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ECONOMIC UPDATE

Number 5 • JANUARY 2020

EXECUTIVE SUMMARY

AMERICAS: THE U.S. FACTORY SECTOR HEADED INTO 2020 ON A WEAK FOOTING, contracting in December for a fifth-consecutive month as trade tensions continued to pressure manufacturing. **The USMCA** trade deal was signed after Congressional negotiations secured some changes. **Employers** added 145,000 jobs and unemployment stayed at a 50-year low of 3.5 percent. **Services companies** grew more quickly, a sign that the economy's steady expansion should continue. **Consumer confidence** slipped slightly in December; expectations fell about economic growth over the next six months. **Fear of a recession** topped the list of U.S. CEOs' concerns going into 2020, according to a Conference Board survey. In November, **factory orders** decreased, propelled by a steep decline in defense-related orders. **U.S. tariffs against China** triggered a slide in imports, contributing to the lowest trade deficit in three years. **Consumer prices** rose 0.3% as households paid more for energy, health care and rent, pushing the rate of inflation up to the highest level in a year. The six-month growth rate of the **Leading Economic Index** suggests that economic expansion is likely to stabilize around 2% in 2020.

OVERSEAS: EUROZONE MANUFACTURING CONTRACTED FOR THE ELEVENTH-STRAIGHT MONTH IN DECEMBER. However, confidence about the future strengthened to a six-month high at the end of 2019. **EU leaders** have agreed to cut the bloc's greenhouse gas emissions to net-zero by 2050. December was the second-consecutive month of expansion for **China's manufacturing sector**, but the trend may not be sustainable due to strong headwinds from the cooling property sector and a worsening fiscal situation.

STEEL: U.S. STEEL WILL IDLE MOST OF ITS GREAT LAKES MILL NEAR DETROIT as the company's losses mount in a weak domestic steel market. **Acerinox** reached an agreement to acquire specialty alloy producer VDM Metals, allowing Acerinox to expand into new markets and growing sectors, such as aerospace, the chemical and medical industries, oil and gas, renewable energies, water treatment and emissions control. **Baowu Steel Group**, China's largest steelmaker, is approaching its target of becoming a global industry leader with an annual output of 100 million tonnes, as the company intends to acquire a controlling stake in Chongqing Iron and Steel.

METALS/COMMODITIES: NICKEL PRICES SANK TO A FIVE-MONTH LOW IN DECEMBER of \$13,085/tonne but have since moved slightly upwards to around \$13,795/tonne. **The U.S. Army** plans to fund construction of rare earths processing facilities, part of an urgent push by Washington to secure domestic supply of the minerals used to make military weapons and electronics. The move would mark the first financial investment by the U.S. military into commercial-scale rare earths production since WW II's Manhattan Project.

AEROSPACE: NASA OFFICIALS HAVE APPROVED THE FINAL ASSEMBLY OF THE X-59 QUESST, the supersonic X-plane designed and assembled by Lockheed Martin. **Boeing** will suspend production of its 737 MAX jetliner, raising the prospect of industry-wide job cuts and furloughs. **Airbus** became the world's largest plane maker for the first time since 2011 by delivering 863 aircraft in 2019. **Boeing** delivered just 345 jets through November of 2019, less than half the number delivered in the same 2018 period.

AUTOMOTIVE: U.S. TOTAL LIGHT-VEHICLE SALES FELL LAST YEAR TO 17.1 MILLION VEHICLES, a 1.6% decline from 2018. **General Motors** reported a 2019 sales decline of 2.3% in the U.S.; **Ford** sales fell 3.2%. **Fiat Chrysler** sales in the U.S. fell 1%, while **Toyota** reported a nearly 2% decline. **Honda** had flat 2019 U.S. sales and **Nissan** sales fell nearly 10%. Electric-vehicle maker **Tesla** said its deliveries rose 50% last year. **Ford Motor** plans to invest more than \$1.45 billion at two plants in Michigan to make electric, autonomous and sports utility vehicles, adding 3,000 jobs. **Fiat Chrysler and Peugeot maker PSA Group** have agreed to binding merger terms.

MEDICAL: TECH TRANSFER HAS LED TO A REACTOR FOR MEDICAL ISOTOPES for a New Mexico company which secured funding to build a small reactor dedicated to producing medical isotopes. The concept was developed by **Sandia National Laboratories** to help establish a stable domestic supply of medical isotopes, which are made with low-enriched uranium. Medical isotopes are used annually around the globe in 40 million imaging procedures that diagnose heart disease, cancer and other life-threatening conditions.

ENERGY: SOLAR POWER FROM 'THE DARK SIDE' IS UNLOCKED BY A NEW FORMULA that reveals the bifacial cells making up double-sided panels generate on average 15% to 20% more sunlight to electricity than the monofacial cells of today's one-sided solar panels, taking into consideration different terrain such as grass, sand, concrete and dirt. The hope is that these calculations developed by two **Purdue University** physicists would help solar farms to take full advantage of bifacial cells earlier in their use.

INNOVATION: MICROBES CAN RECOVER RARE-EARTH MAGNET MATERIALS FROM CONSUMER WASTE. Rare earth elements are essential for technologies like solar and wind energy, advanced vehicles and modern electronics. Because of their geochemical properties and the current geopolitical situation, they are seldom discovered in easily extractable deposits. To increase the U.S. supply of rare earth elements, a Critical Materials Institute team led by **Lawrence Livermore National Laboratory** is using microbe beads to recover rare earth elements from consumer electronic waste such as cell phones.



THE AMERICAS


- **The USMCA trade deal** was signed after Congressional negotiations secured some changes. Key modification were new labor regulations and mechanisms that reduce Mexico's competitive labor cost advantage. The deal was signed by representatives of the three countries and approved by the House, but it still needs to be ratified by the Senate. The modified USMCA is likely to take effect in 2020. The signing of this agreement reduces uncertainty for the U.S. and it is considered vital for trade and investment to increase in the region.
- **U.S. employers** added 145,000 jobs in December and unemployment stayed at a 50-year low of 3.5%, capping a tenth straight year of payroll gains. Private-sector wages advanced 2.9% in December from a year earlier, the smallest annual gain since July 2018.
- **U.S. tariffs against China** triggered a slide in imports in November, contributing to the lowest trade deficit in three years. U.S. exports climbed by 0.7%. Exports of automotive vehicles, parts and engines rose 3.3% from October. The foreign-trade gap in goods and services contracted 8.2% to \$43.09 billion in November which was the lowest goods and services deficit since it hit \$42 billion in October of 2016.
- **U.S. consumer confidence** slipped slightly in December, as expectations fell about economic growth over the next six months. The Conference Board's consumer confidence index edged down to 126.5 from November's 126.8.
- **U.S. retail sales** rose at a modest 0.2% pace in November as the holiday shopping season appeared to have a slow start. Healthy car sales lifted the overall figure. Excluding autos, sales ticked up just 0.1%. Sales declined sharply across categories that are closely tied with holiday gift-giving: clothing, department stores and sporting goods.
- **U.S. consumer prices** rose 0.3% in November. U.S. households paid more for energy, health care and rent, pushing the rate of inflation up to the highest level in a year. Core prices increased 0.2%. The overall cost of living climbed 2.1% and core prices 2.3% in November from a year earlier, but inflation is still low by historical standards.
- **The U.S. Leading Economic Index** was unchanged in November, remaining at 111.6, following a 0.2% decline in both October and September. The Conference Board said, "While the six-month growth rate of the LEI remains slightly negative, the Index suggests that economic growth is likely to stabilize around 2 percent in 2020."



- **U.S. industrial production** increased 1.1% in November from the prior month. Manufacturing rebounded 1.1% as auto-industry output rose after the GM strike ended. Excluding motor vehicles and parts, industrial production increased 0.5%. Mining production fell 0.2%, while utilities output increased 2.9%. Steel capacity utilization increased by a 0.7 percentage point to 77.3% in November.
 - **U.S. import prices** rose 0.2% in November driven by a 2.6% increase in fuel prices, which more than offset lower nonfuel prices. A 48.5% increase in natural gas prices and a 1.1% rise in petroleum prices each contributed to the November advance in fuel prices. U.S. export prices rose 0.2%.
 - **The U.S. factory sector** headed into 2020 on a weak footing, contracting in December for a fifth consecutive month as trade tensions continued to pressure manufacturing. The ISM factory index fell to 47.2 in December, its lowest level in over 10 years. The ISM's weak manufacturing reading contrasted with IHS Markit's PMI report suggesting manufacturing in the U.S. and Asia was stabilizing. IHS Markit's U.S. manufacturing purchasing managers index for December was 52.4, down slightly from 52.6 in November.
- U.S., China Factory Activity Stabilizing**
National Manufacturing Purchasing Managers Indexes
■ Caixan, China ■ IHS Markit, U.S.
- Key Update:** *The ISM expressed the hope that the preliminary trade deal with China would help support demand.*
- **Durable goods orders** fell 2.0% in November, driven down by a 35.6% drop in orders for defense capital goods. Excluding the volatile defense category, overall orders were up 0.8% in November. Motor vehicles and parts orders increased 1.9%. New orders for nondefense capital goods, excluding aircraft, rose 0.1% in November. Through 11 months this year those orders were up 0.7% from the same period in 2018, rising less than the rate of inflation.
 - **U.S. factory orders** decreased 0.7% to \$493 billion in November from the previous month, propelled by a steep decline in defense-related orders. While the decline is a negative sign for the manufacturing industry, other broader economic data point to strength. In December, Congress authorized a fresh round of military spending.
 - **U.S. producer prices** were unexpectedly unchanged in November. Increases in food and gasoline prices were offset by declining costs for services, pointing to muted inflation despite a recent uptick in consumer prices. The PPI gained 1.1% in the 12 months through November.



- **U.S. services companies** grew more quickly in December than the previous month, a sign that the economy's steady expansion should continue. The ISM service-sector index rose to 55, from 53.9 in November. Any reading above 50 signals an expansion. However, many details of the report were mixed. Export orders grew but at a slower pace and order backlogs shrank for the third straight month. An emerging trade fight between the U.S. and EU over a tax on digital services levied by France could hurt the export of consulting and other services in the coming months.
- **The U.S. housing market** in November was mixed. Existing-home sales fell 1.7%, the second drop in three months and a sign limited inventory is constraining buyers. The median-sales price for an existing home was up 5.4% from the previous year to \$271,300. Housing starts increased 3.2% in November to an annual rate of 1.365 million. Residential permits rose 1.4%. New home sales rebounded 1.3% to an annual rate of 719,000, lifted by gains in the Northeast and West but they were flat in the Midwest and fell in the South. *Key Update: New-home sales increased 9.8% YTD, reflecting a steady decline in mortgage rates. The median new-home sales price was up 7.3% in November from a year ago.*
- **Personal-consumption expenditures** climbed 0.4% in November and were up 2.4% from a year ago. The increase came alongside a rise in personal income, which gained 0.5%. Spending on services in November rose 0.4% from the prior month, with health-care spending contributing most to the increase. Spending on vehicles contributed strongly to the 1% increase in expenditures for long-lasting goods.
- **U.S. construction spending** grew 0.6% in November to an annual rate of \$1.324 trillion. From a year earlier, overall spending in November was up 4.1%, well outpacing the rate of inflation. However, through 11 months of 2019, spending was down 0.8% compared to the same period in 2018. Private construction spending increased 0.4% in November vs. the previous month and was 1.6% higher than November 2018. Government construction spending rose 0.9% in November and was greater by 12.4% than a year earlier.
- **Fear of a recession** topped the list of U.S. chief executives' concerns going into 2020, according to a recent Conference Board survey. The year prior, recession fears ranked third for U.S. chiefs, though first overall for CEOs around the world (as is again the case for 2020). Last year, growth in gross domestic product globally slipped to 2.3% from 3% in 2018, and executives felt the pressure. Uncertainty around a host of issues, from trade to climate change, has exacerbated their anxiety, they noted. The manufacturing sector chiefs feel that uncertainty acutely.

- **The U.S. population** grew in 2019 by <0.5%, or 1.5 million people, with the population at 328.2 million. That ranks as the slowest growth in 100 years as the number of births declined, the number of deaths increased and international migration slowed. Population growth and productivity improvements are key to economic growth.
- **ArcelorMittal's steel mill in Indiana** suffered an unexpected outage that could support further upside for the price of hot-rolled steel.  MT's basic oxygen furnace at its Indiana Harbor operation experienced fire damage in late December. The furnace can produce three million tons/year of steel, about 3% of total U.S. steelmaking capacity. Hot-rolled steel prices bottomed in October at \$510/ton, but January futures are trading at \$590/ton. Some analysts think prices could hit \$625 early in 2020.
- **Steel Dynamics, USS and Nucor** have forecast lower 4thQtr profits due to falling prices and weakening demand. The GM strike, less drilling for oil and natural gas and falling production of farm and construction machinery have sapped steel demand. Prices for sheet steel rallied in December as steel users stepped up purchases to replenish inventories. However, many steel analysts expect prices to weaken again early in 2020 as manufacturing output remains subdued. (See [Appendix: Steel](#), page 9)
- **United States Steel** will idle most of its Great Lakes mill operations near Detroit as the company's losses mount in a weak domestic steel market. U.S. Steel and its competitors have been hurt lately by falling prices and demand from U.S. manufacturers. Steel production at Great Lakes Works will cease around April 1 and the rolling mill for making sheet steel will close sometime later in 2020. Layoff notices were issued to more than 1,500 employees at the mill. *Key Update: Several of U.S. Steel's competitors are investing in production capacity that will add several million tons of additional steel to the U.S. market over the next three years. That will likely hold down prices and make it increasingly difficult for USS's older, high-cost mills to operate profitably.*
- **Steel mills** in the U.S. shipped 7.914 million tons of steel in October, a 1.9% gain from September but a 3.2% decline from October 2018. Steel mill product shipments year-to-date through October were 80.492 million tons, a gain of 1.1% over 2018 shipments for ten months.
- **U.S. raw steel production** for the year-2019 through December 28th was 96.326 million tons at a capability utilization rate of 80.2%, an increase of 1.8% from the same period in 2018 at a utilization rate of 78.2 percent.



- **Steel imports into the U.S.** were 1.541 million tons in November, including 1.311 million tons of finished steel, down 29.9% and 12.5% respectively compared with October. For the first eleven months of 2019, total and finished steel imports were 26.332 million and 19.675 million tons, down 17.3% and 18.1% respectively vs. a year ago. Finished steel import market share was estimated at 19% year-to-date through November.
- **The president of Brazil**, Jair Bolsonaro, said he convinced President Trump not to implement a new tariff on Brazilian steel and aluminum imports as threatened in December.
- **Tesla** produced more than 100,000 vehicles in the 4thQtr of 2019, a record which put its yearly deliveries within the range it had promised. The electric-vehicle maker said it delivered 112,000 cars in the final three months of last year and produced 104,891, a sign of high demand for its vehicles as it enters 2020 amid a global expansion. Tesla's total deliveries for 2019 were 367,500, 50% more than in 2018. Tesla had forecast deliveries of 360,000 to 400,000.
- **Ford Motors** reported reservations for the Mustang Mach-E are full, although it didn't specify the number of people who put down \$500 to reserve the electric Mustang crossover. More than 80% of U.S. customers made Mach-E reservations with an extended range battery and 55% opted for all-wheel drive. Almost 30% of U.S. customers are choosing the Mach-E GT. The Mach-E is one of more than a dozen all-electric models that Ford plans to start producing by 2022. (See **Appendix: Automotive**, page 11)
- **General Motors** sold nearly 2.9 million vehicles last year, a 2.3% decline compared with 2018, which includes a drop of 6.3% to 735,909 vehicles in the 4thQtr. GM sold more than one million crossovers for the second year in a row, an increase of 12.7% from 2018. That increase wasn't enough to make up for the 30.5% decline in passenger cars and a 2% slide in trucks, which include pickups, full-size SUVs and vans. Production and sales were hurt by a 40-day strike by the UAW union that ended in October.
- **The Securities Exchange Commission** opened an investigation into BMW, looking into the Munich-based auto maker's sales practices in the U.S. to determine whether the company engaged in a technique known as sales punching. Sales punching occurs when a company boosts sales figures by having dealers register cars as sold when the vehicles are still actually standing on car lots.



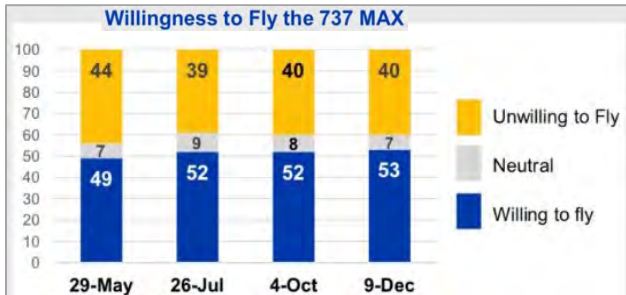
- **Fiat Chrysler and Peugeot maker PSA Group** have agreed to binding merger terms that include sweeteners to make the trans-Atlantic tie-up more attractive to U.S. regulators and PSA shareholders. The tie-up aims to create a \$50 billion auto giant that would rank among the world's largest car companies by sales. The transaction is expected to close in the next 12 to 15 months and will create a car maker selling 8.7 million vehicles a year with revenues of nearly \$189 billion. The merger won't result in any plant closures and will lead to annual cost savings of some \$4.1 billion a year. The merged company's name is so far undecided.
- **Ford Motor** plans to invest more than \$1.45 billion at two plants in Michigan to make electric, autonomous and sports utility vehicles, adding 3,000 jobs. Ford will invest \$750 million at its Wayne facility to make SUVs and pickup trucks and hire 2,700 workers over the next three years. Ford also plans to invest \$700 million at its Dearborn plant to make electric and hybrid versions of the F-150 truck and will hire 300 people next year. It will assemble battery cells for the F-150's hybrid and electric versions at the Dearborn facility. Ford previously said it would invest \$11 billion to make 40 new hybrid and fully electric vehicle models by 2022.
- **U.S. total light-vehicle sales** fell last year to 17.1 million vehicles, a 1.6% decline from 2018. GM reported a 2019 sales decline of 2.3%; Ford sales fell 3.2%. Fiat Chrysler sales in the U.S. fell 1%, while Toyota reported a nearly 2% decline in U.S. sales. Honda had flat 2019 U.S. sales and Nissan sales fell nearly 10%. Electric-vehicle maker Tesla said deliveries rose 50% last year to 367,500 vehicles.
Key Update: The industry faces potential headwinds in the U.S. in 2020. In 2019, dealers grappled with unusually large stockpiles of unsold vehicles and struggled to unload older models, forcing steeper discounts. Auto makers are spending more to lure buyers, potentially heralding weaker demand and slower sales ahead. The industry's spending on sales incentives in recent months hovered around 11% of a car's sticker price, the highest level since 2008.
- **Boeing's spacecraft Starliner** failed to achieve its intended orbit after launch, making it impossible to complete its mission of docking with the ISS, deliver cargo and return safely to demon-strate its capabilities. The spacecraft's autonomous flight-control system misfired shortly after the launch, putting Starliner in the wrong orbit. NASA has awarded Boeing nearly \$5 billion to develop Starliner, which is built to carry five people. (See **Appendix: Aerospace**, page 10)



- **NASA officials** have approved the final assembly of the X-59 QueSST, the supersonic X-plane designed and assembled by Lockheed Martin. A long pointed nose and sharply swept wings ensure that the individual pressure waves created by an airplane surpassing Mach 1 never converge, resulting in a soft "thump" rather than a loud sonic boom. Test flights are scheduled for 2021. The sonic boom led U.S. authorities to ban supersonic passenger flights over land in 1973.
- **Boeing** will suspend production of its 737 MAX jetliner, escalating the crisis confronting the aerospace giant and raising the prospect of industrywide job cuts and furloughs. Boeing's decision to halt production of the 737 MAX is likely to reverberate throughout the U.S. economy. The plane maker is the nation's largest manufacturing exporter and one of the top private employers. Boeing employs around 12,000 workers at its 737 assembly plant and also supports thousands of jobs across the network of over 600 suppliers and hundreds of other smaller firms in the global MAX supply chain.



Key Update: Boeing will still burn more than \$1 billion a month, even after halting 737 MAX production. Boeing's overhead and labor costs will continue and it's expected to support its suppliers until the 737 MAX is cleared for flight.



- **General Electric** will likely take a significant hit to its cash flow from Boeing's decision to halt production of the 737 MAX jetliner, which has already dented the conglomerate's finances. GE makes all of the MAX's engines through a joint venture with France's Safran. In April when Boeing cut monthly production of the plane to 42 from 52, GE's quarterly cash flow was reduced by \$400 million. The suspension of production will reduce cash flow by much more because GE won't receive the usual payments made as new planes are being built.
- **IBM quantum computing service** now tops 100 clients up from 40 last year. By 2023, a fifth of organizations, including businesses and governments, are expected to budget for quantum-computing projects, up from less than 1% in 2018.

- **Lockheed Martin** hit its 2019 target to deliver 131 F-35 fighter jets to the U.S. and allies. The company built 47% more jets in 2019 than in 2018. LMT aims to deliver 141 F-35s in 2020 and hit peak production in 2023. The company notes the price of an F-35A is now \$77.9 million, which meets the \$80 million goal a year earlier than planned.
- **Duke Energy** reached an agreement with North Carolina regulators and environmental groups to permanently close all nine remaining coal ash basins in the state. Duke estimates the total undiscounted cost to permanently close all ash basins in the Carolinas at \$8 to-\$9 billion. Under the plan, nearly 80 million tons of ash will be excavated from the remaining sites, bringing the total amount of material to be excavated in North Carolina to 124 million tons. (See [Appendix: Energy](#), page 12)
- **U.S. shale wells** are not producing as much oil and gas as producers forecasted when they were raising capital. Recently drilled wells in the four largest U.S. oil regions are expected to produce 15% less oil and gas over their lifetimes as claimed by fracking companies. The potential shortfall represents 1.4 billion barrels over 30 years or more than \$60 billion at current prices.
- **Goldman's newly adopted environmental policies** will prohibit it from financing drilling in the Arctic, as well as projects in Alaska's Arctic National Wildlife Refuge. The funding freeze extends to new thermal coal mine and power plant development and projects that significantly convert or degrade a natural habitat. Goldman also committed to invest \$750 billion over the next decade into areas that focus on climate transition and inclusive growth.
- **Johnson & Johnson** will acquire the remaining stake in Verb Surgical from partner Verily. The joint venture was designed to bring together J&J unit Ethicon's capabilities in surgery and advanced instrumentation with Verily expertise in machine learning and data analytics to build robot-assisted interventions for use in open surgery, laparoscopic, percutaneous and endoluminal procedures. (See [Appendix: Medical](#), page 13)
- **The medtech industry** is now in the clear to move past one of the biggest issues it has faced in recent years. The proposed 2.3% tax on medical device sales has been eliminated because of a new federal spending package signed into law in December. A Tax Foundation study showed the tax would result in a decline of about 21,390 full-time equivalent jobs along with a reduction in GDP of \$1.7 billion. The medical device tax was introduced in 2013 as part of the Affordable Care Act and has been on temporary hiatus since the beginning of 2016.



EUROPE, AFRICA & THE MIDDLE EAST

- **The IHS Eurozone Manufacturing PMI** fell to 46.3 in December from 46.9 in November. The reading pointed to the eleventh-straight month of contraction in factory activity and at a rate that matched September's 81-month record. New orders declined further and job loss was the sharpest recorded by the survey since the start of 2013. Work backlogs declined for a sixteenth-successive month.
- **German manufacturing** fell unexpectedly in December although recent data had suggested that German factories were exiting a year-long slump. IHS Markit's manufacturing PMI fell to 43.4, keeping the private sector in contraction for a fourth-straight month. IHS Markit reported, "Manufacturing continues to weigh heavily on private sector output even though slower declines in new orders and exports provide glimmers of hope."
- **Britain's Manufacturing PMI**, which measures confidence in the sector, fell to its lowest level since 2012. The reading sank from 48.9 in November to 47.5 in December; anything under 50 suggests a contraction. The disappointing figure reflects disposal of inventories that firms had built up in case of a no-deal Brexit and wider worries about the world economy and the trade wars.
- **EU leaders** have agreed to cut the bloc's greenhouse gas emissions to net-zero by 2050. The only holdout was Poland, which refused to implement the decision before June of 2020. Poland sought financial assurances to safeguard its economy, which relies on coal for 80% of its energy needs. The EU Commission estimates the bloc's 28 members could need as much as €575 billion annually to cover the costs of reaching their mid-century target.
- **Tata Steel's UK losses** rose from £222 million in 2018 to £371 million in 2019, increasing the pressure on its last two major mills, Port Talbot and Scunthorpe. The future for Port Talbot's steelworks appears bleaker than ever after Tata warned it must become self-sustaining or face closure.
- **Acerinox** reached an agreement in November to acquire specialty alloy producer VDM Metals. The deal is valued at €532 million. Acerinox will pay about €310 million in cash and assume debt of €57 million, along with pension plans and other liabilities of €165 million. VDM Metals, headquartered in Germany, represents an opportunity for Acerinox to expand into new markets and growing sectors such as aerospace, the chemicals, the medical industry, oil and gas, renewable energies, water treatment and emissions control.



- **The Italian government** is prepared to take an 18% stake in the Ilva steel plant through a public agency. Industry ministry officials presented a proposal to ArcelorMittal in hopes of convincing the company to end its threat to walk away from a 2018 deal to buy the plant in the city of Taranto. The government also offered to reinstate a legal shield against prosecution for the company while it carries out a clean-up plan for the heavily polluting plant. (See **Appendix: Steel**, page 9)
- **Fully electric cars** made up 42.4% of sales in Norway last year, a global record, rising from a 31.2% market share in 2018 and just 5.5% in 2013. The Nordic nation currently exempts battery-powered vehicles from the taxes imposed on petrol and diesel engines as it seeks to become the first country to end the sale of fossil-fueled cars by 2025. The country's best-selling car in 2019 was Tesla's Model 3 sedan with an 11% market share.
- **Airbus** became the world's largest aircraft maker for the first time since 2011 after delivering 863 aircraft in 2019. The race was overshadowed by Boeing's 737 MAX crisis and underscored the distance the U.S. company must travel to recoup its market position in 2020. Boeing delivered 345 jets through November, less than half the number in the in the same period of 2018, when the MAX was being delivered.
- **European Airlines** are rallying against the threat of jet fuel taxes that would help fund the EU's environmental ambitions. Newly elected European Commission President Ursula von der Leyen unveiled her Green Deal, a road map for the bloc to reach zero net emissions by 2050. She pledges to examine current tax exemptions including aviation. An EU-wide jet fuel tax could cost €13 billion a year, doubling the airlines current yearly taxes in the bloc.
Key Update: Airline emissions in 2020 will be 70% higher than 2005 levels but they currently account for only around 3% of the bloc's overall greenhouse-gas emissions, well behind the 12% emitted by cars.
- **China's ambassador to Germany** threatened Berlin with retaliation if Germany excludes Huawei as a supplier of 5G wireless equipment, citing the millions of vehicles German carmakers sell in China. Chancellor Angela Merkel's government has been widely accused of bowing to Chinese pressure after she ruled out banning Huawei from the country's 5G network. Lawmakers from her ruling coalition are seeking to overrule her decision with legislation that would impose a ban on "untrustworthy" 5G vendors.



ASIA/PACIFIC, JAPAN, AUSTRALIA & INDIA

- **China's official manufacturing PMI** came in slightly above expectations at 50.2 for the month of December, the same level as November. New export orders increased in December for the first time since May 2018. Even though December was the second straight month of expansion for the official manufacturing PMI, economists from Nomura cautioned that the trend may not be sustainable due to strong headwinds from the fading property sector and China's worsening fiscal situation.
- **China's additional tariffs** on some U.S. goods that were meant to be implemented on Dec. 15 were suspended, after the world's two largest economies agreed to a "phase one" trade deal. The deal reduces some U.S. tariffs in exchange for a big jump in Chinese purchases of American farm products and other goods. Beijing agreed to import at least \$200 billion in additional U.S. goods and services over the next two years on top of the amount it purchased in 2017. The U.S. would leave in place 25% tariffs on \$250 billion worth of Chinese goods to insure Chinese compliance.
- **China's government** slashed investment subsidies in 2018 but last year it gave priority to wind and solar projects that



- generate power at the lowest prices. However, Chinese investment in renewable energy fell by 60% in the past two years. A dollar's worth of investment in solar-power yields about four times as much capacity as it did ten years ago. The costs of wind energy have fallen similarly. Yet renewables are a long way from replacing fossil fuels. Coal still accounts for three-fifths of China's energy mix.
- **Industrial profits in China** for November rose 5.4% from a year earlier to US\$84.93 billion, snapping three months of decline, as production and sales expanded. November's gain compared with a 9.9% drop in October. For January through November, industrial firms notched profits of US\$803 billion, down 2.1% from a year earlier but slightly better than a 2.9% decline in the first 10 months of 2019.
- **China Baowu Steel Group**, China's largest steelmaker, is approaching its target of becoming a global industry leader with an annual output of 100 million tonnes as it intends to acquire a controlling stake in Chongqing Iron and Steel.

Key Update: By 2025, China's top 10 steel enterprises will have their combined output contribute between 60 and 70 percent of the nation's total capacity.

- **World crude steel production** was 147.8 million tonnes (Mt) in November, a 1.0% decrease vs. November 2018. China's crude steel output was 80.3 Mt, an increase of 4.0% compared to a year ago. The U.S. produced 7.2 Mt of crude steel, a decrease of 2.2% from a year ago. Japan produced 7.7 Mt of crude steel, down 10.6%. Brazil's crude steel production for November was 2.6 Mt, down by 10.5% on November 2018. France produced 1.1 Mt of crude steel, an 18.2% decrease compared to November 2018.
- **Daimler's main China joint venture partner BAIC Group** set in motion a plan to double its stake to 10%, win a board seat at the German luxury car maker and upstage rival Geely. State-owned BAIC has been Daimler's main partner in China for years and operates Mercedes-Benz factories in Beijing. Geely owns 9.69% of Daimler and is seeking to expand its partnership with Daimler. Meanwhile, Daimler is trying to buy a majority stake in its Chinese operations to counter Chinese investors' moves to tighten their grip. If BAIC clinches a 10% shareholding, Chinese companies will control just under 20% of Daimler, enough to block significant decisions at its shareholder meeting.
- **General Motors** posted its biggest-ever sales drop in China last year and warned of a tough 2020, underscoring the challenges that U.S. car makers are facing as a protracted decline grips the world's largest auto market. GM, the country's second-largest car maker by sales after Volkswagen, sold about 3.09 million vehicles in China in 2019, roughly a 15% drop from 2018. It was GM's second straight year of falling sales in its biggest overseas market.
- **Tesla and a group of Chinese banks** have agreed a new \$1.4 billion five-year loan facility for the automaker's Shanghai car plant, part of which will be used to roll over an existing loan. Tesla broke ground on the factory last January and aims to build at least 1,000 Model 3 cars a week by the end of this year. The Shanghai government has also thrown its support behind the Tesla project, China's first wholly foreign-owned car plant, and a reflection of the government's broader shift to open up its car market.
- **Nickel prices** hit a five-month-low on December 10th at \$13,085/t and have since moved slightly upwards to around \$13,795/t. Prices had surged in September when Indonesia announced a ban on nickel ore exports in January 2020. News of the January ban caused exports to soar. In October all Indonesian deliveries of unprocessed laterite nickel ores were suspended for two weeks. After inspections into reports of violations of ore export rules, nine out of eleven companies were allowed to resume deliveries until the end of 2019. (See [Appendix: Commodities](#), page 15)



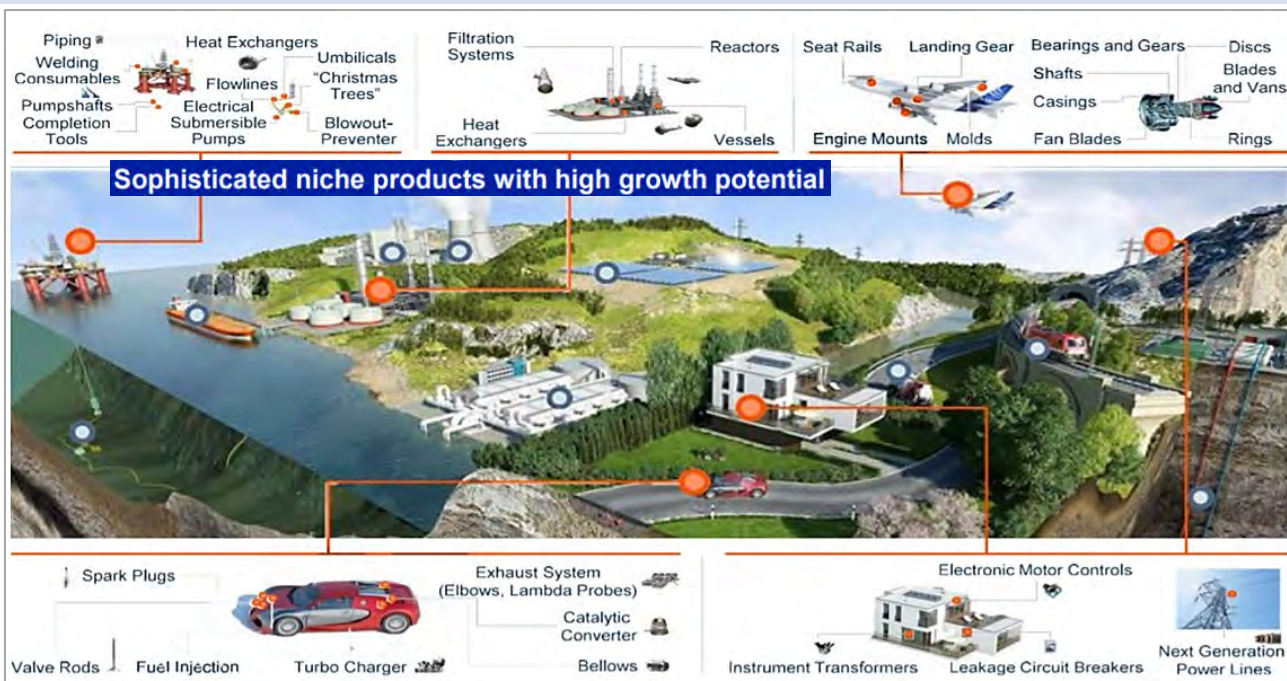
ECONOMIC UPDATE: APPENDIX TO JANUARY 2020 REPORT

STEEL: HOW STEEL HELPED USHER IN THE ERA OF ROCK AND ROLL

From its use in acoustic steel guitars in the 1930s to modern ‘pick-ups’ and guitar strings, steel has played a central role in the evolution of popular music. **By providing the technological leap that made rock and roll possible, the electric steel string guitar changed music forever. The unique sound created by the magnetic pickup device at the heart of the instrument, combined with its steel strings gave rise to a new wave of musical expression.** From rock-a-billy to punk, progressive, hard and just plain rock, it is the reverberations of a steel string electric guitar that made all these variations possible and played a hand in creating iconic songs the world over. The true magic behind the electric guitar are the magnetic fields that make it work. Key to this is the ‘pickup’, a permanent magnet with a wire coil wound around it that is fitted to each electric guitar. The pickup magnet’s north pole faces outwards from the guitar body, magnetizing the steel strings suspended above it. The strings in turn become magnets themselves, with their magnetic field in alignment with the permanent magnet. The steel string is absolutely integral to the workings of the electric guitar and, when plucked, the strings’ magnetic vibrations are converted into an electrical signal for the amplifier using the pickup. In the 1930s, string manufacturers opted for steel with a corrosion-resistant zinc coating, and this material choice of a thin steel string lasted unchanged for decades. In the 1960s, artists such as Keith Richards who were interested in blues rock wanted even thinner strings to bend the note to get more of a rock effect, so they took steel strings off banjos. Rock guitarists find that steel strings deliver the cutting tone with the high output levels that they need. Higher output results in a stronger signal being sent to the amplifier and this, along with the type and strength of the magnet, impacts the tone a guitar produces. **Stainless steel strings, which entered popular use in the 1960s, are known for giving guitars a clear, bright sound with sustainability. They also last longer because they are corrosion-resistant. For maximum brightness, steel strings with hex cores are a popular choice.** A hex core is a steel string with five sides, formed in a hexagon shape that can be wrapped in another material. The hex core produces a brighter sound while feeling stiffer to the player when compared with a normal round core string. The variety of electric guitar strings is now wider than ever, but the basic construction is the same as acoustic strings, with round or hexagonal core wires. That variety includes steels called super-alloys which are used in the aerospace industry for high-stress applications. Known as Maraging steel, strings made from this are said to offer a rich tone, beefy lows and hold their tune for longer. Almost 90 years on, steel, whether in rounded or hexagon form, wrapped in nickel or made from stainless steel, continues to be at the beating heart of the instrument that changed music forever.



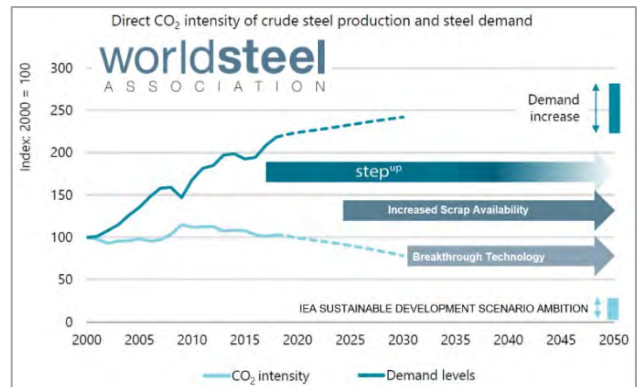
STAINLESS STEEL: NOT ALWAYS VISIBLE, BUT INDISPENSABLE NOW AND FOR A SUSTAINABLE FUTURE



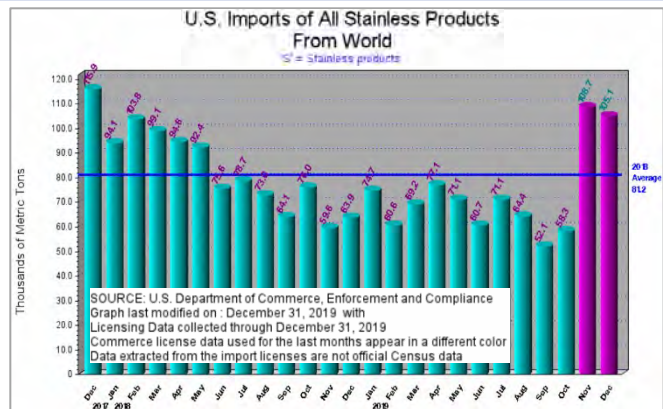
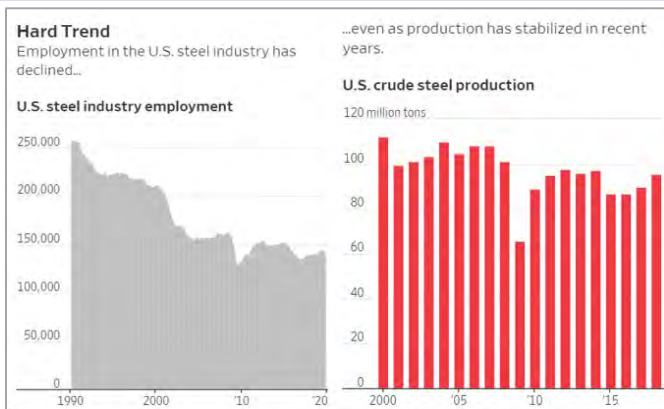


STEEL: CLIMATE CHANGE - STEEL'S THREE-PHASE APPROACH TO INDUSTRIAL TRANSFORMATION

Recognising the critical role and impact of steel products and production processes on greenhouse gas emissions, *worldsteel* and many of its members participated at the UN's annual climate change conference (COP) in Madrid. As more and more countries recognise a climate crisis and civil society increases pressure on governments and individuals to act, the steel industry must recognise that addressing its footprint is as important as the essential work steel will do to enable and support society in the transition to a low carbon future. **The world needs a sustainable steel sector able to provide the advanced materials that will enable us to manage in a rapidly changing world, and the steel industry needs to change to make this possible.** Given the ubiquitous nature of steel, in 2018 consumers around the world used some 1.7 billion tonnes of steel in buildings, transport and a myriad of other applications. Transforming such a behemoth of an industry will take time and immense effort, especially at a time when demand is expected to increase, but it can be done. *worldsteel* and its members see the industry's transition as a three phase process. (1) Step up is a new industry-wide four-stage efficiency methodology. This multistep process covering raw materials, energy input, yield and maintenance can be used to support improvements in mill operations to efficiency levels commensurate with the steel industry's top performers. Efficiency is key to ensuring every tonne of steel produced has the lowest possible environmental and greenhouse gas impact. (2) Increased scrap use. Steel is already highly recycled. About 630 million tonnes of scrap are recycled every year. Scrap becomes available when steel reaches the end of its working life, which varies by application – from a few months for packaging steel to closer to 100 years for steel used in buildings. In the decade 1998 to 2008 global steel production increased from around 800 million to 1.3 billion tonnes. In the next few decades much of this steel will reach the end of its life, and that which cannot be reused or remanufactured will be returned for recycling. This injection of increased scrap steel will play a key role in reducing sector emissions. (3) **Breakthrough technology. Ultimately, virgin steel (steel made from ore) will need to be produced in an entirely new and zero net greenhouse way.** A number of *worldsteel* members and other research groups are developing exciting and promising new technologies. This is very good news, as a portfolio of technologies will be required that can be applied in different conditions. For example, in regions with an excess of cheap renewable energy, the best option might be electrolysis-based hydrogen reduction. While in regions with access to ample CO2 storage and infrastructure, it may be that natural gas-based hydrogen or carbon capture and storage would make more sense. In other areas hybrids or entirely different approaches could be taken. A common theme will be that steel produced using new low carbon technology will cost more to produce, and as new technology is deployed there will be a period when conventionally produced steel and new higher cost net zero steel compete in the same market. During the transitional period it will be important that policy supports the transformation and enables rather than inhibits the very high levels of investment that will be necessary to create a steel industry fit for the challenges of the 21st century.



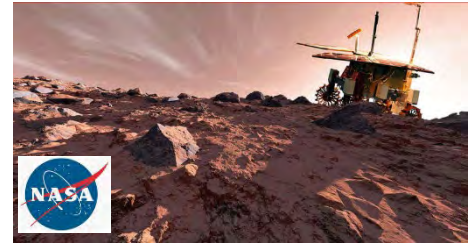
STEEL: EMPLOYMENT AND PRODUCTION IN THE U.S.; IMPORTS OF ALL STAINLESS STEEL PRODUCTS





AEROSPACE: THE YEAR AHEAD FOR SPACE MISSIONS, THE RUSH TO MARS IN 2020

It will be a thrilling year for Mars buffs, as the space agencies of America, Europe, China and the United Arab Emirates all plan launches of unmanned Martian probes. Each will have different ambitions. **NASA already drives robots on Mars, but its rover will carry a helicopter drone that could become the first extraterrestrial aircraft.** It will also test a device to convert abundant carbon dioxide into scarce oxygen, which could help future astronauts breathe, or could be used to make rocket fuel. Both the European and Chinese space agencies must prove that they have learned lessons from recent failures to reach Mars. The Europeans plan to drill an unprecedented two meters into the planet's surface to search for fossilized signs of life. The UAE's mission, developed with American help and to be launched on a Japanese rocket, will be an interplanetary first for the Arab world. It will use ultraviolet spectrometry to study Mars's atmosphere. The space schedule for 2020 may also include the maiden launch of NASA's SLS, the world's biggest rocket. Virgin Galactic and Blue Origin may begin commercial suborbital flights for wealthy thrill-seekers, but it is ESA's launch of a solar probe, scheduled for February 2020 that could prove to be of greatest import for Earthlings. *Solar Orbiter* will be put into an elongated orbit that takes it close to the sun every five months. Instruments behind peep-holes in its heat shield will seek correlations between that star's internal rumblings and its periodically fierce ejections of charged particles. These could knock out electrical grids and computers on Earth, potentially plunging entire continents into chaos and conflict. One such "coronal mass ejection" blew across the orbit of Earth in 2012, missing the planet by just a few days. *Solar Orbiter* should be thought of as a form of "planetary defense", said Ian Walters of Airbus, the craft's European maker. Its data will help with the development of models that might allow an incoming burst of electronics-frying particles to be foreseen a few days before they strike Earth. Electrical grids and other equipment might then be temporarily switched off or otherwise protected. Although this lacks the glamour of exploring Mars, but it may be the noblest mission of 2020.



AEROSPACE: NASA OFFICIALS HAVE APPROVED THE FINAL ASSEMBLY OF THE X-59 QUESST

Quiet Supersonic Technology (QueSST) aircraft

The long, thin profile of this aircraft is designed to break up the thunderous sonic boom of normal supersonic flight into a series of much quieter "heartbeats". This technology could be applied to new airliners, possibly allowing supersonic flights over populated areas.

Length 28.7m (84.2ft)
Wingspan 8.99m (29.5ft)
Ceiling 16,764m (55,000ft)
Speed Mach 1.4 (1,074mph)

Extended nose
Shapes forward shock through atmosphere

Canards (small forward wings)
Helps break up pressure points that cause sonic shockwaves

Conventional aircraft tail
Provides stability and control at low speeds

Single jet engine
Similar to the one currently used on the F/A-18 Hornet fighter

Sonic booms and loudness

Decibels	Comparison
140	Fireworks
130	Threshold of pain
120	Damage threshold for short duration sound
110	Front row at a rock concert
100	Concorde boom
90	Orchestra
80	Ear plugs recommended
70	Town traffic
60	Normal conversation

HOW AIRCRAFT CREATE A SONIC BOOM

Below Mach 1 Aircraft create pressure waves that travel at the speed of sound

Mach 1 At sound barrier waves compress and create a shockwave

Beyond Mach 1 Shockwaves form a cone, trailing the aircraft and is heard as a boom

New X-Plane could halve current flight times

City	Current Boeing 747	New X-Plane
Los Angeles	11hrs	5hrs
New York	7hrs	3.5hrs
Beijing	10hrs	5hrs
Tokyo	11.5hrs	5.5hrs
Auckland	23hrs	11hrs
Sydney	22hrs	10hrs
Johannesburg	11.5hrs	5.5hrs
Buenos Aires	13.5hrs	6.5hrs

Boom passenger jet to fly faster than Concorde

Aerospace company Boom says it has received 76 orders for its supersonic passenger plane from five airlines. The aircraft will use modern turbofan engines which are both quieter and more fuel-efficient. A one-third scale prototype will be tested in 2018

Length 52m (170ft)
Wingspan 18m (60ft)
Passengers 45-55
Speed Mach 2.2 (1,451mph)
Ceiling 60,000ft (18.2km)

2.6 times faster than Concorde

London - New York in **3hrs 24mins**

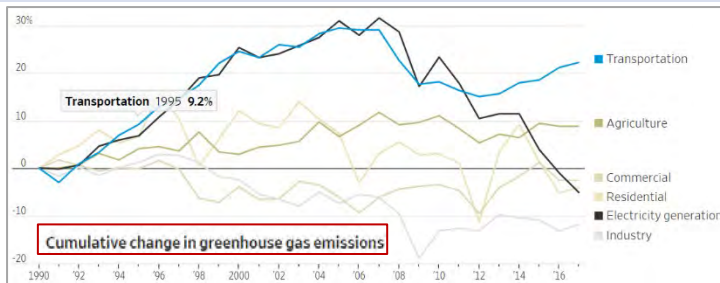
SOURCE: NASA, LOCKHEED MARTIN, BOOM, GRAPHIC NEWS

AUTOMOTIVE: TRANSITION TO EVS DEPENDS ON A NATIONWIDE NETWORK OF EV CHARGING STATIONS

Analysts at Bloomberg New Energy Finance have predicted that 20 years from now, more than half of new cars sold will be electric. However, **before there can be a nationwide transition to electrical car usage, there must be a sufficient network of EV charging stations to reduce range anxiety for potential owners.** EV charging stations typically fall under three main categories. A Level 1 EV charging station uses a 120 V AC plug and can be plugged into a standard outlet. A Level 2 EV charging station uses a 240V for residential and 208V for the industrial plug, usually installed by a professional electrician and can also be part of a solar panel system. Level 3 EV charging station (DC Fast Chargers) can offer 60 to 100 miles of range for an electric car in 20 minutes of charging, but DC fast chargers are only used in commercial and industrial applications because they require highly specialized, high-powered equipment to install and maintain. GM and construction company Bechtel are teaming up to build a network of fast chargers. Data from drivers of both electric and gasoline-powered GM cars, gathered voluntarily through GM's OnStar system, will help dictate where chargers will be built. Electrify America, a charging network company financed by VW as part of its diesel emissions scandal settlement, is rapidly building out a charging network and has deals to allow its network to seamlessly work with others. Tesla has a huge network of its Superchargers that the company frequently points to as an important selling point for its cars and SUVs. Chargers are getting faster. Swiss industrial company ABB claims its chargers will be able to fill a car's battery pack to 80% in under 10 minutes but this depends on cars being able to accept a charge that quickly. Charging speeds are already becoming a bragging point for automakers.



AUTOMOTIVE: U.S./EUROPE TRANSPORTATION SECTOR GREENHOUSE-GAS EMISSIONS STEADILY RISING

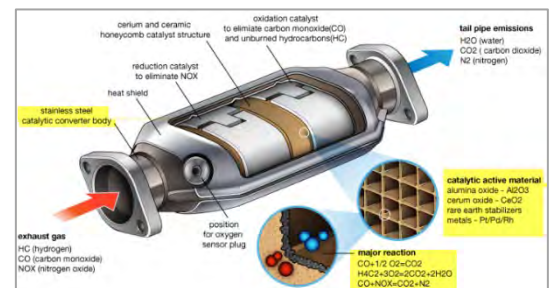


Sustainability seems hardest for the firms that generate energy or extract the necessary commodities because moving away from oil and gas and into renewable sources requires turning their entire business models upside down. **But the past five years suggest that businesses that move people and goods may have just as difficult a road ahead.** During this period the transportation sector has been the only sector in which greenhouse-gas emissions have consistently risen both in the U.S. and in the European Union.

AUTOMOTIVE: CUTTING THE COST OF CATALYTIC CONVERTERS BY REARRANGING A FEW ATOMS

Cars use catalytic converters to remove carbon monoxide, hydrocarbons and other harmful chemicals from exhaust emissions, but converters rely on costly metals such as palladium to do the job, and they quickly lose their effectiveness. Replacing the converters is an option, but they are one of the costliest components on a car at about \$1,000 apiece.

A team at Stanford University have come up with a way to reduce the cost of converters and extend their operational life. Catalytic converters are costly in part because they contain up to five grams of palladium at \$50/gram, which is more than the price of gold. The palladium and other metals are the catalysts needed to maintain and accelerate the chemical reactions that clean the exhaust. In theory, catalysts can be used over and over but in practice catalysts' performance goes down over time. To compensate, auto engineers use more of these expensive metals, adding to the cost. Ideally, catalysts should have the greatest surface areas possible to promote the greatest number of chemical reactions. So manufacturers typically spread a layer of small particles over the surface of new catalytic converters. Research has shown that these metal atoms move, forming larger and larger particles with less surface area and becoming less effective, a process called sintering. To counteract sintering, manufacturers use enough catalytic metal that the converter will meet emissions standards for 10 to 15 years, the lifespan of the car. The Stanford team discovered that sintering isn't the only cause of catalyst deactivation. In fact, this new deactivation mechanism turns out to be quite the opposite of sintering. Under some circumstances, instead of particles sintering, they decompose into smaller particles and eventually become inactive single atoms. The team wants to carefully control the size and spacing of catalytic particles so they will neither sinter into large clumps nor decompose into single atoms. The Stanford researchers provided a scientific basis for maintaining catalytic converters' pollution reduction while using less precious metal. If automotive engineers confirm and implement these findings, it should lower the cost of converters without harming their performance.

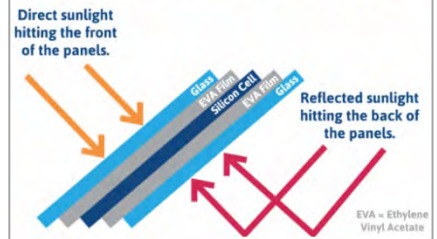




ENERGY: SOLAR POWER FROM 'THE DARK SIDE' UNLOCKED BY A NEW FORMULA

Most solar panels capture sunlight and convert it to electricity only from the side facing the sky. If the dark underside of a solar panel could also convert sunlight reflected off the ground, even more electricity might be generated. Double-sided solar cells are already enabling panels to sit vertically on land or rooftops and even horizontally, but it hasn't been known exactly how much electricity these panels could ultimately generate or the money they could save. **A new thermodynamic formula reveals that the bifacial cells making up double-sided panels generate on average 15% to 20% more sunlight to electricity than the monofacial cells of today's one-sided solar panels, taking into consideration different terrain such as grass, sand, concrete and dirt.** The formula, developed by two Purdue University physicists, can be used for calculating in minutes the most electricity that bifacial solar cells could generate in a variety of environments, as defined by a thermodynamic limit. The formula involves just a simple triangle, but distilling the extremely complicated physics problem to this elegantly simple formulation required years of modeling and research. This triangle will help companies make better decisions on investments in next-generation solar cells and figure out how to design them to be more efficient. The formula can be used to calculate the thermodynamic limits of all solar cells developed in the last 50 years. These results can be generalized to technology likely to be developed over the next 20 to 30 years. The hope is that these calculations would help solar farms to take full advantage of bifacial cells earlier in their use. **The Purdue physicists might have gotten the math settled just in time: experts estimate that by 2030, bifacial solar cells will account for nearly half of the market share for solar panels worldwide.** Their approach is called the *Shockley-Queisser Triangle* since it builds upon predictions made by researchers William Shockley and Hans-Joachim Queisser on the maximum theoretical efficiency of a monofacial solar cell. This maximum point, or the thermodynamic limit, can be identified on a downward sloping line graph that forms a triangle shape. The formula shows that the efficiency gain of bifacial solar cells increases with light reflected from a surface. Significantly more power would be converted from light reflected off of concrete, for example, compared to a surface with vegetation. The researchers use the formula to recommend better bifacial designs for panels on farmland and the windows of buildings in densely-populated cities. Transparent, double-sided panels allow solar power to be generated on farmland without casting shadows that would block crop production. In addition, creating bifacial windows for buildings would help cities to use more renewable energy.

Bifacial Solar Panel Cross Section



MANUFACTURING: GLOBALIZATION IN TRANSITION WITH MOVEMENT AWAY FROM MANUFACTURED GOODS

A connected world in flux

30 years of cross-border trade flows have transformed the global economy, but now they're moving in a new direction.



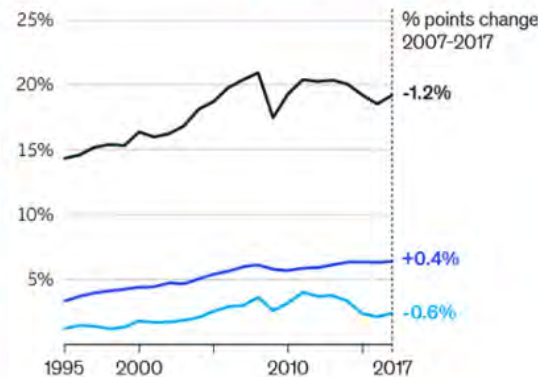
Globalization in transition

We are entering a new phase of globalization.

Global value chains are fundamentally shifting—one sign of this is the movement of global exports away from manufactured goods, and toward services.

Although goods are still traded at higher volumes, certain services are growing up to 3x faster:

- Manufactured goods
- Services
- Primary resources



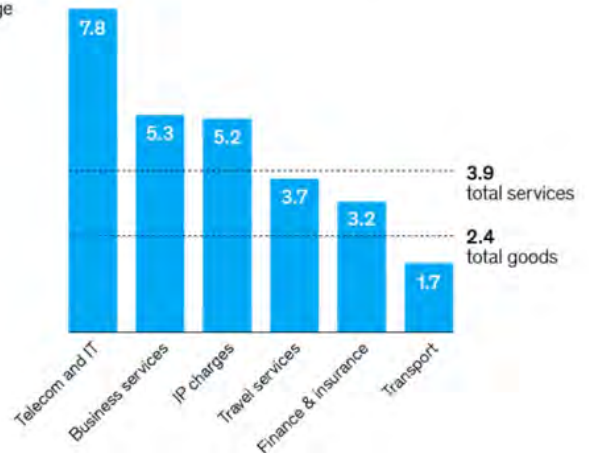
based on McKinsey Global Institute 2019 research



This has a profound impact on the mix of industries and countries that are involved in both sides of this shift.

Service sectors

Global CAGR, 2007-2017, % of GDP



MEDICAL: WHAT DOES 2020 HAVE IN STORE FOR MEDTECH?

A recent report from Needham & Co. offered some predictions about 2020 for the medical device industry. Needham expects medtech market growth to improve somewhat in the new year (from 4.9% in 2019 to 5.5% in 2020 on a constant currency basis). Breaking that down



to specific sectors, **it expects to see market growth in knee and hip replacements, spine, trauma, extremities, cardiovascular, pacemakers, peripheral vascular, transcatheter aortic valve replacement, drug-eluting stents, electrophysiology, and neuromodulation.** Needham noted that the medical device tax is scheduled to kick in again in January after being suspended for the last four years, but a repeal appears imminent as part of a bipartisan year-end spending. If the tax is

not suspended or repealed, Needham estimates it would reduce 2020 earnings per share at large companies by an average of 5% and at small and midsize companies by an average of 11%. **The number of medtech M&A deals was relatively stable last year, with about 332 deals in 2019, which is down a bit from 338 deals in 2018. The dollar value of such deals dipped from \$30 billion in 2018 to about \$28 billion in 2019. Deal activity is expected to remain high in 2020.** "From a financing perspective, interest rates have been lowered and are likely to continue to remain stable next year, in our view, and they remain very low by historical standards. Since stock prices remain relatively high, we think that companies should continue to be willing to use their stock as currency. However, we think that there is a risk that M&A slows as the 2020 election approaches given increased uncertainty about potential changes to healthcare policy."

Transitioning to become compliant with Europe's new Medical Device Regulation (MDR) framework may be causing disruption for medtech now, but the change should be beneficial for the industry in the longterm. The new MDR will demand more rigorous clinical evidence for Class III and implantable devices (both pre-market and post-market, and existing products will need to be recertified under the new MDR requirements by 2024 in order to keep them on the market in Europe. "Our conversations with management teams suggest that the notified bodies in Europe have backlog of new and existing products which has resulted in a delay in products receiving approval," Needham said. "We went through transcripts for our coverage universe and the consensus seems to suggest that the longer-term impact should be beneficial. However, there is a significant amount of disruption and investments in the near-term to either come into compliance with the new framework or to try to get products approved before the MDR effective date."

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MEDICAL: TECH TRANSFER LEADS TO REACTOR FOR MEDICAL ISOTOPES

A New Mexico company secured funding this year and acquired 240 acres of land in the southeastern corner of the state to build a small reactor dedicated to producing medical isotopes. **The concept was developed and licensed by Sandia National Laboratories to help establish a stable domestic supply of medical isotopes, which are made with low-enriched uranium and help diagnose a number of diseases.** This effort earned a regional Excellence in Technology Transfer Award from the Federal Laboratory Consortium, an association that recognizes industry and federal laboratories for outstanding work to develop and commercialize innovative technologies. Medical isotopes are used annually around the globe in 40 million imaging procedures that diagnose heart disease, cancer and other life-threatening conditions. The isotopes are injected into patients and emit gamma rays that can be tracked in the body, letting physicians

"see" the spread of a disease. The isotopes also decay quickly, so patients are exposed to little radiation. Building a new reactor is important because there are a limited number of them in the world that primarily produce molybdenum-99, or moly-99, which decays to technetium-99m, a short-lived isotope that makes up the individual patient doses. Some of those reactors have unplanned outages, causing shortages and price spikes. For example, one major supplier of Moly-99 incurred an unplanned complete production outage for nine weeks between September and November 2019, while at the same time another major supplier has been operating at 40% of normal production for several months. These unplanned Moly-99 production outages have caused significant world-wide shortages of patient doses. Until Eden's Moly-99 production capacity comes to market, supply reliability will continue to remain an issue, potentially putting patient health at risk. **Sandia's concept to produce moly-99 with a small 2-megawatt reactor requires less maintenance than larger reactors.** The reactor will use low-enriched uranium and could help contribute to a reliable domestic supply of moly-99 without using high-enriched uranium. The company building the reactor, Eden Radioisotopes LLC, first had to demonstrate that it had a funding plan and experience to obtain an exclusive license for the technology. "This has been a stellar example of transferring Sandia technology," said Sandia business development specialist Bob Westervelt, who worked on licensing the concept. "The team that worked on this from Sandia was really committed to making this work, and Eden is making it possible for the technology to move forward."



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INNOVATION: VIRTUAL TRAVEL COULD CHANGE THE WORLD—IF IT GETS OFF THE GROUND

Virtual travel or “live delivery” doesn’t exist yet, but proponents of the technology believe that in the coming years a mix of virtual reality, fast wireless networks and machines such as drones and rovers will allow people to immerse themselves in actual, far-flung environments



in real time. “Live delivery is a new type of tool that will reinvent the way we experience the world, allowing us to be on the spot when things are happening,” said Marc Carrel-Billiard, senior managing director at Accenture Labs. While VR shows prerecorded scenes, live VR allows users to experience what is happening in place. Companies are starting to pair simplified versions of live VR with drones to give users a sense of being in another place. Live VR can also give people access to places they can’t physically go, even in relation to medical treatment. **Seattle-based Pyrus Medical is developing a system that gives surgeons an immersive look inside patients’ blood vessels. The system uses a**

VR headset and sensors attached to catheters inserted during surgery. By giving surgeons a view into the body, the company hopes to reduce the need for surgical X-rays and operating suites for minimally invasive procedures.

Significant technological hurdles stand in the way of their ultimate vision. The amount of data needed for live 360°, three-dimensional video isn’t possible to transmit without significant time lags on current wireless networks. Headsets can be clunky and expensive, and the systems require additional graphics cards and cables. The emergence of ultrafast 5G wireless networks and computing that would allow data to be processed closer to devices—rather than in the cloud—could help these issues, but 5G service is still in its infancy, especially in the U.S.. Some startups are developing live VR without drones. Immertec, a Tampa-based startup, partnered with Johnson & Johnson to provide physicians with live, VR-enabled streams of real surgical procedures at dozens of U.S. hospitals. Pairing live VR with drones is the next step. Many huddles exist, however. The large processing chips required for live-streaming immersive scenes would weigh down small drones and require extended battery power. Many governments have restricted drones in populated areas and require operators to undergo a hefty approval process to fly them beyond the line of sight. There are safety and privacy concerns and a lack of awareness about the commercial value of drones, so in many urban areas people have not yet socially accepted them. Still, startups are pushing ahead. For consumers, San Diego-based NewBeeDrone is working on a headset for use with first-person-view drones that comes with high-definition views. Still, the technological developments needed for useful, widespread teleportation by drone are likely years away.

INNOVATION: MICROBES CAN RECOVER RARE-EARTH MAGNET MATERIALS FROM CONSUMER WASTE

Rare earth elements (REEs) such as neodymium and dysprosium are essential for technologies like solar and wind energy, advanced vehicles and modern electronics. They comprise 17 elements in the periodic table—scandium, yttrium, and the 15 lanthanides. Despite their name, the rare earths (except for promethium) are not all that rare and found in relatively high concentrations across the globe. However, because of their geochemical properties and the current geopolitical situation, they are seldom discovered in easily extractable deposits. Once mined, it usually takes extensive (and expensive) chemical processing to isolate the individual REEs. As a result, the cost of REEs is climbing while they become more essential for American competitiveness in the clean energy industry, as well as in many devices important to a high-tech economy and national security. **To increase the U.S. supply of rare earth elements, a Critical Materials Institute team led by Lawrence Livermore National Laboratory is using microbe beads**



to recover rare earth elements from consumer electronic waste such as cell phones. The team developed a scalable biosorbent, a microbe-embedded polymer, by combining material science with microbiology. In the new research, an E. coli biosorbent was placed inside a permeable polyethylene glycol diacrylate hydrogel. The resulting microbe beads can selectively extract REEs from a liquid passed through electronic waste (a feedstock leachate). In addition, the microbeads are reusable, with an adsorption capacity that remains unchanged after nine consecutive adsorption/desorption cycles tested so far. The microorganisms synthesize and display high-density surface-accessible adsorption groups as they grow and multiply, facilitating high-capacity REE recycling without complicated and costly chemical synthesis. The new method could be used to recover REE’s from end products thrown away that use neodymium magnets. **These permanent rare-earth magnets are commonly used in wind turbines, hybrid and electric vehicles, household electrical appliances, computer hard disk drives, and small consumer electronic devices.** The magnet’s useful life varies with application, going from as short as 2 to 3 years for cell phones to 20 to 30 years in wind turbines. Recycling REEs from this type of magnet from the end-of-life products will play an important and complementary role in the total supply of REEs in the future. Recycling REEs is currently limited. The Livermore team hopes to change this with its biosorption extraction method.



METALS: COMMODITY PRICES — NICKEL, ALUMINUM, COPPER & IRON ORE; COBALT SUPPLY

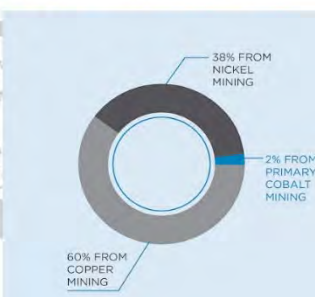
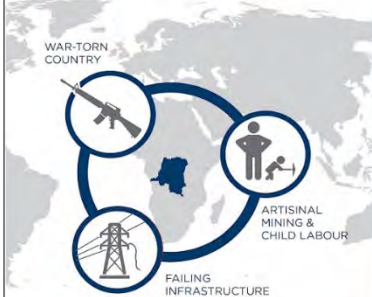


Cobalt Supply

Problematic Supply Chain

60% OF COBALT RESOURCES ARE IN THE DRC

98% OF COBALT PRODUCTION IS MINED AS A BY PRODUCT



IRON ORE

Iron Ore increased 1.50 USD/MT or 1.63% since the beginning of 2020, according to trading on a contract for difference (CFD). Historically, Iron Ore reached an all time high of 200 in November of 2007.



COMMODITIES: U.S. ARMY WILL FUND RARE EARTHS PLANT FOR WEAPONS DEVELOPMENT

The U.S. Army plans to fund construction of rare earths processing facilities, part of an urgent push by Washington to secure domestic supply of the minerals used to make military weapons and electronics. **The move would mark the first financial investment by the U.S. military into commercial-scale rare earths production since World War II's Manhattan Project built the first atomic bomb.** China, which refines most of the world's rare earths, has threatened to stop exporting the specialized minerals to the U.S., using its monopoly as a weapon in the ongoing trade war. A rare earth processing pilot plant could cost between \$5 million and \$20 million, depending on location, size and other factors, with a full-scale plant potentially costing more than \$100 million to build. After processing, rare earths need to be turned into rare earth magnets, which are found in precision-guided missiles, smart bombs and military jets. China controls the rare earths magnet industry too. The Pentagon has not yet launched an effort to finance domestic magnet manufacturing.



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