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ECONOMIC UPDATE

Number 4 • DECEMBER 2019

EXECUTIVE SUMMARY

AMERICAS: U.S. MANUFACTURING CONTRACTED FASTER THAN EXPECTED IN NOVEMBER, rekindling worries about the country's trade wars. It was the fourth-consecutive month of contraction for the ISM manufacturing index. Businesses have reduced production in response to softer demand, especially for exports. A mild recovery in farm exports to China wasn't enough to offset a broad decline in goods exports. **U.S. job growth** increased by the most in 10 months as striking workers returned to GM payrolls and the healthcare industry boosted hiring, the strongest sign yet the economy was not in danger of stalling soon. **U.S. services sector activity** slowed again amid lingering concerns about trade tensions and worker shortages. **Retail sales** climbed slightly, driven by higher spending at gas stations and at food and beverage stores. **The housing market** perked up, with gains in housing starts and existing home sales. **U.S. consumer confidence** fell for the fourth consecutive month in November. **U.S. productivity** fell 0.3% in the 3rdQtr, the first decline in almost four years. **The Leading Economic Index** slipped 0.1% in October following a 0.2% decline in both September and August.

OVERSEAS: CHINA'S FACTORY ACTIVITY UNEXPECTEDLY ACCELERATED in November, ending six months of contraction. **The Bank of Korea** turned downbeat about the South Korean economy. **Eurozone manufacturing activity** contracted for a 10th straight month in November although the forward-looking indicators indicate a possible rebound. **The German economy** unexpectedly rebounded in the third quarter, easing fears of a recession that could drag down the rest of the eurozone.

STEEL: TARIFFS ON STEEL AND ALUMINUM IMPORTS FROM BRAZIL AND ARGENTINA WERE REINSTATED by the U.S.; both nations were accused of devaluing their currencies. **ArcelorMittal** idled a blast furnace at its Indiana Harbor West mill in East Chicago, as the U.S. steel industry continues to struggle with weak demand. **Cleveland-Cliffs will buy AK Steel** in a stock deal valued at about \$1.1 billion. **Output by the major European stainless steel producers** from January to September declined by -9% year-over-year.

METALS/COMMODITIES: NICKEL PRICES LOST MORE GROUND IN THE FINAL WEEK OF NOVEMBER due to concerns over slowing Chinese demand. LME nickel price fell nearly 17% in the past four weeks. **The nascent lithium industry** has entered its first major downturn with global supply exceeding demand by about 5%. The metal is used to make electric vehicle batteries. The global average of lithium prices is already down more than 50% since the start of 2018. **Apple will take delivery of the first batch of carbon-free aluminum** produced by a joint venture of Alcoa and Rio Tinto (Elysis) using new smelting technology that emits pure oxygen.

AEROSPACE: BOEING WAS AWARDED A \$1 BILLION NATO CONTRACT to upgrade its fleet of AWACS reconnaissance planes. **United Airlines** is buying 50 Airbus A321XLR jets for flights between the U.S. East Coast and Europe. It is the latest setback for Boeing, which has fallen behind Airbus in their annual contest for orders and deliveries. **The U.S. government is pushing into hypersonic weapons** in a big way and nanotechnology is key to enabling delivery systems to survive traveling through the atmosphere at \geq Mach 5.

AUTOMOTIVE: VW WILL BUILD A NEW FACTORY NEXT TO ITS CHATTANOOGA PLANT to assemble battery packs for its upcoming line of battery electric vehicles. About 1,000 jobs are expected to be added to the plant as a result of the \$800 million investment. **Tesla's electric pickup** called Cybertruck was unveiled in Los Angeles in November. The futuristic, trapezoid-shaped vehicle will use the same 301 stainless steel Tesla's SpaceX will use for its Starship spacecraft. **U.S. total light-vehicle sales** were estimated at an annualized rate of 17.5 million in November, a touch better than a year ago. Automakers boosted incentives by 12% per vehicle in November.

MEDICAL: INCREASING TECHNOLOGICAL ADVANCEMENTS ASSOCIATED WITH CORONARY STENTS, such as bifurcated stents and use of biodegradable materials, are expected to contribute to a rise in the overall market value. Over \$8 billion worth of coronary stents will be sold annually by 2025. The increase over the years will be primarily due to an increase in artery diseases. **Glucose monitoring systems maker Dexcom** reported third quarter revenue grew by 49% to \$396.3 million vs. a year ago.

ENERGY: THE U.S. SOLAR INDUSTRY LOST 62,000 NEW JOBS AND \$19 BILLION IN INVESTMENTS because of tariffs on imported panels imposed two years ago, according to a new report from the U.S. Solar Industries Association. A **\$10 billion offshore wind-power project** in Taiwan demonstrates Asia's growing presence in a market previously centered in Europe. Japan's largest power-generation company, Jera Co., is in talks to take a 40% stake in Formosa 3, a project to make Taiwan a leading offshore wind producer.

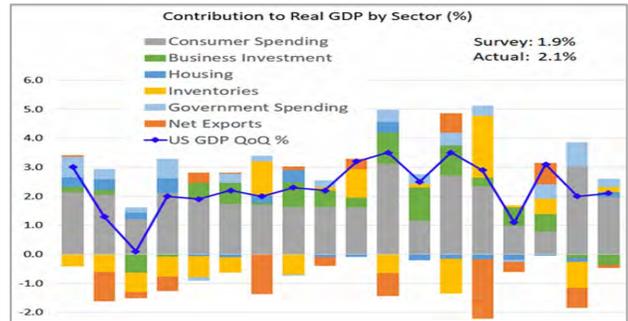
INNOVATION: ATOM BY ATOM, SUPERCOMPUTERS SHED LIGHT ON ALLOYS. Trial-by-error alloy development in smelting metals has given way to the use of high-performance computing to micromanage alloy development down to individual atoms. **German manufacturing giant ThyssenKrupp** has completed a successful, first-of-its-kind demonstration of running a steel furnace completely on hydrogen, a development that is likely to further dent the future prospects for the global coal industry. **Sono Motors intends to build the world's first solar-electric vehicle**, one underpinned by a conventionally charged battery and augmented with solar power.



THE AMERICAS

- **The Federal Reserve**, in its latest financial stability report, identified elevated asset prices and record high debt owed by U.S. businesses as top vulnerabilities facing the U.S. financial system. The Fed cited potential risks tied to borrowing by non-financial companies, particularly leveraged loans—a \$1.1 trillion market that is growing quickly despite consistently “weak” credit standards.
- **U.S. nonfarm payrolls** increased by 266,000 jobs in November as striking workers returned to GM payrolls. Employment growth was also boosted by a gain of 60,200 healthcare workers. The unemployment rate dipped to its lowest level in nearly half a century at 3.5 percent.
- **The foreign-trade gap** in goods and services in October contracted 7.6% to \$47.2 billion. Imports decreased 1.7% overall with imports of consumer goods dropping 4.4% as the U.S. imposed new tariffs on them. Motor vehicle and parts imports dropped \$1.8 billion. Exports fell 0.2% from September. Exports of vehicles, civilian aircraft engines and consumer goods all declined in October.
- **U.S. import prices** dropped 0.5% in October, excluding tariffs. Petroleum prices tumbled 3.7%. Excluding fuels and food, import prices slipped 0.2%. Export prices dipped 0.1% in October after falling 0.2% in the prior month. Export prices decreased 2.2% on a year-on-year basis in October.
- **U.S. consumer confidence** fell for a fourth consecutive month in November, driven by a softening in consumers’ assessment of current employment. The Conference Board confidence index edged down to 125.5 vs. 126.1 in October.
- **U.S. retail sales** climbed 0.3% in October. Consumer spending at gas stations and at food and beverage stores rose by 1.1% and 0.5%. Vehicle sales were up 0.5%. Excluding the often volatile categories of vehicles and gasoline, October sales were up 0.1%. Americans spent less on items such as clothing and eating and drinking out.
- **U.S. consumer prices** rose 0.4% in October driven by higher energy costs, which rose 2.7% and accounted for more than half of the headline increase. Energy prices were led higher by a 3.7% increase in gas prices. Core prices were up 0.2%. From a year earlier, consumer prices in October increased 1.8% and core prices were up 2.3 percent.
- **The U.S. Leading Economic Index** slipped 0.1% in October, following a 0.2% decline in both September and August. The LEI six-month growth rate turned negative for the first time since May 2016. The decline was driven by weaknesses in new orders for manufacturing, average weekly hours and unemployment insurance claims.

- **U.S. industrial production** fell 0.8% in October, evidence that slower global growth and trade tensions are weighing on the manufacturing sector. Manufacturing production, the biggest element of overall industrial production, declined 0.6%. Mining output fell 0.7% and utilities output dropped 2.6%. Industrial capacity utilization slumped to 76.7%, the lowest level in 25 months.
- **The U.S. economic expansion** remained broadly on track as it entered the 4thQtr. GDP for the 3rdQtr was revised 0.2% higher to a 2.1% annual rate, mainly due to an upward revision to inventory investment. Consumer spending drove economic momentum as businesses struggled.



- **The ISM index of national factory activity** dropped 0.2 of a point to 48.1 in November. The ISM index needs to break below the 42.9 level to signal a recession in the broader economy. Though the ISM said business sentiment had improved, November's reading marked the fourth straight month that the index signaled contraction.
Key Update: Economists say without a complete trade deal, manufacturing is unlikely to rebound much and the sector could remain under pressure with the resumption of tariffs on steel and aluminum imports from Brazil and Argentina.
- **Durable goods orders** rose 0.6% in October after dropping in September. Orders for military aircraft increased 18.1%. Excluding defense, durable goods orders edged up just 0.1%. The numbers reflected a strike at General Motors, settled in late October. Orders for cars and auto parts fell 1.9% in October and 2.9% in September.
- **U.S. factory orders** rebounded in October after two straight monthly declines. Total factory goods orders increased 0.3%, driven by orders for civilian aircraft and parts which increased 10.7% after a 19.0% drop in September. Transportation equipment orders expanded 0.7% in October after diving 3.2% in the prior month.
- **U.S. producer prices** rose 0.4% in October, the biggest jump in six months, reflecting a surge in energy costs. The October increase followed a 0.3% decrease in September. Core prices rose 0.3% in October. Over the past year, the overall PPI gained 1.1% while core prices have risen 1.6%.

- **U.S. services sector activity** slowed again in November amid lingering concerns about trade tensions and worker shortages, reviving fears about the economy's health. The ISM non-manufacturing activity index fell to a reading of 53.9 from 54.7 in October. The index for business production in the service sector slumped 5.4 points to 51.6, dropping to the lowest level since 2010 and accounting for most of the decline in the overall survey.
- **The U.S. housing market** has perked up in recent months, catching up to the Fed's easy monetary policy, which has pushed down mortgage rates from last year's multi-year highs. In October, existing-home sales rose 1.9% to an annual rate of 5.46 million. The median-sales price for an existing home in October was \$270,900, up 6.2% from a year ago. Housing starts increased 3.8% to an annual rate of 1.314 million units and 8.5% on a YOY basis. Sales of new homes dipped 0.7% to an annual rate of 733,000 units.
Key Update: The housing market momentum could slow as mortgage rates have risen in the last two months. The 30-year fixed mortgage rate is currently at 3.66%, still below its peak of 4.94% in November 2018.
- **Personal-consumption expenditures**, also known as household spending, increased 0.3% in October but much of that rise was due to higher outlays on electricity and gas. Households pared back their goods purchases, a sign of caution among consumers as the holiday season gets underway. Spending for long-lasting goods, particularly new motor vehicles, fell at a 0.7% rate.
- **U.S. construction spending** dropped 0.8% in October as investment in private projects tumbled to its lowest level in three years. Spending on private construction projects dropped 1.0% to \$956.3 billion, the lowest level since October 2016. It was held down by a 0.9% decrease in spending on private residential projects. Spending on private nonresidential structures, which includes manufacturing and power plants, plunged 1.2% in October to the lowest level since January 2018.
- **Seaborne imports** into the largest U.S. gateway for trans-Pacific goods plummeted in October as the latest sign of supply chain volatility from the U.S./China trade war. Los Angeles and Long Beach handled 120,077 fewer loaded inbound containers than a year ago, a 14.1% drop. The Pacific ports together handle about 37% of U.S. seaborne container import volume and are considered a bellwether of U.S. trade, particularly with Asia. The decline in container volume followed the implementation of a new round of tariffs in September on more Chinese products, including the first large list of tariffs on consumer goods items.

- **U.S. consumer credit** grew in September at the slowest rate in 15 months, increasing just \$9.5 billion vs. \$17.8 billion in August. This level was well below the monthly average growth for the first eight months of the year of \$16 billion. Revolving credit fell for the second straight month, the first time this has happened since the summer of 2012.
- **U.S. productivity** fell 0.3% in the 3rdQtr, the first decline in almost four years. Businesses reduced production in response to softer demand, especially for exports. Unit-labor costs rose at a 3.6% annual rate. Over the past year these costs have climbed 3.1%, the highest year-over-year clip in more than five years. The U.S./China trade war has disrupted global supply chains and contributed to a world wide slowdown in economic growth.
- **Capital spending by S&P 500 companies** rose by just 0.8% in the 3rdQtr for a combined \$1.38 billion. That modest increase can be chalked up to a few big spenders: Amazon and Apple alone raised capital spending by \$1.9 billion. Without them, total spending by the 438 other companies that have reported so far would have shrunk slightly. Overall spending would have shrunk by 2.2% absent increases from three others: Intel, Berkshire Hathaway and NextEra Energy. Together, the five companies increased their capital budgets by \$4.7 billion or 30 percent.
Key Update: The biggest pullback among S&P 500 companies came in the industrial sector where total spending fell by 10% or \$1.8 billion.



ArcelorMittal will idle a blast furnace at its Indiana Harbor West mill in East Chicago, IN, as the U.S. steel industry continues to struggle. After operating four blast furnaces at Indiana Harbor as recently as 2013, the idling leaves just two remaining blast furnaces at the facility. Meanwhile, U.S. Steel started a round of layoffs tied to a restructuring plan announced in October. USS did not disclose the number of job cuts, all non-union positions, but said the layoffs affect operations nationwide. In October, USS announced a realignment of its operating and organizational structure, a move it expects will generate \$200 million/year in cost savings by 2022. (See **Appendix: Steel**, page 9)



- **Steel mills** in the U.S. shipped 7.767 million tons of steel in September, an 8.3% drop from August and a 0.6% decline from September 2018. Steel mill product shipments year-to-date through September were 72.577 million tons, a gain of 1.6% over 2018 shipments for nine months.
- **U.S. raw steel production** for the year-to-date through November 30th was 88.9 million tons at a capability utilization rate of 80.2%, an increase of 2.0% from the same period last year at a utilization rate of 78.1 percent.
- **Steel imports into the U.S.** were 2.177 million tons in October, including 1.479 million tons of finished steel, up 14.5% and down 3.5% respectively vs. the prior month. For the ten months of 2019, total and finished steel imports were 24.770 million and 18.343 million tons, down 15.9% and 17% respectively vs. a year ago. Finished steel import market share was estimated at 20% YTD through October.
- **Tariffs on steel and aluminum imports** from Brazil and Argentina were reinstated by President Trump, saying both nations have been devaluing their currencies. The Brazil Steel Institute said the decision to levy tariffs will hurt U.S. steelmakers that need semifinished exports from Brazil to operate their own plants. For example, new tariffs on Brazil will raise the delivered costs of semi-finished steel for ArcelorMittal in Alabama which imports slabs from Brazil.
- **Cleveland-Cliffs will buy AK Steel** in a stock deal valued at about \$1.1 billion. The companies said the tie-up will create a vertically integrated company that pairs Cleveland-Cliff's iron ore pellet production with AK Steel's rolled and stainless steel operations. Cleveland-Cliffs is the largest producer of iron ore pellets in North America.
- **The first batch of carbon-free aluminum** produced by a joint venture of Alcoa and Rio Tinto (Elysis) will be taken by Apple in December. Elysis uses a new smelting technology innovation by Alcoa that emits oxygen and eliminates greenhouse gases when producing aluminum. Apple has said that 80% of its emissions from the iPhone 8 came during the aluminum smelting phase.
- **U.S. Steel** raised flat-rolled steel prices by \$30/ton, its third increase in less than a month. USS's announcement came after SSAB announced an increase in steel plate prices by \$40/ton, SSAB's second increase in two weeks.
- **Deere & Co.** warned of lower earnings next year after reporting a fall in 3rdQtr profits, hurt by trade tensions as well as poor weather in the U.S. farm belt that has slowed equipment purchases by farmers. Deere expects net income of \$2.7 billion to \$3.1 billion next year, lower than \$3.25 billion in 2019. Deere expects global agriculture and turf equipment sales to decline 5% to 10% next year.

- **The United Auto Workers union** secured a new labor deal at Ford Motor. The now-ratified contract at Ford, covering 56,000 UAW-represented factory workers, includes wage increases, a cap on the use of temporary employees and about \$6 billion in new U.S. factory investment to add or retain 8,500 jobs. Full-time workers will also get a \$9,000 signing bonus. (See **Appendix: Automotive**, page 11)
- **Tesla's electric pickup**, called Cybertruck, was unveiled in Los Angeles in November. The futuristic, trapezoid-shaped vehicle will start at \$39,900 with 7,500 lbs. of towing capacity and 250 miles of range per charge. Dual motor (\$49,900) and tri-motor models (\$69,900) extend towing capacity to 10,000 and 14,000 pounds, as well as a 300 and 500 mile range. Expected to arrive in late 2021, the pickups feature a cargo bed that can hold and charge an electric ATV. The Cybertruck will use the same 301 stainless steel Tesla's SpaceX will use for its Starship spacecraft.
Key Update: Tesla reported it received 200,000 orders for its Cybertruck within three days of its launch.
- **Volkswagen** plans to build a new factory next to its Chattanooga assembly plant to assemble battery packs for its upcoming line of battery electric vehicles. The announcement was made at the groundbreaking ceremony for an \$800 million expansion of the Chattanooga assembly plant to allow the operation to make EVs based on VW's global EV architecture. About 1,000 jobs are expected to be added to the plant as a result of the \$800 million investment, which will include a large addition to the body shop. VW will build internal combustion engine vehicles and battery EVs on the same assembly line. The battery cells for the EVs will come from a newly built \$1.7 billion SK Innovation plant under construction in Commerce, GA.
- **U.S. total light-vehicle sales** ran at an annualized rate of 17.5 million units in November, a touch better than a year ago, according to J.D. Power. The market researcher expects industry deliveries to drop to 16.8 million in 2020 from about 17.1 million this year. To move older model year vehicles from dealer lots, automakers boosted incentive spending by an estimated 12% to \$4,538 per vehicle.
- **Porsche** ranked highest among luxury auto brands in the J.D. Power 2019 U.S. Sales Satisfaction Index Study released in November. Mercedes-Benz finished a close second and Infiniti came in third. Buick ranked highest among mass-market brands. Buick was followed by GMC, Mini, Chevrolet, Volkswagen, Subaru, Ford, Honda and Nissan.



- **General Motors** filed a federal racketeering lawsuit against Fiat Chrysler and a handful of former executives at the auto maker. The suit is related to a federal investigation into corruption in the United Auto Workers' top ranks and the company's possible involvement. GM is accusing its rival of corrupting the collective bargaining process in 2009, 2011 and 2015 to solidify a labor cost advantage. Separately, the head of the UAW union resigned after the UAW's board publicly accused him of submitting false and misleading expense reports and concealing the misconduct. Earlier, Gary Jones took a leave of absence as UAW president amid a federal investigation into union corruption.
- **Fiat Chrysler** announced a tentative four-year labor contract with the UAW union as it looks to complete a \$50 billion merger with Peugeot-owner PSA Group. The agreement includes \$4.5 billion in new plant investments and 1,400 new jobs (adding to the \$4.5 billion in investment and 6,500 jobs Fiat announced earlier this year). Other details weren't released, but they are expected to echo contracts the UAW already concluded with Ford and GM.
- **Boeing** was awarded a \$1 billion NATO contract to upgrade its fleet of AWACS reconnaissance planes. The 14 planes are based in Germany and can already exchange information via digital data links, with ground-based, sea-based and airborne commanders. However, they will need a greater capacity to transmit data as technology develops.
Key Update: The AWACS upgrade will keep one of the few military assets operated by NATO in service until 2035.
- **Emirates Airline** reduced its order for Boeing's 777X jet and will buy the smaller 787 Dreamliner instead, a setback for Boeing's newest plane. Emirates continues to be the biggest customer for the upgraded 777 with orders remaining for 126 planes. (See [Appendix: Aerospace](#), page 10)
- **United Airlines** is buying 50 Airbus A321XLR jets for flights between the U.S. East Coast and Europe, a blow to Boeing, which has fallen behind Airbus in their annual contest for orders and deliveries. The new Airbus long-range jets, with a total list value of around \$6.5 billion, will replace United's aging fleet of 53 Boeing 757-200 planes beginning in 2024.
- **Amazon Web Services** is offering select enterprise customers the ability to experiment with early-stage quantum-computing services over the cloud, following other companies racing to commercialize the emerging technology. Boeing plans to collaborate with AWS in exploring potential applications for quantum computing, including how the technology could speed up materials-science research and how it could secure communications. (See [Appendix: Innovation](#), page 14)
- **Exxon Mobil** is accelerating its biggest asset sales in decades with plans to divest up to \$25 billion of oil and gas fields in Europe, Asia and Africa as it sharpens its focus on a handful of mega projects in Guyana, Mozambique, Papua New Guinea and the United States.
- **The U.S. solar industry** lost 62,000 new jobs and \$19 billion in investments because of tariffs on imported panels imposed two years ago, according to a new report from the U.S. Solar Industries Association. Despite the tariffs, global panel prices have continued to fall due to an oversupply in China. U.S. prices are among the highest in the world.
- **A sharp drop in coal use in the U.S. and Europe** has helped to slow the growth of global carbon dioxide emissions this year, with softening demand in China and India also contributing. A report launched at the U.N. climate summit in December showed that reduced coal use helped slow the projected growth in carbon dioxide emissions to 0.6% in 2019 compared with 2.1% the previous year. (See [Appendix: Energy](#), page 12)
- **Google's Project Nightingale** is collecting personal health data from Ascension facilities in 21 states without patient or doctor knowledge, according to *WSJ* sources. The data includes lab results, diagnoses and other information, including patient names and dates of birth. Privacy experts say Project Nightingale appears allowable under the HIPAA law, which lets hospitals share data with business partners if the information helps "the covered entity carry out its healthcare functions". (See [Appendix: Medical](#), page 13)
- **Glucose monitoring systems maker Dexcom** reported 3rdQtr revenue grew by 49% to \$396.3 million vs. a year ago. Volume gains and strong new patient additions continue to be the primary revenue growth driver. Operating income was \$56.0 million compared to \$13.9 million in the 3rdQtr 2018 and net income was \$45.8 million compared to \$46.6 million a year ago. The firm noted the three-year COMISAIR study results demonstrated Dexcom's CGM resulted in significant improvements to A1C and time in range regardless of method of insulin delivery.
- **A new UPS service for health-care customers** will launch early next year, using sensors and data analytics to track medical packages' exact location in near-real time. UPS Premier will prioritize the handling of shipments of medicines, DNA/gene therapies, investigative drugs, lab specimens and implantable medical devices to ensure that packages arrive at exactly the right time and place.



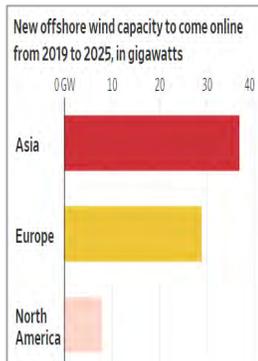
EUROPE, AFRICA & THE MIDDLE EAST

- **The world economy** is growing at the slowest pace since the financial crisis, according to new estimates from the OECD, which cut GDP growth to 2.9% this year and next (from 3% in 2020). "It would be a policy mistake to consider these shifts as temporary factors that can be addressed with monetary or fiscal policy; they are structural," OECD's chief economist wrote. Besides trade wars and a sharp Chinese slowdown, bigger concerns include climate change, digitalization and the crumbling of the multilateral order.
- **Eurozone manufacturing activity** contracted for a 10th straight month in November although the bloc's battered factories may have turned a corner as forward-looking indicators indicate improvement. IHS Markit's final manufacturing PMI has been below the 50 mark separating growth from contraction since February, but at 46.9 it was above October's 45.9. An output index that is seen as a good gauge of economic health rose to 47.4 from 46.6.
- **The German economy** unexpectedly rebounded in the 3rdQtr as the trade war between America and China lost some of its intensity, easing fears of a recession that could drag down the rest of the eurozone. GDP in Europe's largest economy grew 0.1% compared to the second quarter, when output had fallen 0.2 percent.
Key Update: Germany, Europe's biggest economy, is going through a soft patch but is on track to grow 0.2% this quarter. Its export-dependent manufacturing sector contracted at a slower pace for the second month in a row in November.
- **Emirates** ordered 50 Airbus A350-900 aircraft powered by Rolls-Royce Trent XWB engines in a deal at the Dubai Airshow worth an estimated \$16 billion.
- **ArcelorMittal's South Africa unit** will close its steel operations at Saldanha Works because it can no longer compete in export markets. MT said the process of winding down the operation, which employs 568 workers and produces 1.2 million mt/year of steel, will begin immediately and should be completed during during the 1stQtr of 2020. In Italy, Prime Minister Conte says his government would consider reintroducing guarantees of legal immunity for MT only if the company re-commits to a contract to buy the troubled Ilva steel plant.
- **Tata Steel** confirmed that 1,600 jobs in the Netherlands will be eliminated and that a further 1,000 jobs will be cut in Britain. Another 350 jobs will be cut across the rest of the company's European workforce. According to Tata Steel, two-thirds of the reductions will be management and administrative positions.

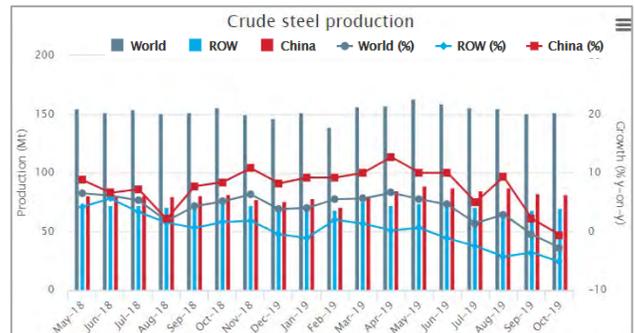
- **Output by the major stainless steel producers** in Europe (Outokumpu, Acerinox, Aperam) from January to September has declined by -9% year-over-year. While Outokumpu reported a loss for that period, Aperam and Acerinox still achieved positive results, but down by 50% year-over-year. Due to low market activity and continued import pressure from Asia, the steel mills project similar results for the 4thQtr. (See [Appendix: Steel](#), page 8)
- **German auto suppliers Continental and Osram** plan deeper cost cuts after reporting weaker results as a global slowdown hits the car industry. Demand in China, the world's biggest auto market, has fallen for 15 months, while carmakers are under pressure to invest in cleaner and self-driving technologies set to reshape the industry. BMW, Daimler and VW have all announced cost cutting plans because of the industry downturn that could tip Germany into recession for the first time since 2013. Japan's Nissan reported a 70% plunge in third quarter profit.
- **Tesla** will build its first European factory and design center near Berlin, giving the U.S. electric car pioneer the coveted "Made in Germany" label just as local rivals Audi, BMW and Mercedes prepare to launch competing cars. The new plant will make batteries, powertrains and cars - starting with the Model Y sports utility vehicle. Germany's biggest labor union, IG Metall, was quick to welcome Tesla's plan.
- **BMW** ordered more than €10 billion worth of battery cells from Chinese battery cell maker Contemporary Amperex Technology and Samsung SDI. Taking a major step towards the EV revolution, the automaker will get the cobalt and lithium it needs for cell production from mines in Australia and Morocco. BMW plans to have 25 electrified models in its offering by 2023 (more than half of them fully electric), and expects sales of EVs to double between 2019 and 2021.
- **Tata Group**, the owner of Jaguar Land Rover, approached carmakers including China's Geely, the owner of Volvo Cars, and BMW as it seeks partnerships to share the cost of a new generation of vehicles. Scale has become increasingly critical in the auto industry as carmakers pool resources to tackle electrification and self-driving capabilities. VW this year decided to team up with Ford, while PSA Group in October agreed to merge with Fiat Chrysler to create the world's fourth-largest automaker.
- **The European Union** filed a lawsuit with the WTO over the Indonesian government's policy of banning the export of nickel. Indonesia had 10 days to answer the request and also was allowed 30 days of formal consultation. The EU formally raised the issue with the WTO on November 22, claiming that the policy was "violating the rules".

ASIA/PACIFIC, JAPAN, AUSTRALIA & INDIA

- China's factory activity** unexpectedly accelerated in November, ending six months of contraction. Both domestic and external demand showed improvement. China's official PMI came in at 50.2 in November, up from 49.3 in October and the first time above the 50 mark that separates expansion from contraction since April. Nonmanufacturing PMI rose to 54.4 in November from 52.8 in October, as services and logistics related to factory productions registered big jumps.
- A free-trade agreement** between the EU and Singapore went into effect in November. The deal scraps the vast majority of customs duties between the signatories and reduces non-tariff barriers. Singapore is the EU's largest trading partner in Southeast Asia.
- Key Update:** *Bilateral trade in goods and services between Singapore and the UK was worth US\$115 billion last year.*
- Profits at China's industrial firms** slid 9.9% YOY in October to US\$60.7 billion under pressure from slowing demand at home and the fallout from the Sino-U.S. trade war. That marks the greatest slump since the January-February period and compares with a 5.3% decline in September. The big drop suggests the real economy is still facing plenty of difficulties, likely prompting authorities to unveil more growth-boosting measures but in a restrained way.
- India's economy** slowed for the sixth quarter in a row during the 3rdQtr, with GDP dipping to a 6½-year low as concerned companies and consumers continued to hold back on spending. GDP in Asia's third-largest economy slowed to 4.5% growth, down from 5% in the previous quarter. Starting with lending and moving to automobile and home sales, economic indicators are all showing domestic consumption suffering.
- A \$10 billion offshore wind-power project** in Taiwan demonstrates Asia's growing presence in a market previously centered in Europe. Japan's largest power-generation company, Jera Co., is in talks to take a 40% stake in Formosa 3, the third installment of a project to make Taiwan a leading offshore wind producer. Formosa 3's two gigawatts of capacity would make it three times as powerful as the largest offshore wind farm currently in operation. Formosa 3 is scheduled to be completed between 2026 and 2030.



- The Bank of Korea** turned downbeat about the economy in line with private forecasts, lowering GDP estimates for this year to 2.0% (from 2.2%) and 2.3% in 2020 (from 2.5%). South Korea's GDP gained 0.4% in the 3rdQtr and 1.0% in the 2nd, while contracting 0.4% in the first quarter.
- World crude steel production** was 151.5 million tonnes (Mt) in October, a 2.8% decrease vs. October 2018. China's crude steel output was 81.5 Mt, a decrease of 0.6% compared to a year ago. The U.S. produced 7.4 Mt of crude steel, a decrease of 2.0% from a year ago. Japan produced 8.2 Mt of crude steel, down 4.9%. South Korea's crude steel output was 6.0 Mt, a decrease of 3.5% on October 2018.



- India's Supreme Court** removed the last legal hurdle for ArcelorMittal's \$6 billion takeover of Essar Steel, upholding key provisions of the three-year-old bankruptcy code in a critical test of the country's new debt resolution process. The fight among Essar Steel's creditors, who were owed a combined \$7 billion, over distribution of the proceeds from MT's acquisition had upended the takeover process last summer. The court decision not only ended tycoon Lakshmi Mittal's long wait to enter the world's second biggest steel market, but also comes as a reprieve for Indian banks which are struggling with bad loans worth \$140 billion.
- Nickel prices in London and Shanghai** lost more ground the final week of November on concerns over slowing Chinese demand. London nickel has fallen nearly 17% in the past four weeks, while Shanghai nickel has shed 14%. The stainless steel ingredient has come under pressure from worries about demand from stainless steel mills, mostly located in China, which account for roughly two-thirds of nickel consumption, estimated at about 2.4 million tonnes this year. (See [Appendix: Commodities](#), page 15)
- The nascent lithium industry** has entered its first major downturn with global supply exceeding demand by about 5%. The powerhouse metal is used to make electric vehicle batteries. The global average of lithium prices is already down more than 50% since the start of 2018, though analysts and mining executives are expecting a brighter future when they look out over the next decade.



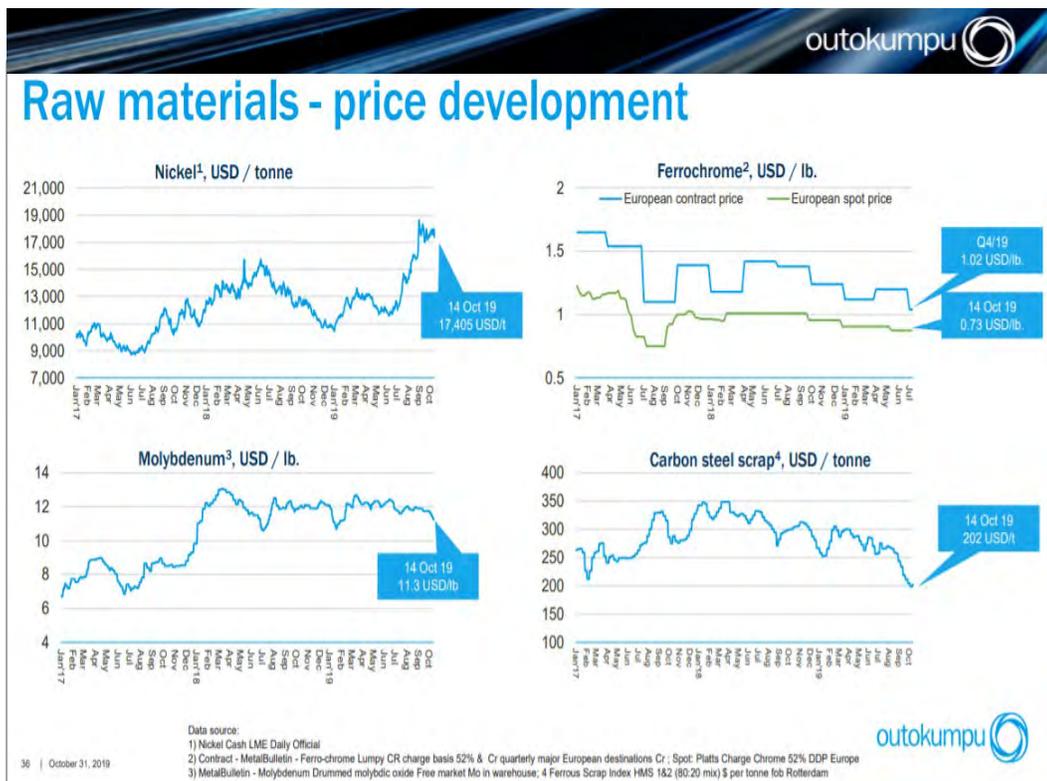
ECONOMIC UPDATE: APPENDIX TO DECEMBER 2019 REPORT

STEEL: THE USE OF MARAGING STEEL DELIVERS WORLD'S FINEST FENCING BLADES

U.S. two-time Olympian fencer Lee Kiefer, has what is known in fencing circles as a 'killing flicking riposte'. From the French for 'retort', the riposte is an offensive fencing action made to hit your opponent after blocking an attack. But what makes Kiefer's riposte special is her spectacular flick, in which she whips her fencing blade to drastically bend it, so she can hit opponents in hard-to-reach places. **The fencer has used her killer riposte again and again to win medal after medal, and it wouldn't be possible without her maraging steel blade.** Maraging steel first came to the fore in fencing following the death of Soviet fencer Vladimir Smirnov in 1982. During the Rome Championships, his opponent's blade broke and penetrated his mesh mask, piercing his eye and brain. His death nine days later prompted safety improvements in fencing gear, including the use of maraging steel in blade production. **With roots in aviation, maraging steel is a high-strength alloy made with around 18% nickel and lesser amounts of cobalt, molybdenum, titanium and aluminum. This combination of alloying elements stops titanium carbide precipitates from forming during heat-treatments as part of the manufacturing process.** This in turn preserves the alloy's amazing impact strength, ductility and toughness. Thanks to its chemical composition, the blade typically lasts four times longer than a carbon steel version, reducing the chance of injury. When microcracks inevitably form on the blade during swordplay, maraging steel slows the cracks from spreading. This slow propagation of cracks preserves the steel's rare combination of high strength and toughness, which for fencers is critical. Three types of fencing weapon exist, each featuring different blade designs. The 'foil' is a thrusting weapon with a rectangular blade designed to bend on impact, while the 'epee' is similar to the foil but has a triangular blade. The 'sabre', with its flat blade, is designed for cutting as well as thrusting. To make the blade, a steel rod is cut to the correct length according to sword-type and then heated by induction coils so that it's malleable, ready for hammering into shape while still red hot. After air-cooling, the blades are hardened and tempered in blisteringly hot salt bath ovens to impart the much-loved springy yet strong properties. In a final step, the cooled blades are pelted with glass beads—a process known as shot-peening—to further strengthen the weapons and improve surface finish.

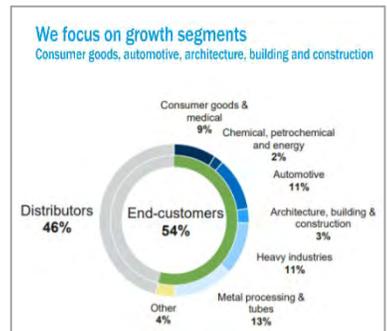


STEEL: OUTOKUMPU REPORTS ON STAINLESS RAW MATERIALS PRICES, OUTLOOK FOR 4TH QTR 2019



Outlook for Q4 2019

- The stainless steel market is expected to be subdued
- Deliveries are expected to be lower than in Q3/19
- The planned annual maintenance work at the Tornio stainless steel mill is expected to have up to €15 million negative impact on BA Europe's profitability
- Assuming the current raw material prices, the losses from raw material-related inventories and metal derivatives from Q3/19 are not expected to be repeated

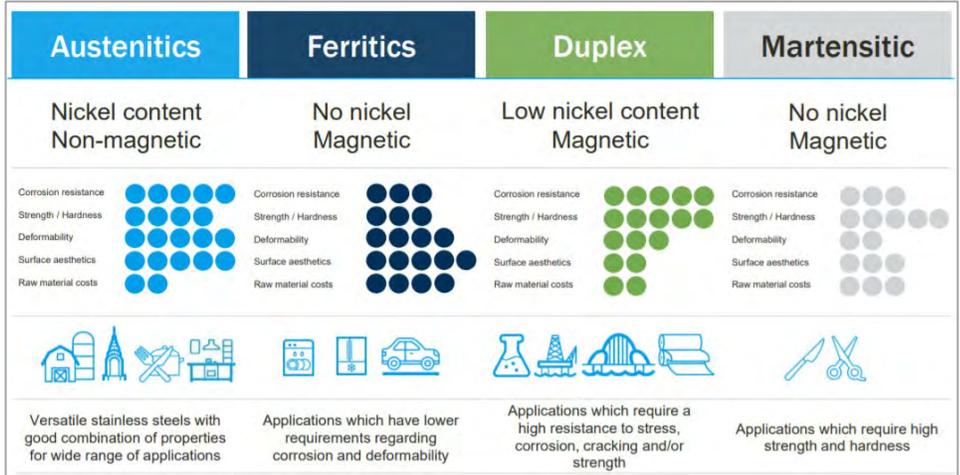




STEEL: STAINLESS STEELS CAN BE DIVIDED INTO FOUR MAIN GROUPS



Stainless steels are iron-chromium (Fe-Cr) alloys often with nickel (Ni) additions that "do not rust in sea water", "are resistant to concentrated acids" and "do not scale at temperatures up to 1100 °C". Molybdenum (Mo) and other alloying elements are sometimes added to achieve specific properties. Over the years ever since the development of stainless steel, the number of grades have increased rapidly. Stainless steels can be divided in four main groups that are suited for different applications. Outokumpu is global leader of advanced solutions.



STEEL: ARCELORMITTAL—GLOBAL STEEL DEMAND, USA PRICES AND SERVICE CENTER INVENTORY

Global steel demand

Global Apparent Steel Consumption (ASC) growth of +0.5% to +1.0% forecast in 2019F



- **Global apparent steel consumption to grow by +0.5% to +1.0%** in 2019F vs. 2018
- **US:** demand declined with ongoing weakness in automotive demand and a slowdown in machinery offset in part by healthy non-residential construction demand
- **Europe:** Ongoing automotive demand weakness and slowing construction exacerbated by supply chain destocking
- **China:** Positive demand growth due to better than expected real estate demand
- **Brazil:** Demand moderated to reflect delayed growth in infrastructure spend, ongoing supply chain destocking, as well as impacts of the Argentinian recession

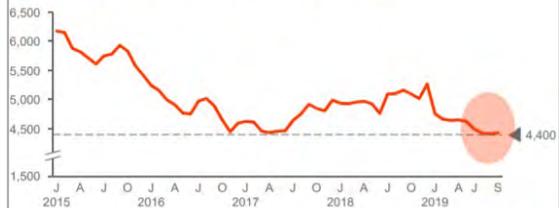
Forecast ASC growth 2019F v 2018* at Nov 2019



USA HRC price ExW Indiana \$/t vs Import Parity Price (\$/t)



MSCI US carbon flat rolled inventory (000' kt)

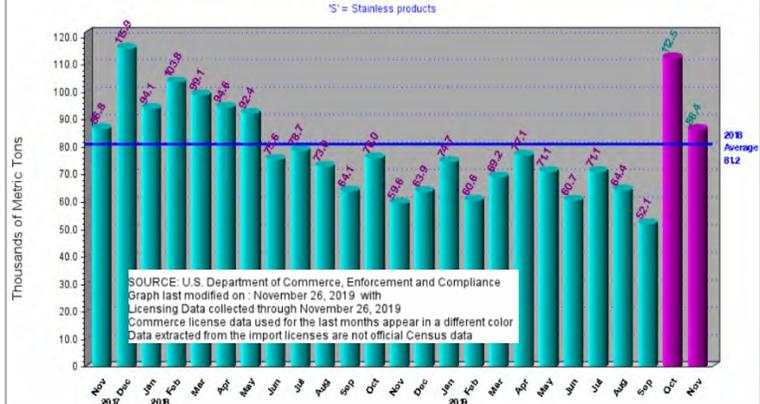


STEEL/AUTOMOTIVE: GLOBAL CAR SALES; U.S. IMPORTS OF STAINLESS STEEL PRODUCTS

Global Car Sales - Annual Change

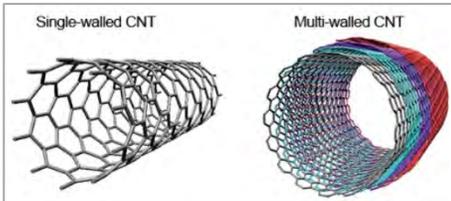


U.S. Imports of All Stainless Products From World



AEROSPACE: HOW NANOTECH WILL HELP THE U.S. MILITARY REACH MACH 5

The U.S. government is pushing into hypersonic weapons in a big way, with at least five different weapons programs currently in development. **Nanotechnology is shaping up to be a key tech that will enable delivery systems to survive traveling through the atmosphere at Mach 5 and above, with carbon nanotubes showing promise as a strong, lightweight material that rapidly sheds heat.** Hypersonic weapons travel at incredible speeds through the atmosphere. Hypersonics start at Mach 5 (3,836 miles/hour), or five times the speed of sound. Pushing an object through the air at super-fast speeds creates a unique problem: as speed increases, the friction from the object passing through air also increases and generates heat. The skin of the SR-71 Blackbird strategic reconnaissance jet, the fastest manned airplane ever built, regularly warmed up to 500°F at Mach 3. The X-15 rocket plane, flown during the 1960s, reached temperatures of 1200°F as it flew to Mach 6. At Mach 10, the friction is enough to melt the toughest steel, while at Mach 20, the temperature reaches an astounding 17,000°F. Eventually, hypersonic weapons could reach Mach 24. Scientists and engineers understand how to handle traditional air friction problems due to the technical challenges of spacecraft and nuclear warheads re-entering the atmosphere. However,



a missile warhead de-orbiting over an enemy target is only exposed to heat for a handful of minutes as it transitions from space to the atmosphere and finally smashes into its target. A hypersonic weapon, on the other hand, spends its entire flight within the atmosphere and is exposed to high heat the entire time. Scientists are working with carbon nanotubes to solve the heat issue. Scientists at Florida State University's High-Performance Materials Institute are looking into using carbon nanotubes as a construction material for hypersonic weapons.

Carbon nanotubes are a synthetic material consisting of carbon tubes with a diameter as small as one nanometer. Carbon nanotubes are stronger than steel and insulate against heat. Now, researchers have discovered that soaking carbon nanotubes in phenol can increase their ability to disperse heat by one-sixth, allowing less nanomaterials to be used for the same job. What does this mean for hypersonic weapons? It means that materials that can stand the heat and stresses of hypersonic, atmospheric travel are on the way, and that hypersonic weapon designers could even safely achieve higher speeds by using thicker layers.

AEROSPACE: WHEN WILL ELECTRIC AIRCRAFT REALLY TAKE OFF?

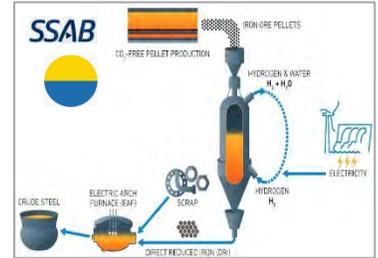
Every minute, 84 flights take off worldwide. In 2018, more than four billion journeys were made by plane. Today's aircraft are around 80% more fuel efficient per passenger-kilometer than 50 years ago. **Besides environmental implications, cost is another motivation for airlines to make the switch to electric. Airlines spend 25 to 50% of their costs on jet fuel, \$180 billion a year in total, making the switch to electric compelling.** Electric planes could mean cheaper tickets and quieter flights. The number of electric aircraft in development increased 50% in 2018 to 170 and investment is bound to increase. Despite all the hype surrounding electric flight, the industry is still far from achieving widespread electric commercial flight. Currently, electric flight is confined to small aircraft travelling short distances. One of the major limitations is the weight of batteries. Because they offer a much lower power to weight ratio than traditional jet-engines, they're extremely heavy. By using innovative composite materials, it is possible to achieve weight savings of up to 70% on key components. Alternatively, by using metal 3D printing, which adds material only where it is needed and can produce lattice structures, manufacturers can reduce weight. Designing lighter, better planes, is part of the solution, but what is really needed is higher battery energy density. Aerospace companies large and small are working on electric aircraft. Airbus is working with Siemens and Rolls Royce to develop a hybrid electric airline demonstrator, which uses two electric motors and has a flight time of 60 minutes. Another exciting project is "Alice", unveiled at the 2019 Paris Airshow by Israeli company Eviation. Developed from 95% composite materials, the plane will be able to carry nine passengers up to 1,046km, using one main pusher-propeller on its tail and one on each wing. The company is using Siemens and magniX to provide the electric motors. At this point, short to medium range electric flight seems achievable and is on the horizon. It seems likely that hybrid aircraft will be the next step for the industry, rather than fully electric planes. Hybrids could plug the gap until the technological requirements for electric aircraft have been met, as these craft will save on fuel, while still retaining many of the performance benefits of the modern gas turbine or propeller-based engines. Further developments in battery technology and in aircraft design are necessary for electric aircraft to truly take off.





AUTOMOTIVE: SSAB FOSSIL-FREE STEEL PRODUCTION—AUTOMAKERS PAY ATTENTION

Sometime after 2025 an automaker will have the bragging rights to the first car to feature steel components made via a fossil-free production process. Instead of CO₂ emissions, only H₂O (water vapor) will be released during the conversion of iron ore to iron; then that iron will be made into steel. Many automakers want to ‘stay ahead of the curve’ and be the first to market fossil-free steel from SSAB. A direct reduction of iron (DRI) ore using hydrogen has been done in laboratories before, but scaling up the hydrogen process has never been attempted. One of the reasons SSAB and its partners are so convinced they are on the right path is the result from the feasibility study completed in 2018. It had been calculated that fossil-free produced steel would have a 20% to 30% cost increase compared to traditional steel, but that difference keeps shrinking as the cost for carbon emissions increases and the cost of fossil-free electricity decreases. In 2016, SSAB, LKAB and Vattenfall joined forces to create HYBRIT, an initiative that endeavors to revolutionize steel-making by replacing coking coal with hydrogen. The result will be the world’s first fossil-free steel-making technology with virtually no carbon footprint. HYBRIT can take advantage of that extra renewable energy by using electrolysis to convert ordinary water to hydrogen. Green power will now be stored in the form of hydrogen in vast, underground caverns and ready for use by HYBRIT’s iron production. SSAB is making other major investments concurrent with HYBRIT in converting existing blast furnaces from using carbon to electric arc furnaces. SSAB’s blast furnace in Oxelösund must be rebuilt in 2025, but SSAB will replace it with an electric arc furnace instead. The electric arc furnace can be fed scrap steel until the HYBRIT plant produces its own sponge iron feedstock for SSAB’s steel production. About 90% SSAB’s current CO₂ emissions are from converting iron ore to iron using coking coal. HYBRIT will eliminate those CO₂ emissions. In line with SSAB’s global ambitions, the company anticipates that its U.S. operations, which utilize scrap-based electric arc furnace (EAF) technology, will be powered completely by renewable energy by 2022 at its Iowa operations. SSAB is looking into the possibility of building the demonstration plant in 2025, three years ahead of plan. **The goal is to be selling fossil-free produced steel on a broad scale by 2035.**



AUTOMOTIVE: SONO MOTORS PLOTS SOLAR-ELECTRIC VEHICLE

Sono Motors intends to build the world’s first solar-electric vehicle, one underpinned by a conventionally charged battery and augmented with solar power. **The car, called a Sion, comes with functionality banked in that allows motorists to both share power and vehicles themselves.**



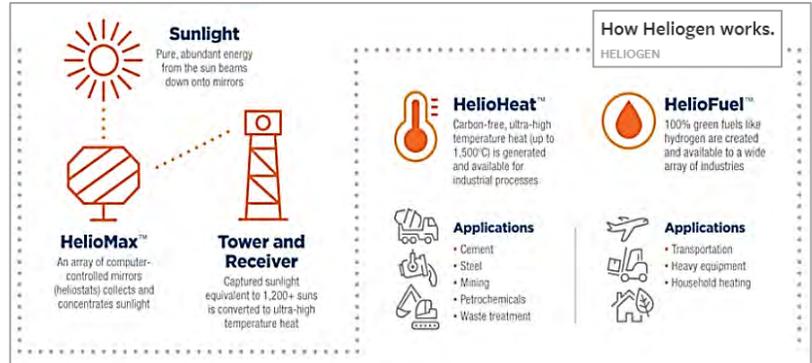
With a lithium ion battery supplied by Continental that has a 35- kilowatt-hour capacity, the Sion has a range of roughly 158 miles, augmented by the solar capabilities. Panels are embedded in the roof and sides of the Sion. Exactly how much range they add depends on the fickle nature of sun, season and clouds. On average, the company says motorists can expect about 3,600 miles/year, or just shy of 10 miles per day. The Sion is made to draw, store or share energy. Potential recipients of that power include other vehicles, homes and electric grids. The car is compatible with standard chargers, fast-chargers and European household outlets, and it can import or export energy via alternating or direct current. The vehicles are tailor-made with an eye toward a demographic that’s allegedly on the brink of a generational shift away from traditional ownership and toward shared mobility services. More than 10,000 customers have plunked down an average of \$1,200 to reserve a Sion, with 80% from Germany.

AUTOMOTIVE: STEEL AND ALUMINUM RULES FOR CARS MAY STALL USMCA PROGRESS

The rules governing the use of steel and aluminum in cars have emerged as the latest obstacle to completing a revised NAFTA deal between the U.S., Mexico and Canada in time for congressional approval by year-end. The three nations are discussing the fine print of the agreement that requires 70% of steel and aluminum in vehicles to come from the continent in order to receive duty-free treatment. Mexico and the U.S. administration are seeking to agree on changes to the text before presenting a proposal to House Democrats. In early December, the U.S. put on the table a demand to count only steel and aluminum slab toward the 70% threshold that originates in North America, complicating qualification for cars produced in Mexico, whose slabs often originate in Brazil, Japan and Germany. The proposal was floated as a demand from the United Steelworkers union last year. President Trump announced plans to reinstate tariffs on steel and aluminum from Brazil and Argentina, nations he accused of devaluing their currencies to the detriment of U.S. farmers. Rules for cars are at the heart of Trump’s bid to replace the North American Free Trade Agreement with the so-called U.S.-Mexico-Canada Agreement, or USMCA, that gives more incentive to manufacture in the U.S. They were among the most difficult and painstaking issues to resolve in the negotiations last year. “The USMCA rule of origin is challenging to comply with, but we can meet this additional requirement,” said Matt Blunt, president of the American Automotive Policy Council which represents the Big Three U.S. Automakers.

ENERGY: SECRET SOLAR STARTUP HAS GENERATED EXTREME HEAT WITH MIRRORS

Scientists working stealthily announced a way to turn solar energy into extreme heat that could be used by industry. Startup company Heliogen, funded by Bill Gates and other high-profile environmental investors, has built a solar plant where large mirror panels point the sunlight toward each other to harness and multiply heat, a phenomenon called concentrated solar power. The overall principle is the same reason a magnifying glass can start a fire. Concentrated solar power is popular around the world, e.g., Morocco built the largest plant to date in 2016. **This new application of age-old technology has concentrated solar heat to above 1000°C, which is hot enough to enable industries that rely on chemical reactions at extreme temperatures, such as ceramics, cement or even steelmaking.** Most concentrated solar power plants use the heat to boil water into steam that turns a generating turbine. Solar panels can overheat and for most panels the overheat threshold is surprisingly low. Heliogen’s mirror panels act together as a single magnifying lens within a system designed to withstand temperatures up to 1500°C. Most consumer glass melts at or below that temperature, but pure silica glass doesn’t melt until 2000°C. Solar mirrors can also hypothetically be made with materials other than glass. Heliogen’s special angle in the market is the direct transmission of extremely high heat that can power kilns, furnaces, and other industrial processes. A typical nuclear power plant contains temperatures of 300° C, and that’s only safe and contained because of careful construction and the continuous flush of cold water or other coolants through the reactor. Gates’s investment in the project has catapulted its landmark test into media around the world, and the billionaire’s serious interest in solar is part of his overall belief, first published in 2016, that the world will make a clean energy breakthrough by 2031. The name “Heliogen” is a play on helio- (sun) and generator. Heliogen founder Bill Gross calls his company’s first commercial service HelioHeat. Heliogen says its heat can also be used to help plentifully split water into pure hydrogen, solving a tough energy supply chain problem and potentially opening up the already-working clean hydrogen blast furnace demonstrated in Germany in November. Heliogen is still testing its heat technology. The company plans to develop ways to store energy for later use. Thermal solar has a huge advantage over photo solar: heat energy can easily be stored and distributed on demand.



ENERGY: HOW TO POWER A STEEL BLAST FURNACE USING ONLY HYDROGEN

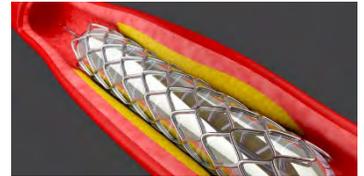


German manufacturing giant ThyssenKrupp has completed a successful, first-of-its-kind demonstration of running a steel furnace completely on hydrogen, a development that is likely to further dent the future prospects for the global coal industry. **The company successfully demonstrated the ability for hydrogen to be used to fuel a steel blast furnace, and ThyssenKrupp sees the achievement as the first step towards transitioning the manufacturing industry towards zero-emissions steel production.** The use of hydrogen to fuel the blast furnaces in steel production also provides a pathway for using renewable hydrogen, potentially eliminating the dependence of the industry on coal. As part of the demonstration

conducted in its furnace 9, ThyssenKrupp fed hydrogen into one of 28 tuyeres, or nozzles, that otherwise supply coal into the blast furnace. Following the successful trial, ThyssenKrupp plans to scale up the injection to all 28 tuyeres within the furnace and aims to eventually run at least three furnaces completely on hydrogen by 2023. ThyssenKrupp is one of the world’s largest steel producers and makes around 12 million tonnes of crude steel annually. The company has committed to achieving a 30% reduction in the company’s emissions by 2030. The company is also aiming to become carbon neutral by 2050. It’s a huge development in the use of zero-emissions and renewable energy supplies in the manufacture of industrial products like steel and presents a major threat to the coal industry. To make 1,000 kg of steel, a blast furnace environment requires 780 kg of coal. Because of that, steelmaking around the world uses one billion tons of coal each year. Cleaner steelmaking has seemed like as much of a pipe dream as cold fusion. Many have argued that coal will be required for decades to come, citing the need for coal in steel production to supply materials to the renewables industry. In other words, even though steel itself is such a recyclable and reusable product, the sheer quantity of coal it requires to make is enough to prop up the flagging coal industry. Coal around the world has counted on this relationship to steelmaking as the last and most resistant market. Hydrogen isn’t a perfect fuel option either—scientists are still searching for ways to manufacture “loose” hydrogen so it can be more plentiful and less costly.

MEDICAL: A RISE IN HEART DISEASE WILL PUT DEMAND ON CORONARY STENT MANUFACTURERS

Over \$8 billion worth of coronary stents will be sold annually by 2025, according to a new research report by Global Market Insights. The increase over the years will be due to an increase in artery diseases, coupled with a growing demand for minimally invasive surgeries. Increasing prevalence and recurrence of cardiovascular disorders across the globe will boost industry growth across the forecast timeframe. Coronary heart disorder is a medical condition where the patient's blood circulation to the heart is interrupted due to deposition of fatty plaques in the artery walls. It is the most common heart disorder that affects millions of people across the world. As more people suffer from heart diseases, the more the market for stents will grow. **Increasing technological advancements associated with coronary stents, such as bifurcated stents and use of biodegradable materials, are also expected to prompt a rise in the market value.** Bioresorbable stents will grow at 7.8% over the projected period. Bioresorbable stents get absorbed by the body after serving their purpose, thereby lowering the necessity of further surgery for stent removal. Major players operating in the market are also focusing on design innovations to modify the stents as per the patient's condition. For instance, in February of this year, Medtronic announced the launch of Resolute Onyx 2.0 mm Drug-Eluting Stent (DES), the smallest DES on the market. Such technological innovations will boost demand. However, stringent regulations in developed countries, coupled with post-surgical complications, will limit industry growth to a certain extent. There are several types of coronary stents; the major ones are drug eluting stents, bare metal stents, and bioresorbable vascular scaffolds. **Bare metal stents accounted for \$506 million in 2018 and will see significant growth through 2025. Bare-metal stents without a covering or coating were the first stents licensed for use in cardiac arteries. These stents reduce the risk of stent thrombosis after a heart bypass.** End-users are classified as hospitals, cardiac centers and ambulatory surgical centers. The hospital segment was responsible for around 40% of revenues in 2018 and is poised to show tremendous growth during the forthcoming years. A few notable companies making stents include Abbott, B. Braun Melsungen, Biosensors International Group, Biotronik, Boston Scientific Corp. and Medtronic. Industry players are using several strategies to expand their geographic presence and strengthen market position. For instance, this past January, Terumo bought Essen Technology, a China-based company specializing in drug-eluting stents. This will let Terumo expand its market in China and strengthen their Asia Pacific market presence.



MEDICAL: FUEL CELL FOR WEARABLES RUNS ON SWEAT

Scientists from l'Université Grenoble Alpes and University of California San Diego collaborated to create a unique new device—a fuel cell that is flexible and can be worn on someone's skin to produce energy using their own perspiration. With the growing adoption of wearable technology, researchers are constantly looking to design new energy sources that aren't dependent on typical batteries and instead can harvest energy from other sources for autonomous power. **The device is designed to use “biofuels” present in the compounds of human sweat. It functions by following deformations in the skin and produces energy by reducing oxygen and the oxidation of the lactate present in perspiration.** Scientists from the molecular chemistry department of the French university who specialize in bioelectrochemistry teamed up with UC San Diego nanotechnology experts to create the device, which incorporates technology from various disciplines, including biosensors and nanobioelectronics. Researchers have developed a whole host of novel ways to create energy-harvesting devices to replace batteries in wearable technology. However, many of those have focused on using people's natural movements to create electricity rather than actual bodily fluids. Researchers at UC San Diego first developed the technology that is the basis of the fuel cell two years ago. They later collaborated with the team from l'Université Grenoble Alpes to improve the device and develop its latest incarnation. The current device is comprised of a flexible conductive material made from carbon nanotubes, crosslinked polymers and enzymes, and joined by flexible connectors that are screen-printed directly onto the material. The functionalized electrodes are assembled onto a stretchable screen-printed current collector with an 'island-bridge' configuration, which ensures conformal contact between the wearable BFC (biofuel cell) and the human body and endows the BFC with excellent performance stability under stretching condition. Researchers tested the device and found that once applied to someone's arm, it can use a voltage booster to continuously power an LED. They envision that it can one day meet the need for a reliable and efficient energy sources for wearable devices, particularly those that provide fitness and health monitoring. The new device is relatively simple and inexpensive to produce, the researchers said. The production of the enzymes that transform the compounds found in sweat is the most expensive part of its construction. However, the device currently has limitations in voltage, something the researchers aim to improve in the future. An amplification in voltage means that the fuel cell can be used to power larger portable devices than is currently possible.





INNOVATION: ATOM BY ATOM, SUPERCOMPUTERS SHED LIGHT ON ALLOYS

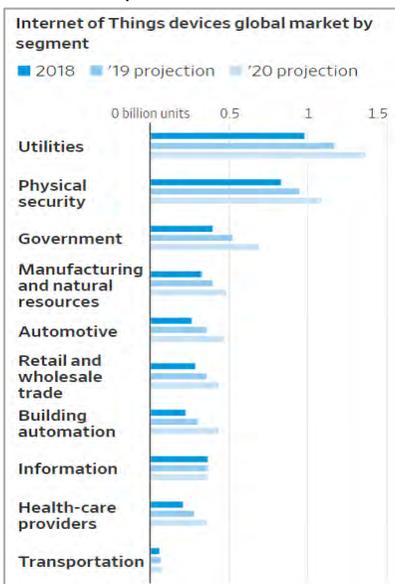
Alloys are at the heart of human civilization, but developing alloys in the Information Age is much different than it was in the Bronze Age. **Trial-by-error smelting has given way to the use of high-performance computing to micromanage alloy development down to individual atoms.** At Oak Ridge National Laboratory, Markus Eisenbach and his colleagues are tackling the computational challenges of developing those ultra-precise, futuristic alloys. “The specific position of an atom of one element in relation to the atom of another element can make a huge difference in an alloy’s properties and how it impacts tensile strength and resistance to damage,” said Eisenbach, who is a computational scientist specializing in condensed matter and materials science with Oak Ridge’s Leadership Computing Facility (OLCF). The research team utilized an electronic structure code or LSMS created at Oak Ridge to conduct single-atom calculations, aiming to test theories about the phase transitions of certain alloys. “With this research, we are trying to determine when the atom placement changes from ordered to disordered, meaning at what temperature these phase transitions happen.” Analyzing an alloy’s magnetic behavior, crystal structure and individual atomic positions produces enormous amounts of data, so Eisenbach’s team turned to the Titan supercomputer before it was decommissioned in August. Specifically, the LSMS code assigned individual atoms of the simulated alloy to individual nodes within the supercomputer. Thanks to the computing power at play, the research was able to demonstrate that the specific ordering of the atoms was important to understanding how the alloy would perform in the real world. This requires quite a lot of computing power—hundreds of thousands of calculations of many different configurations of energies—which wouldn’t have been possible before Titan. Now, with Titan decommissioned, the researchers are turning to a far more powerful system: the world’s fastest publicly-ranked supercomputer. “We are looking now at Summit to continue this work, running calculations on more complicated materials that make up certain alloys, and incorporating artificial intelligence techniques to improve the performance of the statistical mechanics simulations,” Eisenbach said. Beyond Summit, they have their eyes set on Frontier, Oak Ridge’s exascale system capable of one quintillion calculations per second, expected in 2021, which they anticipate will be able to analyze defects in the microstructures of complex materials.



Xianglin Liu and Markus Eisenbach with the Summit supercomputer.

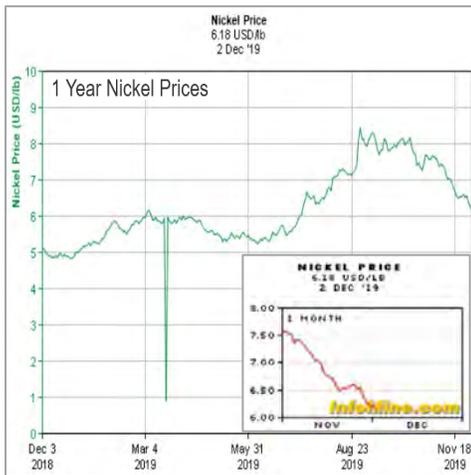
INNOVATION: THE POWER OF COMBINING 5G & AI—TOGETHER THEY WILL CHANGE EVERYTHING

The convergence of artificial intelligence with internet-connected machines and superfast 5G wireless networks is opening possibilities across the planet and even in outer space. These advancements are allowing farmers to pick the optimal way to grow crops, pharmaceutical companies to shorten the development times of new drugs, researchers to track pandemics, and cities to manage their resources in a manner that was pure science fiction at the turn of the millennium. **Taken alone, these technologies have enormous potential in their own right but combined, experts say they have the power to transform industrial technology on a scale not seen since the advent of steam power.** The key ingredient the experts say is 5G, which gives developers the ability to scale up projects more easily because there’s no need to build extensive fiber-optic networks to keep data flowing. 5G networks let internet-connected devices transmit much more information much more quickly, which in turn is spurring developers to come up with more advanced machines that can take maximum advantage of the capability. **The manufacturing process is perhaps one of the ripest for transformation by the combination of rapidly evolving technologies.** For instance, advanced sensors will pick up new levels of performance data about the heavy machinery running inside plants, which will be transmitted at superfast speeds between those machines and central control systems. In the area of maintenance, plant managers could get an early warning of problems by taking performance data from the machines and coupling it with external information, such as data about what makes similar machines break down. The combination of information will also have a huge impact on product quality, as companies can use ever more detailed data to refine the production process. The new technologies will also assist plant owners in being able to quickly establish physical facilities in new locations, as 5G can eliminate the need to set up expensive on-site infrastructure such as fiber-optic cabling. In today’s world, especially with all the trade wars and tariffs and the political situation, companies have to be able to very quickly respond to changes in customer demand or even regulations to move factories from one place to another and 5G is going to be perfect for that kind of response.

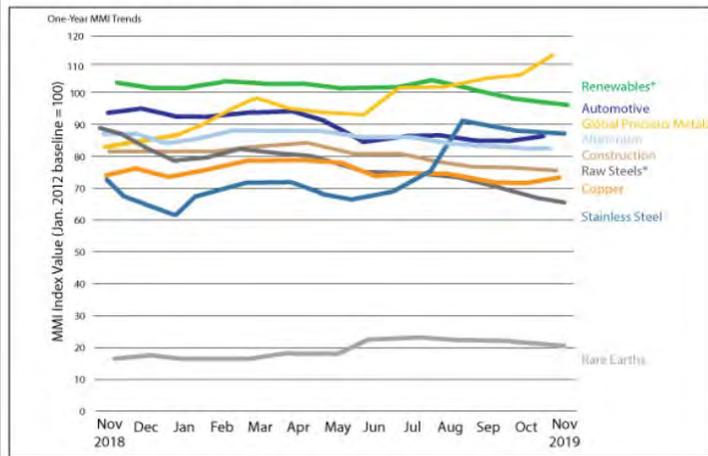




METALS: COMMODITY PRICES — NICKEL, ALUMINUM, COPPER & IRON ORE; MONTHLY PRICE TRENDS



Monthly Report: Price Index Trends – November 2019



COMMODITIES: GAO REPORT ON CONFLICT MINERAL DISCLOSURES—TIN, TANTALUM, TUNGSTEN & GOLD



With the EU's Conflict Minerals Regulation set to go into effect in January 2021, companies that import, smelt or refine four minerals—tin, tantalum, tungsten, and gold—will soon be subject to new rules. Similar efforts have been underway in the U.S., where under Dodd-Frank the U.S. GAO annually assesses the effectiveness of the U.S. SEC Conflict Mineral Rules. Recently, the GAO released its annual report on conflict mineral disclosures filed with the SEC in 2018. The report revealed that 1,117 companies filed conflict minerals disclosures, about the same number as in 2017 and 2016. The companies reported on their efforts to determine the source of minerals in their products through supply chain data collection (country-of-origin inquiries). **The GAO said that 61% of the companies couldn't definitively confirm the source of the conflict minerals in their products, compared with 47% in 2017 and 55% in 2016.**

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Season's Greetings

One of the real joys of the holiday season is the opportunity to say thank you and to wish you the very best for the New Year.

Sincerely,

The Ulbrich Family

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