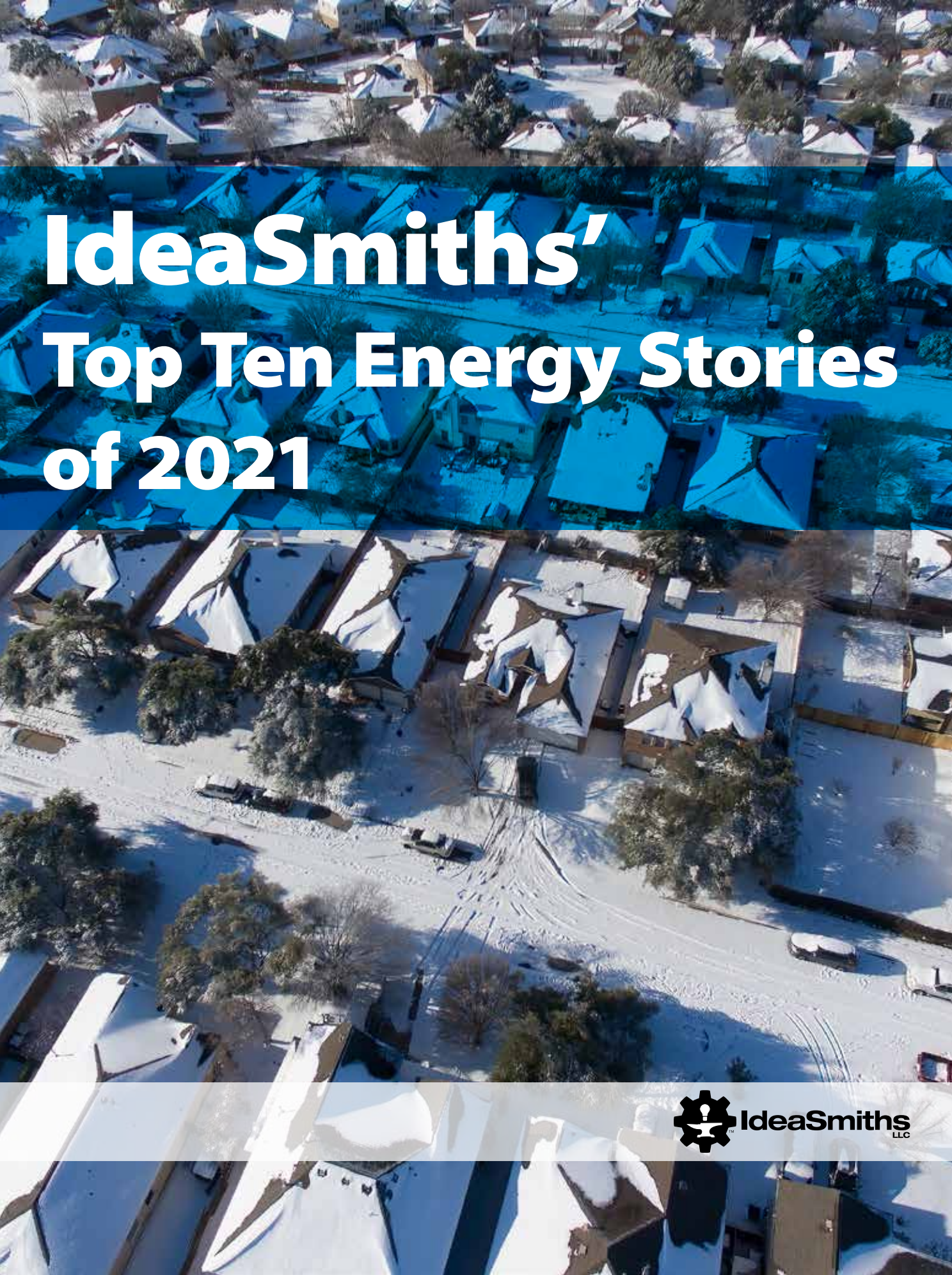


IdeaSmiths' Top Ten Energy Stories of 2021

IdeaSmiths LLC

Winter Storm Uri: An Energy Crisis in Texas

In February 2021, Winter Storm Uri raged through the midcontinent of the United States and northern Mexico with a double-whammy of wet conditions and freezing temperatures. Natural gas production and transportation systems froze and power plants of all types (gas, nuclear, coal, wind and solar) limped along or outright failed. Gas production dropped 50% statewide and 85% in the Permian Basin, creating significant gas shortages as demand for both electric and gas heating were spiking. The declining gas production led to fuel shortages for power plants and triggered very high electricity and natural gas prices, about 150 times higher than before the event. It was a global news story that energy-rich Texas, #3 in the world for natural gas production and #6 in the world for installed wind capacity, had an energy shortage.

Jeffrey M. Phillips

Snow from Winter Storm Uri blankets the football stadium at Leander High School, north of Austin, on February 15, 2021.

In interconnected states, power supplies were supplemented from other regions. However, in the (mostly isolated) ERCOT region of Texas, power outages cascaded throughout the state, in some cases turning off the power to gas production and transportation companies, exacerbating the crisis. More than 4.5 million Texans were without power for days, nearly 15 million Texas water customers were under boil water notices, frozen pipes caused $10-$20 billion in insured losses, and hundreds of people died. There are many reasons why the energy system in Texas failed so catastrophically, including the high dependence on natural gas across the state, lack of sufficient winterization in the gas and power sectors, and an inability to rely on other grids beyond ERCOT's borders. Lingering effects of the storm led to a heightened awareness of power supply concerns and tight grid conditions in spring and summer, underscoring that system resilience in all seasons is needed. Texas policymakers responded by requiring emergency plans for water systems and weatherization plans for power plants. Though there has been a lot of progress, many power plants will not be fully weatherized in 2022, and the Railroad Commission, the entity that regulates natural gas companies in Texas, has not designed weatherization standards for gas wells yet.

Concerns have also been raised about the incentive structure within the Texas energy system. Gas companies made $11 billion of larger-than-expected profits from the event, and the Federal Energy Regulatory Commission is now investigating whether gas or electric companies engaged in market manipulation. The legislature through HB 4492, SB 1580, and HB 1520

Winter Storm Uri: An Energy Crisis in Texas

Getty Images

allowed for securitization of debt owed to ERCOT from market participants and allowed electric cooperatives and gas utilities to finance the increased costs that were incurred during the storm. The Railroad Commission of Texas approved raising gas customer rates as a part of this process.

The Texas Legislature also ordered the PUC to overhaul the electricity market. The maximum market price was lowered from $9,000 per megawatt-hour (MWh) to $5,000/MWh. The change aims to reduce liability on market participants and ERCOT customers while still incentivizing generation. Phase 1 of the redesign, which began January 1, involves incentives for more generation, extra winter fuel supplies, and improvements to energy efficiency and conservation. Regulators also expressed interest in increasing investment in dispatchable power, such as natural gas, coal, nuclear, and energy storage, due to its perceived reliability. Phase 2 is still being developed but would focus on reserve power for emergency response, including specific reliability standards for ERCOT and assistance for homes and businesses.

The effects of the redesign are not known, but experts expect it to increase costs to customers. The cost of power plant weatherization, utility debts, and additional emergency preparation will eventually be passed on to consumers. One estimate suggests the total cost to customers would be $8 billion on top of existing securitization expenses, a 14.3% increase per year onto residential energy bills. ■

Bipartisan Infrastructure Investment and Jobs Act Passed

In November 2021, President Biden signed the Infrastructure Investment and Jobs Act. The final bill includes funding for major clean energy advancements, infrastructure that could help enable a net zero carbon emissions future, and to funding for clean water, superfund cleanup, and expanding internet access. The funding key to a net zero future supports rail, transit, and surface transportation, strengthening supply chains through upgrading airports and ports, electric vehicle charging, transmission and electric grid infrastructure, and strengthening resilience to droughts, heat, floods and wildfires through weatherization and other approaches. There is also funding for research, design, and demonstration for key pathways needed for a net zero future, such as hydrogen, direct air capture, energy storage, advanced nuclear, carbon capture and sequestration, and carbon dioxide pipelines and storage. Princeton's REPEAT Project finds that the bill enables removal of nearly 60 million metric tons (MMT) of carbon dioxide.

The American infrastructure bill follows in the footsteps of the European Union's green recovery in 2020 which included 550 billion euros committed to green projects over the next seven years, the largest single climate pledge ever made. In February 2021, the European Commission also adopted a new EU Strategy on Adaptation to Climate Change that aims to increase adaptive capacity and resilience while also reducing vulnerability to climate change, including by tracking, analyzing, and preventing the health impacts of climate change. ■

Jonathan Ernst/REUTERS

U.S. President Joe Biden signs the "Infrastructure Investment and Jobs Act", on the South Lawn at the White House in Washington, U.S., November 15, 2021.

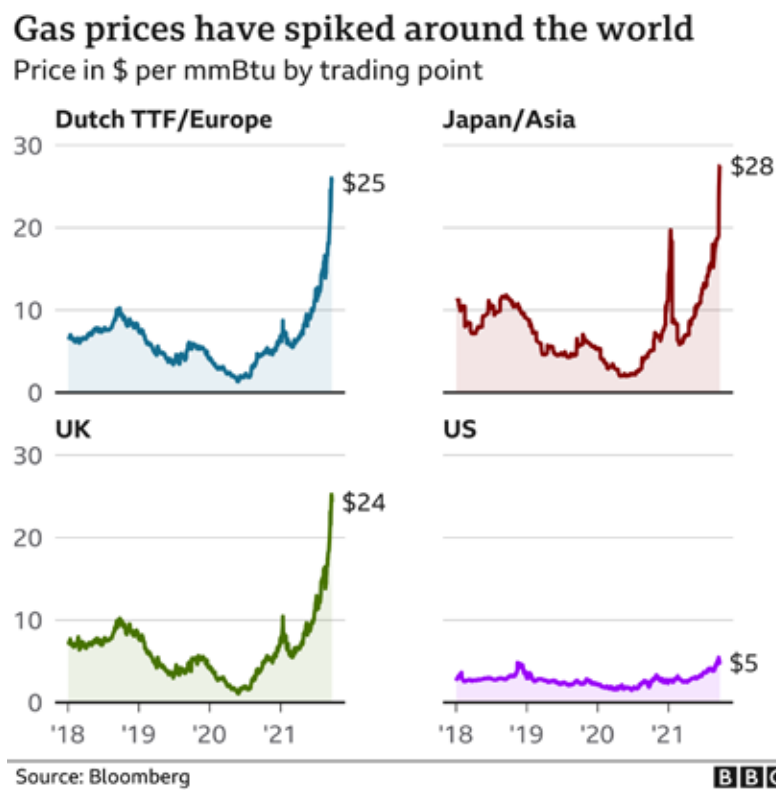
European Energy Crunch

Global energy markets have been in flux since the start of the COVID-19 pandemic, when lockdowns, travel bans, and work-from-home policies dramatically disrupted energy consumption. Electricity consumption shifted significantly from commercial offices to homes and non-essential travel halted. The Brent crude price fell by 10% in March 2020, while West Texas Intermediate prices went negative in Q2 2020 as storage became scarce and demand plummeted. Eventually, production companies slowed investments in new capacity. Because of the lag time between investment decisions and production volumes, prices for crude oil rose throughout most of 2021 with increasing concern that ramp rates on supply would not match increasing demand as economies have started to recover. The higher petroleum prices placed increased burden on drivers around the world, including Europeans who have been seen panic buying fuel.

Pandemic effects have been compounded by weather. A colder winter in late 2020 and early 2021 in both Europe and China increased global demand for natural gas supplies and reduced regional storage volumes. Hotter temperatures later in the year increased electricity demand while power supplies were limited because of drought (which constrained hydroelectric generation), low wind (which constrained output by wind turbines), an untimely fire (which damaged National Grid's interconnection with France), and heat waves (which constrained nuclear generation). Gas supplies struggled to fill the gap, while historic shifts away from nuclear and fossil fuels in many European nations has reduced access to diversified energy sources. Additionally, supply chain delays and outages at LNG export facilities in Australia, Malaysia, Nigeria, Algeria, Norway, and Trinidad and Tobago further restricted LNG volumes. Constrained supplies have led to high prices that have rippled across the supply chain and impacted other sectors. For example, the price of aluminum hit a 13-year high, partly due to the energy crisis.

Some countries' domestic policies limit the ability for energy companies to pass through prices to consumers. While these policies are intended to protect consumers from high energy prices, they have also led to an increased number of market failures. Since August 2021, 26 energy retailers collapsed in the UK. In addition, Germany and France have both experienced record high prices.

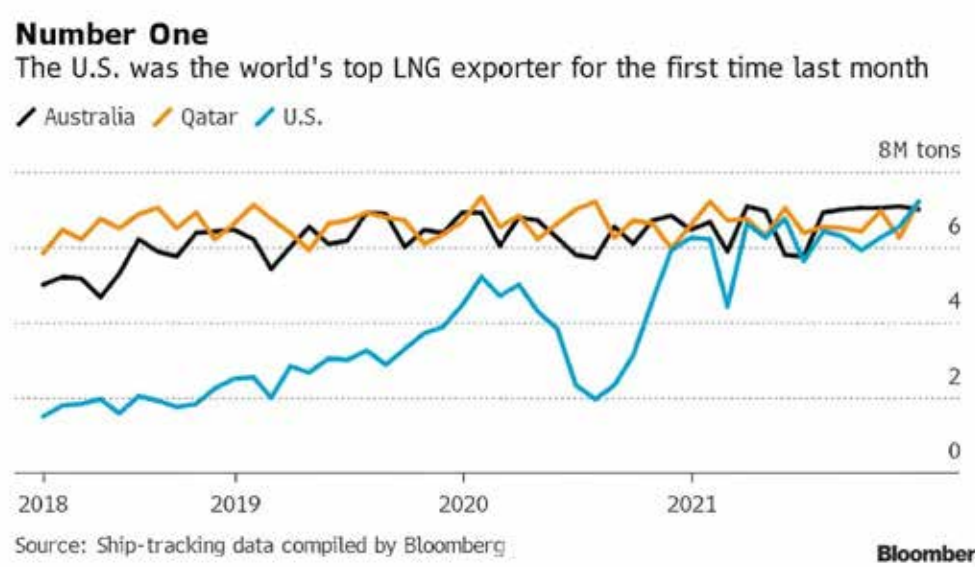
The outlook for energy producers, suppliers, and consumers in Europe remains unclear due to both policy and market dynamics. Consider that prices for natural gas in Europe rose by over a factor of 10 from January to mid-December, before falling roughly 50% by year's end. Russia could increase gas supplies to Europe to ease the crunch, but has not yet done so in part due to continued delays with the Nord Stream 2 pipeline. European countries will continue to grapple with a challenging energy market well into 2022. ■



USA Becomes #2 LNG Exporter in the World

Poised to be #1 in 2022

While the global crisis has led to higher oil and gas prices in the U.S, it has also increased demand for U.S. supplies, which are typically much cheaper than benchmark prices in Asia or Europe. After a wave of permitting applications that started in the Obama administration and continues today, new LNG export capacity along the gulf coast has come online in 2021. U.S. LNG exports reached record highs in 2021, averaging 9.6 billion cubic feet per day (Bcf/d) in the first 6 months of the year out of a peak capacity of 10.8 Bcf/d. By the end of 2021, 20% of U.S. natural gas production was for export partly by pipeline, but mostly by ship-borne LNG. A significant portion of the LNG has been destined for energy constrained Europe. ■



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World's Largest Direct Air Capture Project in Iceland

Orca, the world's largest direct air capture (DAC) facility opened in September 2021 in Iceland. Climeworks AG, a Swiss carbon capture company, has partnered with Carbfix, an Icelandic carbon storage organization to develop the plant. It will capture 4,000 metric tons of CO_2 per year. The CO_2 will be mineralized and sequestered as a solid material, limiting concerns of it reentering the atmosphere at a later date.

DAC is attracting interest as a way to remove carbon dioxide directly from the atmosphere and store it, rather than capturing the emissions of a pollution source. DAC can be implemented anywhere, not just at the point of emissions. However, because the process is energy intensive and requires carbon storage, siting a DAC facility next to a clean source of power as well as near a suitable carbon storage location or a utilization process is ideal. Iceland is a desirable site because energy supply in the region is dominated by low-carbon sources, including geothermal and hydropower. Furthermore, Iceland has abundant basalt formations that can be used for carbon mineralization and storage.

Currently there are 19 DAC facilities operating worldwide capturing approximately 0.01 million metric tons of CO_2 per year. To meet the Net Zero Emissions scenario, the IEA reports that DAC capacity would need to increase by a factor of nearly 10,000 by the year 2030.

Initial investments in DAC have been made by individuals and organizations, such as Microsoft, Stripe, Shopify and Swiss Re, wanting to ensure they achieve their carbon removal targets in accounting for offsets. DAC is also a potential pathway to facilitate a net-zero economy while sustaining consumption of some fossil fuels. Occidental Petroleum in partnership with Carbon Engineering is currently developing the first large-scale DAC facility. The plant will capture up to 1 million metric tons per year near Texas oilfields and could come online around 2024. The larger scale systems, including the one under development by Occidental, could be eligible for the 45Q tax credit established under the Trump administration that incentivizes the deployment of carbon capture. ■

Climeworks

Electric Trucks on the Rise

EVs Comprised 10% of All Auto Sales in November 2021

With more than 1.7 million units sold, electric vehicles (EVs) reached 10.8% of global vehicle sales in Q3 of 2021. Approximately 427,000 EVs were purchased in China alone, 19.5% of total passenger vehicle sales. In India, EV registrations reached a total of 877,000 in November 2021 (compared to 1 million in the U.S. at the end of 2020). Two-wheeler and passenger-type electric three-wheeler EVs dominate sales at 92% of vehicles registered.

In the United Kingdom, EVs made up almost 30% of sales in November 2021, and over 54% of vehicles sold in Sweden in November were plug-in electric vehicles. In all of Europe, plug-in and hybrid vehicles hit 26% of vehicle sales, up from 16% in November 2020 and 6% in 2019. Top vehicles in Europe are produced by Renault, Dacia, Tesla, Volvo, Peugeot, and Ford.

Though EV sales are picking up, the U.S. lags Europe and China. The EV market in the U.S. has been dominated by Tesla with approximately 79% of U.S. EV sales in 2020. However, more automakers are investing in expanding their EV options and manufacturing capacity. The top producing auto manufacturers in the world (as of 2017) have each announced EV goals. General Motors is transitioning to full EV production by 2035. Volkswagen expects to launch 70 EVs and 60 hybrids by 2030. Volkswagen Group's Porsche EV options are already outselling its traditional offerings. Ford has begun producing electric versions of its most iconic models and aims to build four factories specifically for EV production. Toyota recently announced a $35 billion investment in 30 EVs by 2030, including a new electric SUV, built using a common platform with Subaru's new

Tesla

Electric Trucks on the Rise

SUV. Hyundai Motor Group, already has two electric models on the market and recently announced it will stop developing new internal combustion engines to transition to full electric vehicle production. LMC Automotive and IHS Markit expect EVs to make up 34-40% of U.S. vehicle sales by 2030.

Since 2019, multiple auto manufacturers have announced new electric trucks, an important step to electrifying the U.S. vehicle market and reducing emissions. Tesla announced its Cybertruck in 2019. CEO Elon Musk reported over 250,000 orders within the first few weeks. Other auto manufacturers are following suit. In May, Ford announced its F-150 Lightning, the electric version of its Ford F150, the top selling vehicle in America. The company received 200,000 preorders. Rivian, a startup developing electric SUVs and pickup trucks, announced its IPO in November 2021 and has received about 70,000 preorders for its R1T pickup truck. An electric Chevy Silverado is also expected to be on the market in 2023.

Pickup trucks have been about 10-17% of U.S. production share since 1975 and over that time performed with consistent fuel economy of about 19 miles per gallon. Electrifying this large and relatively inefficient portion of the fleet will have outsized impact on total energy consumption and emissions. ■

Rivian

Ford

Toyota

Rivian, Ford, and Toyota are expected to compete with Tesla in the electric pickup market. Other contenders will come from Hyundai and GM, including an electric Hummer.

Battery Prices Continue to Fall

Lithium-ion batteries have decreased in cost from more than $1,200 per kilowatt-hour (kWh) in 2010 to $132/kWh in 2021, a 90% drop in just over a decade. Battery packs used for electric vehicles were $118/kWh on a volume-weighted basis. Batteries were cheapest in China with costs 40% higher in the U.S. and 60% higher in Europe. These significant price drops have occurred because of increased supply chain capacity and manufacturing improvements driven by massive adoption in consumer electronics and electric vehicles. Similar to previous declines in the cost of wind and solar power facilities, demand for batteries has increased in response to the price reductions, which helped bring prices down further. The U.S. had less than a gigawatt (GW) of large battery installations in 2020, but installed roughly six times that in 2021, and is expected to install nearly nine times that in 2022. Nine states in the U.S. have adopted storage mandates or targets. Other states such as Arizona and Texas that lack storage mandates still have large-scale battery installations for standalone deployment and alongside renewable energy projects. Innovation in long duration storage is still needed for widespread adoption in electric grids with increasing deployment of variable generation sources. Though demand is still growing quickly, battery prices are dependent on complex supply chains and raw materials that could slow the drop in battery prices. ■

LS Power's 230-megawatt battery storage system in San Diego county, California.

Bing Guan/Bloomberg

Labor Concerns for Critical Minerals

Broadly speaking, the energy transition is a shift from strategic liquids (like petroleum) to strategic solids (like rare earth metals). For decades, imported oil from the Middle East was a top national security concern. For critical minerals such as cobalt, lithium, silicon, and copper for use in batteries and solar panels, there are significant concerns about labor practices in countries like China and the Democratic Republic of the Congo, which currently accounts for more than 70% of global cobalt production. As such, manufacturers of consumer electronics, electric vehicles, and battery storage are looking to reduce their dependance on such materials and geographically diversify supply chains to locations with better labor practices.

In 2021, the U.S. accused China of committing genocide and using Uyghurs, prisoners, and other ethnic minorities as forced labor in producing polysilicon, which is used for developing solar panels. The U.S. Customs and Border Protection banned imports of silica-based products and goods assumed to be associated with this forced labor. China can redirect this silicon production to be used domestically, so it is unclear whether the U.S. ban will impact forced labor practices.

As of 2020, Chinese companies owned or financed 15 of the 19 cobalt-producing mines in the Democratic Republic of Congo, some formerly owned by US companies. In 2008, China committed to help build roads, bridges, power plants, hospitals, and other infrastructure in addition to royalty payments for cobalt access. The Congo, with help from the U.S., is investigating whether Chinese companies have delivered on this commitment. Because China dominates cobalt production as well as that of many other minerals, some experts question if the country will limit access to these minerals.

The IEA expects a cobalt shortage by 2030, and the U.S. is pushing for access to cobalt from Australia and Canada to reduce dependance on China. Scientists are also working on alternatives to cobalt. Companies and countries currently relying on cobalt for the energy transition will need to evaluate how to ensure the transition is just, including fair compensation for Congolese people. ■

New York Times

Workers extract ore from the Kisanfu copper-cobalt mine in Congo.

COP26 Pledges/Year of Net Zero

The 26th annual Conference of the Parties (COP26) was held in Glasgow in November 2021 with an aim to revisit the Paris Agreement commitment to limit warming to 1.5 °C. Many countries put forward goals to achieve net zero between 2050 and 2070, which was an encouraging sign and a big step forward as it gave more credence to the urgency and importance of the need to decarbonize the global economy. Yet, the cumulative effect of the pledges is expected to only limit warming to about 2.4 °C. Additionally, pledges are self-enforced and few countries have set their pledges into law, raising the question about their ultimate impact.

The Glasgow Climate Pact developed at COP26 is the first explicit plan to reduce coal use, though India and China pushed for phasing down rather than phasing out, to the disappointment of many countries, including vulnerable island nations. The U.S. did not push back on their stance. Signatories agreed on the need for adaptation and mitigation. The pact includes a significant pledge to increase financial aid to help developing countries and those most at risk to climate change make the switch to clean energy and cope with the effects of a changing climate. Additionally, there was agreement to phase out subsidies that lower fossil fuel prices, though a timeline was not specified.

The U.S. and China, the world's largest CO_2 emitters, also pledged to cooperate bilaterally to reduce methane emissions and transition to clean energy. More than 100 countries, including the U.S., also agreed to cut methane emissions by 30% by 2030, which could have outsized impact on reducing climate risk. Additionally, 25 countries and 5 financial institutions committed to stop financing fossil fuel projects by 2022, and some countries joined an alliance to halt oil and gas production. More than 30 countries and auto companies pledged to increase zero-emission car and van sales and leaders of more than 100 countries, comprising 85% of global forests, pledged to curb deforestation by 2030.

Finance was a key component of the climate pact and some of the pledges. A previous pledge to provide $100 billion per year to at-risk countries has not been met. However, at this COP, the pact included increased funding, and Japan and Italy each pledged an additional $2 billion and $1.4 billion per year, respectively. Furthermore, more than 450 financial institutions managing over $130 trillion dollars committed to use their funds to reach net-zero emissions by 2050. ■

COP26 president Alok Sharma delivers his remarks at the COP26 Closing Plenary.

Hydrogen Takes the Stage

After nearly two decades of stops-and-starts, 2021 saw hydrogen return to the stage as a prospective solution to many problems, in particular to reduce emissions from hard-to-abate sectors such as industrial heat, aviation, shipping, and chemicals. As a fuel without carbon, its point of use greenhouse emissions profile is minimal. It can be used for generating electricity directly with turbines, reciprocating engines or fuels cells and it can be blended with natural gas for use in existing pipelines and gas turbines. Conveniently, hydrogen can be stored directly or in carrier form (such as ammonia, methanol, or formic acid), which can solve variabilities in supply and demand in the power sector.

Hydrogen is already used for fertilizers and in industrial processes with a robust global supply chain that is projected to grow quickly. As a sign of its growing market, 200 large-scale hydrogen projects have been announced, including a partnership between Spanish Iberdrola and Sweden H2 Green Steel to develop a major green hydrogen facility, an agreement between JCB and Ryze Hydrogen to buy 10% of Fortescue Future Industries' green hydrogen output while developing customer demand in UK, and a partnership between Norsk Hydro and Shell's Hydro Havrand to develop hydrogen around their existing businesses with potential to scale. Natural gas companies are pivoting to hydrogen or hinting they will. Power plant operators are also actively considering the opportunity to integrate hydrogen, including the Intermountain plant in Utah which plans to repurpose a coal-fired plant and begin operating with a blend of 30% hydrogen in 2025. Entergy Texas plans to build a new combined-cycle natural gas facility with the ability to blend hydrogen.

Additionally, hydrogen has been incorporated in energy and infrastructure policy plans in Europe, the U.S., and China. Research and demonstration project funding is included in the U.S. Infrastructure Investment and Jobs Act signed into law in November 2021. The European Union hydrogen strategy was adopted in July 2020 and aims to accelerate the development of clean hydrogen. Local governments in China have integrated the hydrogen industry as one of the industries of the future in the Five-Year Plan for 2021 to 2025. Overall, more than 30 countries have developed plans for hydrogen with the goal of reducing carbon emissions from sectors of the economy that may otherwise be exceptionally challenging to decarbonize. ■

New Flyer

The New Flyer Xcelsior CHARGE H2™ is a battery-electric vehicle that uses compressed hydrogen as an energy source.