentum for biofuel to help make aviation cleaner. Microsoft signed a deal late last year with Alaska Airlines and SkyNRG, a Netherlands-based maker of biofuel, to use it on some of its frequent business-travel routes. Shell, one of the world's top suppliers of biofuel, took a 40% stake in a plant in Quebec this year that will turn 200,000 metric tons of non-recyclable waste and wood waste a year into biofuel. Late last year, it signed deals with Amazon and DHL to provide SAF for their cargo planes. Another promising technology on the horizon is e-fuels, or power-to-liquid fuels, which use renewable energy such as solar and wind to split water into hydrogen and oxygen (electrolysis). To make fuel, the hydrogen is then combined with carbon monoxide created from captured carbon dioxide**. This fuel is seen as more promising to decarbonize the aviation industry because it would offer an unlimited supply.** Lufthansa signed a letter of intent with the refiner Heide to make and purchase power-to-liquid jet fuel. The project will use wind energy from the North Sea. Within five years, the carrier expects to replace 5% of the kerosene it uses with power-to-liquid fuel. Shell predicts costs for e-fuels will fall much like wind and solar as production scaled up, and that they can play a major role in the decarbonization of aviation from 2030 onward. Massive government aid through taxes, incentives and subsidies is needed to bring down the costs of SAF and scale production, aviation experts say. Biofuels compete with much cheaper fossil fuels that have enjoyed $4.4 trillion in government subsidies over the past decade, according to the International Energy Agency.

AEROSPACE: AIR TRAVEL PLUMMETED DURING THE COVID-19 PANDEMIC

The commercial air travel industry took a hit in 2020 because of the pandemic-induced travel restrictions that began early last year. **According to the International Air Transport Association (IATA), COVID-19 was the most drastic hit to the industry since WW II.** To measure air traffic, IATA uses the industry-wide metric revenue passenger kilometers (RPK). The RPK value is calculated by taking the number of revenue-paying passengers and multiplying that by the total distance traveled. In 2020, RPK dropped by 66%—the steepest yearly decline in aviation history. **As a result, the global aviation industry reported an estimated net loss of $118.5 billion.** International air travel was hit much harder than domestic travel in 2020. RPK for the worldwide international market fell 75.6%. In April of 2020, when strict lockdowns limited travel to the greatest extent, international RPK was down 98% YOY. In contrast, domestic RPK only dropped by 48.8% in 2020. In terms of regional markets, Asia Pacific saw the largest decrease in RPK, with a decrease of more than 80%. On the domestic side of things, Australia saw one of the steepest drops in RPK, at 69.5%. This makes sense, given the country's relatively strict COVID-19 restrictions and regional lockdowns. The U.S. domestic drop in air trafic was 59.6%. While 2020 was a tough year, the future of aviation looks promising according to IATA. For example, China's domestic market showed a negative correlation between new COVID-cases and RPK. When cases were down, RPK increased drastically, showing that there's pent-up demand. Once the virus is eradicated and restrictions are lifted, IATA expects flight activity worldwide to bounce back, as in China.



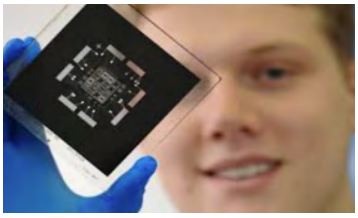
INNOVATION: TECHNOLOGY TRENDS ACCELERATING ADVANCED MATERIALS DESIGN IN 2021

Designing advanced materials has historically required a significant amount of patience. Professionals in some creative and scientific fields can see the results of their work right before their eyes, but material engineers have always needed to wait for their designs to be manufactured and then tested to see if a new material's performance will meet expectations**. Recently, several emerging technologies are letting material engineers more freely tinker and iterate to see results from their work much more rapidly.** As a result, designers and engineering teams developing advanced materials can test out more ideas and discover more solutions to pressing problems faster than ever. Here are five of those emerging game-changing tech trends for advanced materials designers.

Machine learning and artificial intelligence. The rise of machine learning (ML) and artificial intelligence (AI) is probably the single most significant development in the field of advanced materials design over the past decade. ML algorithms simply make materials design much more intuitive than before. They let material engineers make a design change and get immediate feedback about how that new material performs. Meanwhile, AI is helping designers make discoveries that lead to design changes for materials. As humans, we can observe natural phenomena, develop mathematical models to explain them and eventually try to replicate them in the materials design process. But AI tools essentially eliminate the intermediary step and uncover physical laws and solve problems without ever having to work out the equations. This technology is revolutionizing sectors like biology and medicine, and it will have an increasingly significant impact on the materials design field in the coming years.

Cloud computing. Advanced materials design requires some serious computational power, the type of computing power that until recently was largely only accessible in research labs. Today, the public cloud lets researchers spin up vast resources on a temporary basis, paying only for what they use. The benefits of the cloud are on full display at MIT, for example. Although students cannot travel to the MIT campus, they can still write and run code in the cloud directly from their browsers. When people write their first algorithm, it is often a point of great pride. It is made possible thanks to widely accessible (and simple) cloud computing.

Nanoengineering. The advent of nanoengineering, in which engineering is done on the nanoscale, has let engineers improve the internal structure of materials. Through this process, they can more accurately mimic properties of extremely strong natural materials, such as spider's silk. Nanoengineering works on a scale so small it is hard to fathom. To illustrate just how small, the difference in scale between a nanometer and a meter is similar to the difference between a child's marble and the entire earth. It's as though material engineers now have a huge canvas to work with, and until now they've only been using 1% or less of it. Nanoengineering opens up the other 99%.



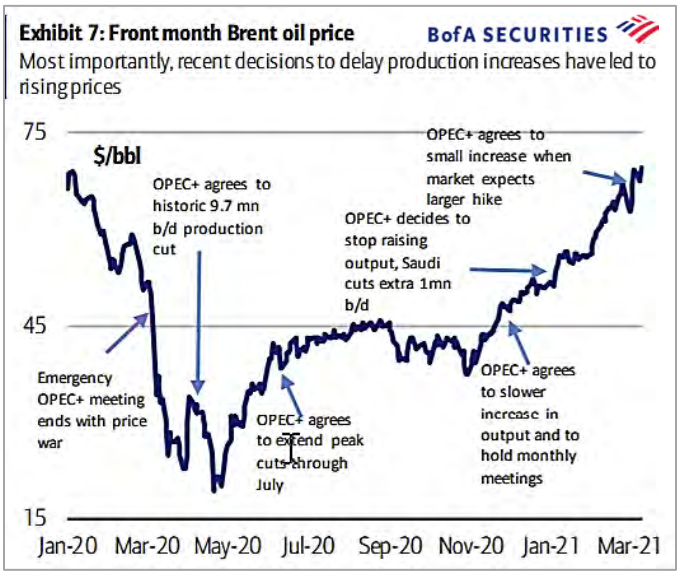
Augmented reality. Usually, augmented reality (AR) refers to overlaying digital information onto the real, physical world. For example, by downloading an app from a furniture company, consumers might be able to point a smartphone at parts strewn around the living room floor and receive assembly instructions. In a different type of AR, material engineers can design a new material and then see the actual forces and the effect they will have on the material pop up on a computer screen. Technically, this is digital information being overlaid onto other digital information (rather than onto the real world), but the effect on designers is like that of more traditional AR programs.

3D printing. Finally, the growth of high-fidelity, micro-level 3D printing puts the "materials" in "materials design." Rather than waiting weeks to see designs brought to life via manufacturers' prototypes, engineers can use 3D printers from their labs (or, depending on their budget, even from their basements) and see real-world results of their efforts in nearly real time. For people without ready access to a 3D printer, companies like Amazon are now offering 3D printing as an on-demand, "as-a-service" option. Although mainstream 3D printing hasn't quite reached the nanoscale, many 3D printers on the market let designers print on a scale of tens of micrometers. More expensive machines are operating on the microscopic level and expected to reach nanometer resolutions soon. In other words, today's technology lets designers print what they can and *cannot* see. The combination of AI and AR lets humans for the first time interactively design at the "ultimate" scale of atoms. Taken together with the other tech trends mentioned, it greatly expands what is possible for advanced materials designers.

INNOVATION/ENERGY: GATES-BACKED STARTUP JOINS RACE TO MAKE GREEN HYDROGEN CHEAPER

Israeli startup H2Pro joined the race to make cheap green hydrogen after securing investments from funds backed by Microsoft founder Bill Gates and Hong Kong billionaire Li Ka-shing. **As governments and industries get serious about cutting greenhouse gas emissions, demand has grown for hydrogen produced by splitting water–using renewable electricity–as a potential carbon-free fuel to replace coal, oil and natural gas.** H2Pro recently raised $22 million to move its technology from the lab to the factory floor. Japan's Sumitomo Corp and automaker Hyundai Motor Company also invested. Hydrogen will likely be a crucial part of decarbonizing industries like steel and cement, and possibly shipping and aviation — given the limits of current battery technology. However, until now green hydrogen hasn't been widely adopted because it's quite expensive to produce. "We definitely see a worldwide market for these devices," said Talmon Marco, H2Pro's CEO. "When we started the company back in 2019, it was much more difficult to have a conversation with investors about hydrogen, but today it's like,'Oh, yeah, absolutely. Hydrogen is happening.'" H2Pro's technology is similar to the alkaline electrolyzers that are most commonly used today to make green hydrogen but with a crucial twist. When water is split, the current process uses electrical energy not just to break the hydrogen and oxygen atoms apart, but also to pair two hydrogen atoms and two oxygen atoms, respectively, to make the separate gases. H2Pro reduces that energy use by splitting the step in two. First, it creates hydrogen at the electrolyzer's cathode. The chemical reaction also changes the composition of its nickel-based anode. The cell is then flooded with a hot liquid, which helps the anode release oxygen gas with the help of thermal energy instead of electrical power, before the first step can be performed again. By tweaking the current methodology, H2Pro says it will be able to make green hydrogen for $1 per kilogram by the second half of this decade. That's far cheaper than current projections by clean energy research group BloombergNEF, which doesn't expect that low a price until 2050. A kilo of green hydrogen cost $2.50 to $6.80 in 2019. Tifenn Brandily, a hydrogen analyst with BNEF, said the $1 per kilo goal was highly ambitious, though he was impressed with H2Pro's technology.

ENERGY: AFTER THREE SHOCKS, U.S. SHALE IS LESS SENSITIVE TO OIL PRICES



OPEC+ surprised the market in March by withholding crude production, pushing oil prices even higher. BofA SECURITIES' recent analysis shows that the sensitivity of U.S. shale output to a 1% increase in oil prices has halved in the past 5 years. In other words, after three price crashes in 2016, 2018 and 2020, the data suggests that U.S. shale producers are becoming more disciplined. **The OPEC+ strategy is working, as decisions to delay production since December have led to rising oil prices. Saudi Arabia is in the driver's seat in the global oil market again.** Other OPEC+ members do not need much convincing to hold on to spare supplies. With OPEC+ fiscal oil price breakevens sitting mostly above $65/bbl and many of the oil-dependent economies in disrepair, the benefit of banding together is apparent. Another factor that keeps catching the oil market off guard is the monthly nature of the OPEC+ meetings. Members can simply jump on to their screens to make a decision on oil output levels, keeping other oil producers on their toes. In addition to supply factors, global economic activity is accelerating and mobility is ramping up as immunization programs advance. BofA SECURITIES now projects GDP growth of 6.5% in 2021 and 5% in 2022. With crude oil markets tightening globally, **BofA SECURITIES increased 2021 and 2022 oil projections toward the center of its medium-term oil price band and now forecasts Brent to average $63/bbl and WTI to average $60/bbl this year.** BofA SECURITIES sees $60/bbl Brent and $57/bbl WTI average crude oil prices in 2022, up from $55/bbl and $52/bbl in its previous forecast. Spot Brent prices won't trade much above $70/bbl. There are a number of reasons to believe that any rally in oil prices to $100/bbl will have to wait until demand recovers more broadly over the coming years, and the most intriguing reason is the growing chance of a two million barrels/day of Iranian oil coming back on the market over the next few quarters.

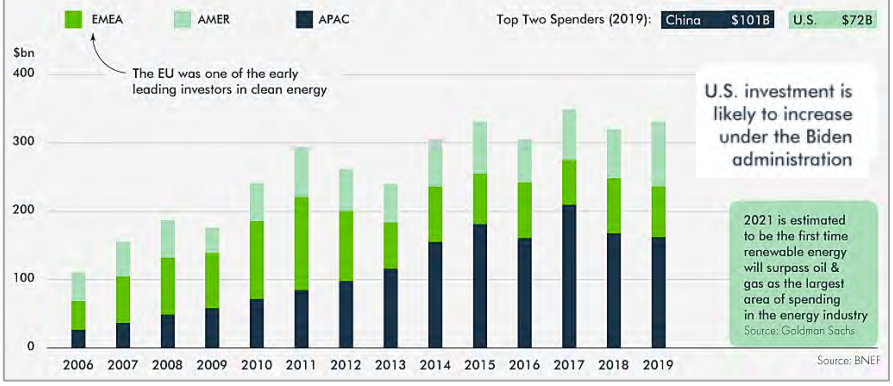
ENERGY: THE RENEWABLE ENERGY SHIFT - THE COSTS OF CLIMATE CHANGE ARE BETTER UNDERSTOOD

The Race for Renewable Energy

For investors to participate in the main trends in the renewable energy sector, it's vital to know what's already happening in energy.

With climate change set to cause an estimated **$20T** in global losses by **2100**, the race is already well underway to ramp up renewable energy use.

GLOBAL NEW INVESTMENT IN CLEAN ENERGY



More and more cities, countries, and companies are committing to emission-free programs.

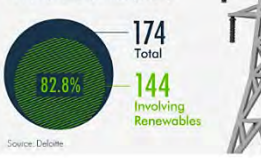
Countries legally pledged to net-zero emission targets by 2050.

Denmark · France · Hungary · Germany · New Zealand · Sweden · United Kingdom · Spain

Consumers and governments are vocal about fighting climate change, but capital markets are currently driving the energy industry's transformation:

Renewables are capturing the majority of deal activity in the power and utilities industry:

U.S. Announced M&A Deals in Power and Utilities (2021)



Source: Deloitte

Investor engagement in climate change is rising:

- **50%** Increase in climate-related shareholder resolutions since 2011
- **33%** Record resolutions voted in favour since 2011 (a 3X increase)
- **50%** Investor proposals targeting big energy producers since 2014
- **30%** Proposals targeting sectors accounting for the most energy consumption

Source: Goldman Sachs

Renewable Energy

For investors to participate in the main trends in the renewable energy sector, it's vital to know what's already happening in energy.

1

The IEA estimates that solar power has become one of the cheapest sources of electricity in history

DROPPING RENEWABLE ENERGY PRICES

Prices for renewable energy generation are dropping more rapidly than projections expected, with solar output last year being **20-50%** cheaper than original estimates.

Estimated Levelised Costs of Electricity 2019

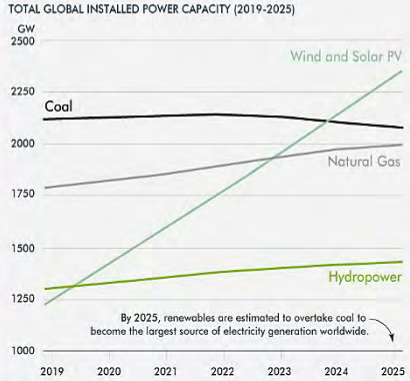
Dollars per MWh

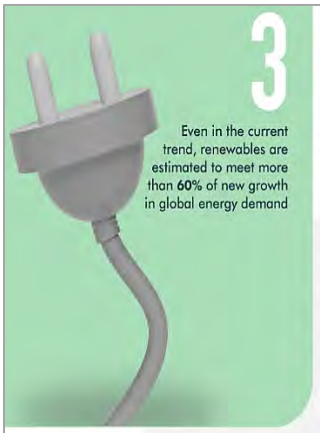
2

INCREASING RENEWABLE ENERGY CAPACITY

Alongside increasing capabilities and dropping prices, the expected rollout of renewable energy is quickening as well.

TOTAL GLOBAL INSTALLED POWER CAPACITY (2019-2025)





3

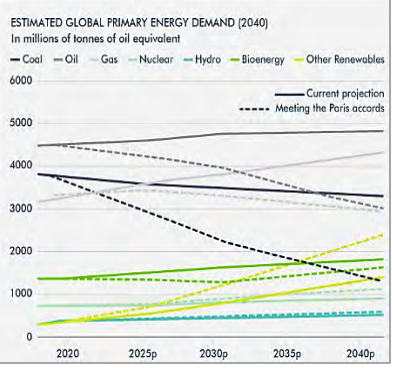
Even in the current trend, renewables are estimated to meet more than **60%** of new growth in global energy demand

DIRE FORECAST FOR RENEWABLE ENERGY NEED

The difficulties of reaching net-zero emissions and beginning to combat climate change will rely on significantly changed demand, across multiple countries and sectors.

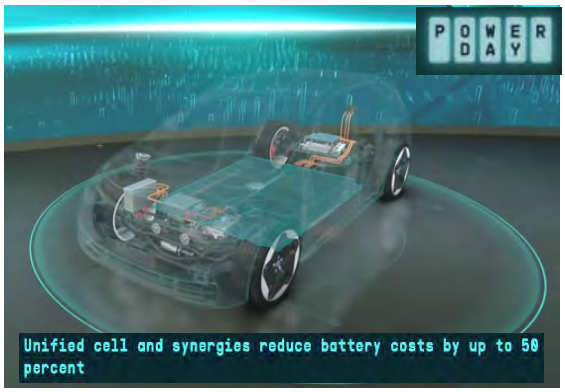
ESTIMATED GLOBAL PRIMARY ENERGY DEMAND (2040)

In millions of tonnes of oil equivalent



AUTOMOTIVE: VW EXPANDS EV OFFENSIVE WITH PLANS FOR SIX BATTERY FACTORIES

Volkswagen has been clear about its goal of leading in electrification, and at a livestreamed Power Day event, the automaker revealed the latest part of its plan to do so: building six new battery factories across Europe. The plants will all be in operation by 2030 and will each have a capacity of 40 gigawatt-hours. For comparison, Tesla claims that its Nevada Gigafactory 1 has an annualized 35-GWh rate**. VW also said it is developing a way to recycle nearly all of its battery components and to cut the price of electric vehicles by 30 to 50 percent.** VW added that it plans to invest in its charging networks around the world, including building another 3500 Electrify America fast chargers in North America in 2021, along with increasing the number of charging stations from 560 to 800. In Europe, VW is going to increase the number of chargers it operates by five times, to 18,000 total chargers. It also plans a major expansion in China. The building of battery factories is part of VW's plan to gain more control over its supply chain. The first VW gigafactory to reach the 40-GWh capacity is in Sweden and will be operated alongside Northvolt, a battery developer. The second will be in Germany and operated by Volkswagen itself; the automaker is looking for partners for the other four factories, including one to be located in Eastern Europe and one in France or Spain. The factories will help VW achieve its goal of producing one million electric vehicles a year by 2023 and 1.5 million a year by 2025. **By 2030, the German automaker aims for fully electric vehicles to reach 50% of its sales in North America.** Tesla currently operates a battery factory in Nevada with its partner Panasonic, and GM is building a battery factory in Ohio alongside LG Chem. Tesla's Nevada plant has a capacity of 35 gigawatt-hours, and GM's plant is slated to have a capacity of 30 gigawatt-hours. At the Power Day event,Volkswagen laid out plans for a new battery cell it calls a unified cell. This new design, VW says, will allow it to reduce costs for entry-level electric vehicles by 50% and for its mainstream vehicles up to 30 percent. Thomas Schmall, CEO of Volkswagen Group Components, said that the cost of the batteries will be brought down below about $119 per kilowatt-hour. VW also outlined plans beyond the battery production during the event, showing off its method of recycling batteries—in a process that VW claims reuses 95% of the battery—as well as its bidirectional charging capabilities. **VW said that its vehicles will be ready for bidirectional charging, or using your car's battery to power electronics in your home, by 2022 using a bidirectional wall box.** VW outlined such plans in 2020, but the timeline for the rollout wasn't clear.



AUTOMOTIVE: DRIVERLESS CARS COULD LEAD TO MORE TRAFFIC CONGESTION

New research from the University of Adelaide has predicted that **driverless cars could worsen traffic congestion in the coming decades, partly because of drivers' attitudes to the emerging technology and a lack of willingness to share their rides.** Using the City of Adelaide in Australia as a test model, researchers surveyed more than 500 commuters, including a mix of those who travel to work by car and public transport, and modeled the potential impacts. "Autonomous or driverless vehicles are likely to have profound effects on cities. Understanding their impact will help to shape how our communities respond to the challenges and opportunities ahead," said study co-author Dr. Raul Barreto, from the University of Adelaide's School of Economics. This multidisciplinary research—conducted by the University's School of Architecture and Built Environment, School of Economics, and the Australian Institute for Machine Learning, in collaboration with researchers from the City of Adelaide—investigated commuters' views on autonomous vehicle ownership and use, vehicle sharing and their attachment to conventional vehicles. The research team then explored potential vehicle flow, with a mix of autonomous and conventional vehicles, and land use change in the Adelaide city center under different scenarios. The findings show that Adelaide has the potential to significantly reduce the number of vehicles on the roads and improve traffic flows, however these benefits may not be achieved in the near to medium term for many reasons. The key factors affecting the transition to autonomous vehicles are commuter attitudes to car ownership and wanting to drive themselves, rather than have technology do it for them, as well as the price of new technology, and consumer attitudes to car sharing. The evidence suggests that as riders switch to autonomous vehicles, there will be an adverse impact on public transport. **With most commuters not interested in ride sharing, this could increase peak period vehicle flows, which is likely to increase traffic congestion over the next 30 years or so.** "Under both scenarios we tested, the number of vehicles overall will eventually drop. However, total vehicle trips may increase, and some of the predicted benefits of autonomous vehicles may not eventuate until a lengthy transition period is complete. Our findings have policy implications for how the transition to autonomous vehicles is managed for other cities around the world," Dr. Barreto said.

MEDICAL: HIGH-TECH FACE MASKS AIM TO STEP UP THE FIGHT AGAINST COVID-19

The face mask is getting a high-tech upgrade. Models now in testing do more than provide a physical barrier between the wearer and potential viruses. **Materials scientists, chemists, biologists and engineers have created working prototypes of masks that include diagnostics, sensors and even the ability to kill viruses.** Some of these new masks are designed for healthcare workers, while others will be marketed to both healthcare workers and consumers. Masks and respirators marketed as medical devices or as worker protection must be approved for sale by the FDA or the National Institute for Occupational Safety and Health, or Niosh. (Respirators are masks that provide a tight seal to the face, such as the N95, and must be appropriately fit to provide their ideal protection.)

A Smart, Long-Lasting N95 Respirator

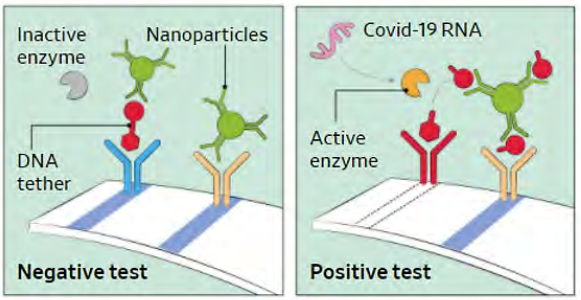
A new type of mask soon to be submitted for evaluation by Niosh remains effective for longer than many masks now being used. The mask stands up better to multiple sterilizations, including using such aggressive methods as boiling, sterilization by heat, UV treatment and isopropyl alcohol. These transparent silicon-rubber masks, which feature pop-out disposable N95 filters, are the work of a team at MIT and a gastroenterologist at Brigham and Women's Hospital, Harvard Medical School. **The masks have sensors that give feedback on fit and functionality. A heat-sensitive coating on the perimeter of the mask indicates a fit to the skin by changing color from black to pink.** In testing, all wearers achieved a proper protective fit and only 5% said they preferred the standard N95 hospital-supplied mask. Users said they also appreciated that the mask's transparency enabled them to communicate better through reading lips and facial expressions. Teal Bio, which plans to manufacture the respirators in the U.S., anticipates the product will be available to purchase this year at a price that is competitive with disposable N95s.

Virus-Killing Masks

Current masks function as barriers to virus particles. A professor of chemical engineering at MIT is developing a mask designed to actually kill virus. **The mask design incorporates a copper mesh heated to about 160°F that traps and deactivates the virus.** Neoprene insulation and a thermoelectric cooler will ensure the inhaled air is comfortable to breathe. The mask, which also kills bacteria and mold, can be run on a 9-volt battery. An MIT team is still building and testing mask prototypes, and their current research has been accepted for publication by AIChE Journal, a chemical-engineering publication. This reusable mask is expected to weigh about a half-pound, to cost just a few dollars and to be available in two models—a slightly larger version for use by healthcare personnel and first responders and a smaller version for the consumer market.

Diagnostic Masks

Researchers at Harvard University have figured out how to integrate a freeze-dried diagnostic COVID-19 test into a face mask. The test reacts with exhaled particles and gives a diagnosis in 90 minutes or less. The tests and a tiny blister pack of water can be mounted on any mask. After the mask has been worn for at least 30 minutes, a person punctures the blister pack to release the water needed to rehydrate and run the reactions. The test result is indicated by one or two lines, similar to a pregnancy test. The researchers tested their technology by putting their masks on a breathing simulator that exhaled a snippet of SARS-CoV-2 RNA in aerosols similar to those generated by humans. **The researchers found that their test performed as well as FDA-approved COVID-19 RT-PCR tests.** The mask is subject to FDA approval. The Harvard team expects the product to cost about $5 each. The technology can be targeted to identify other viruses and variants as well. A team at the University of California, San Diego, is working on a mask-mounted COVID-19 test. This test is contained in a sticker that can be applied to any mask. Unlike the Harvard test, which identifies SARS-CoV-2 RNA, the UC San Diego test identifies the presence of a protease produced in the body during a COVID-19 infection. The team tested the technology with human saliva samples and is preparing to test humans. The cost of the sticker will be just a few cents each.



4 **Test strip results 1:** The strip is embedded with proteins on two lines that capture colored nanoparticles. If the virus is not detected, the DNA tether remains uncut and both lines will be colored. This is a negative COVID-19 result.

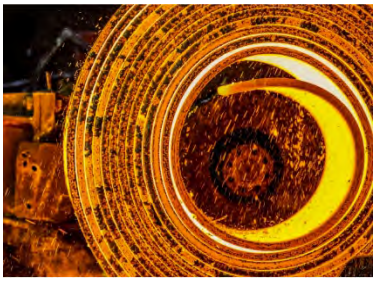
5 **Test strip results 2:** If the reactions detect Covid RNA, enzymes will cut a tether anchoring the nanoparticles, leaving one line clear. This is a positive COVID-19 result.

STAINLESS STEEL: ONE GRAM OF NICKEL CAN KEEP YOUR GLASSES FROM FOGGING UP

Know the feeling of an ill-fitting COVID-mask steaming up your glasses? Nickel is helping to remedy this while providing invisible comfort. Using a fine nickel containing stainless steel strip keeps masks fitting snugly on medical professionals and frontline workers who wear glasses and need to see clearly at all times. In addition to its ease of sourcing and the absence of any allergic reactions, the stainless steel strip can be recycled along with the other materials that constitute the mask**. Quite an achievement for barely one gram of nickel-containing stainless steel.**

STEEL: GLOBAL STEEL DEMAND CLIMBING, PRICES RISING

In Tangshan, China's top steel producing city, 23 steel mills have been told to cut capacity utilization by about 30% to 50% until the end of the year following weeks of smog in northern China. Hebei (China's largest steel producing province) will be cutting steel output and other provinces may adopt similar measures to reduce air pollution. China is expected to produce around one billion tonnes of steel this year, close to last year's record 1.065 billion tons, to balance the need for reducing carbon emission with the economy's requirement for steel. China has seen an upsurge in steel demand over the past year following a post-COVID economic recovery. Tangshan **prices of billet, a semi-finished steel, have risen by nearly 50%, while that of iron-ore has more than doubled to $165/ton from a year ago.** The sharp rise in prices has rippled out across the world since China sets the global benchmark for both steel and iron-ore. However, the surge in prices has not been on account of China alone. Other nations, including Japan and the U.S., restarted blast furnaces in the 3rdQtr, responding to a sudden increase in steel demand. Finished steel prices and raw materials prices all surged. The higher demand coincided with a period when China's demand traditionally slows towards the end of the year leading up to the Lunar New Year holidays in February. However, pent up demand from previous months meant that the drop in buying during the season was less than usual. Housing construction, infrastructure and even automobile sales in China have supported the demand. Globally, the prices of steel and iron-ore have also been affected by logistics disruption as there are only limited ships available to charter. A number of truck drivers are not on the road, especially in Europe. Container freight rates have doubled from the levels before Chinese New Year amid slower loading and unloading, limited availability of trucks and COVID-19 testing procedures. While steel prices have likely plateaued in Japan, they are likely to rise in Taiwan and the U.S. In Europe, ArcelorMittal has recently increased hot-rolled coil steel prices again. The current price is around €830 in Europe, expected to go up to €850 by April.

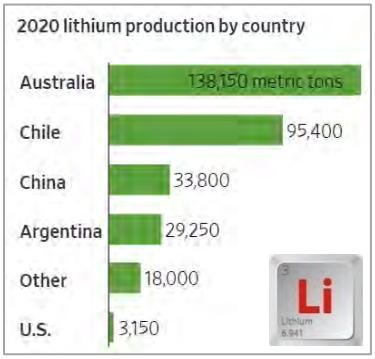


SPECIALTY MATERIALS: NITINOL+ TIRES THAT ARE SUPERELASTIC, AIRLESS AND NEVER GO FLAT

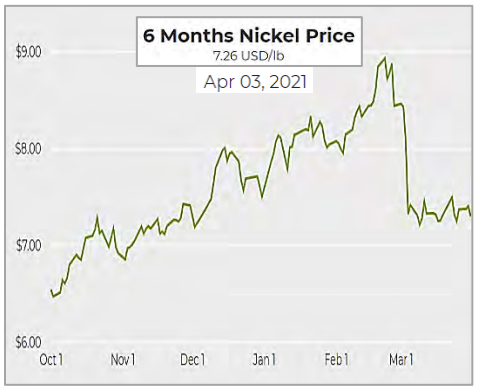
The startup SMART Tire Company, in partnership with NASA, has developed a superelastic tire technology that uses a shape memory alloy (SMA). The airless, non-pneumatic tire design was originally envisioned for Martian and lunar rovers. The first consumer product derived from this technology will be the METL, a bicycle tire that will be available for road, gravel, mountain and electric bike versions. With the elasticity of rubber and the strength of titanium, these bicycle tires could become a permanent part of vehicles, outlasting other equipment without the need for regular maintenance. **Made from a special advanced material, NiTinol+, a shape memory alloy (SMA), the METL tires can travel safely over rocky and sandy terrain.** These shape memory alloys are capable of undergoing significant reversible strain (up to 10%), enabling the tire to withstand an order of magnitude more deformation than other non-pneumatic tires before undergoing permanent deformation. Commonly used elastic-plastic materials (e.g., spring steels, composites, etc.) can only be subjected to strains on the order of 0.3 to 0.5% before yielding. The wires are woven together to create an airless tire structure that has the ability to flex with the terrain, unlike current rigid wheels. The SMA material acts as a shock absorber and can traverse rock-laden terrain effortlessly without breaking or damaging the tire. Even with extreme deformation, the tire regains 100% of its shape through phase transitions at the molecular level. This polyurethane-coated structure offers rubber-like properties, but its grip and durability appear to be far superior in all weather conditions. The material is environmentally friendly due to its great durability and the non-use of rubber. Earth applications of this SMA technology could extend far beyond cycling**. NASA foresees uses in the automotive industry (trucking, all-terrain, commercial and automobile tires), the military (ballistic resistant tires), high-performance sports, commercial aircraft and even search and rescue missions.**

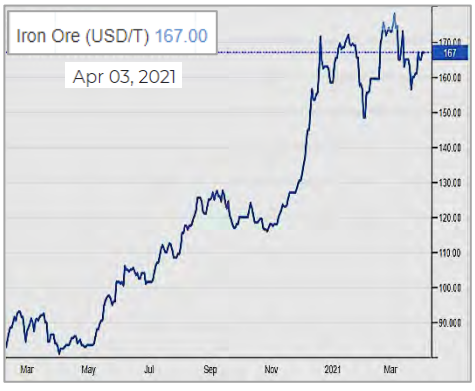
COMMODITIES: BOOMING ELECTRIC-VEHICLE DEMAND SUPERCHARGES LITHIUM PRICES

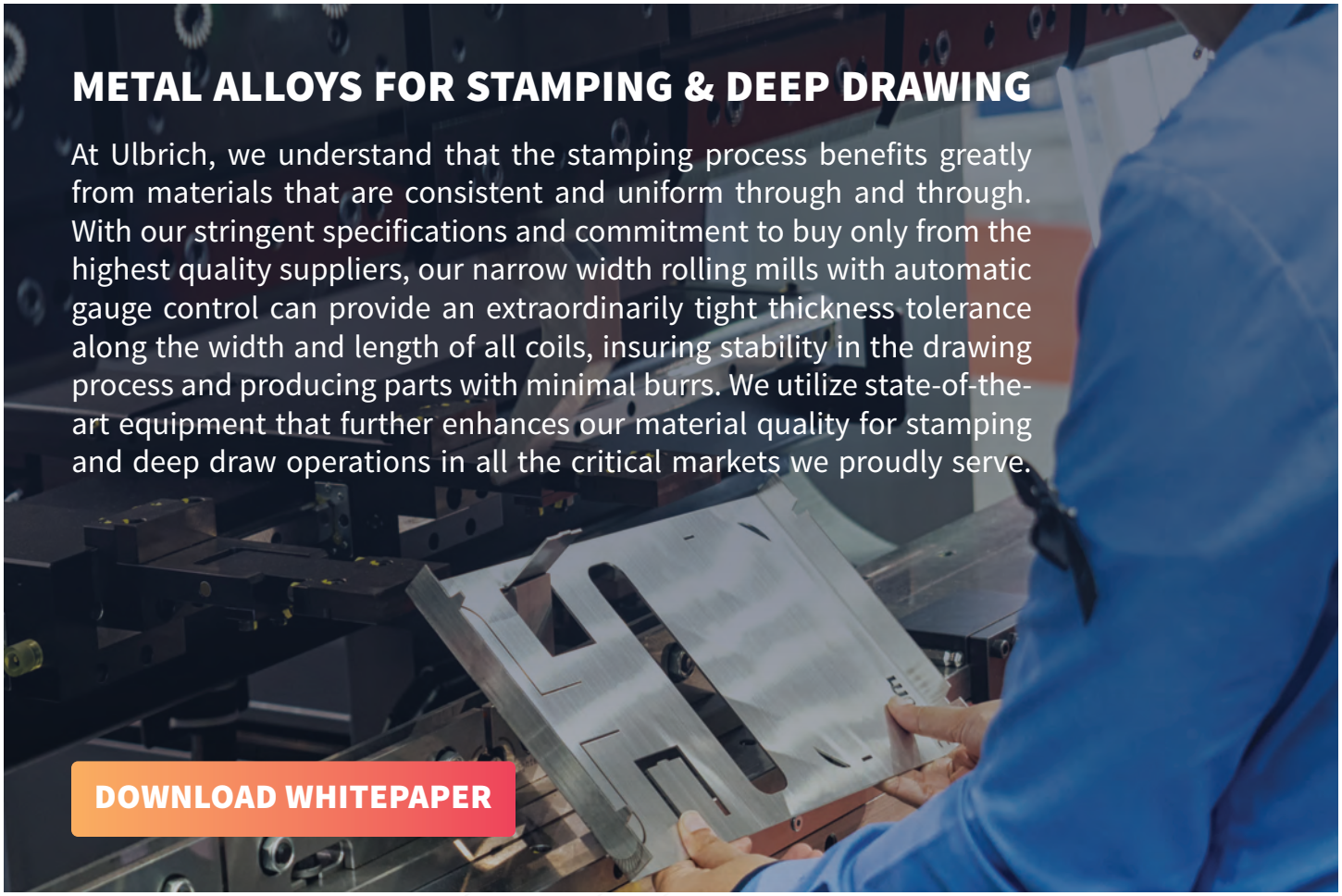
Lithium prices are surging, sparking concerns about limited supplies of the battery metal that is crucial to the electric-vehicle boom. Chinese prices for lithium, considered a bellwether, have soared since the start of the year. Lithium carbonate, a compound of the silvery metal used in the batteries that power most of China's electric-car fleet, has jumped 68% since January to $11,250 a metric ton. However, **lithium isn't traded on any exchange and buyers have long been at a disadvantage in negotiations with producers.** In opaque markets, producers often have greater access to information about fast-moving market dynamics, such as unintended mine outages or suddenly sagging demand. The price rally marks a sharp turnaround for lithium. A wave of investment in new mines until 2018 created a glut of the metal that depressed prices. Now, analysts and industry executives say the pandemic has proved to be a reset point for the market. The gradual end to lockdowns has unleashed a wave of pent-up demand for electric cars that has whittled down surplus stocks of the metal, while governments have emerged from recessions with pledges to invest in clean-energy projects. **While battery-powered vehicles were once regarded as a niche product, they are now seen as the future of transport, providing solid future demand for lithium.** Chinese electric-vehicle sales more than tripled in January from a year earlier. In Europe, sales of alternatively powered cars eclipsed those of diesel-engine vehicles for the first time in the 3rdQtr of 2020 and now account for a third of new passenger cars. Some European governments offer subsidies to electric-car buyers, while President Biden has pledged to build half a million charging stations, addressing a primary concern buyers face: getting stuck without power miles from a plug-in point. The things EVs need before consumers start switching to them is chargeability, durability—the long-road-trip anxiety—and cost. **The supply-and-demand balance for lithium fell into deficit in 2020 for the first time in years, according to CRU. For 2021, the firm is forecasting lithium demand of about 450,000 metric tons, exceeding supply by roughly 10,000 metric tons.** Miners invested heavily in new projects as global lithium prices boomed until 2018. Supply comes mostly from miners in Australia digging up a mineral called spodumene, which contains lithium, and companies extracting it from salt lakes in Chile and Argentina. However, a run of declining prices ever since has dissuaded new investments, leading to expectations of even tighter supplies in the future. A fresh price surge could unleash a new wave of extraction. "There has been very little investment in the supply chain," said Caspar Rawles, head of price assessments at Benchmark. His firm expects global lithium carbonate and hydroxide prices to hit highs of about $16,100 and $18,800 a metric ton, respectively, in 2024. Rising prices are likely to draw in new investors hoping to bet on the global push toward environmentally friendly technologies, but miners would have to be cautious about expansion if they wanted to keep prices high.



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







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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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