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A cross-sector look at the energy transition

Renewables

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Gas

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Contents

Editorial Welcome: The Energy Transition Becomes More Complex Amid Geopolitical Shifts and Security of Supply

Karl Nietvelt, Head of Global Infrastructure & Utilities Research

"The current crisis is providing impetus to renewables, nuclear and more expensive green solutions such as hydrogen, biogas or carbon capture, given the focus on energy security."

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As the energy transition continues to gather pace, decarbonization remains a key priority for both policymakers and market participants. Yet Russia's invasion of Ukraine has thrust the world's dependence on hydrocarbons -- and the complexity of transitioning away from them -- into the spotlight.

The conflict is having an undeniable effect on the transition to net-zero. Soaring energy and commodity prices are now immediate priorities, and as such, decision makers face a trilemma: balancing the urgent need to decarbonize with concerns around energy affordability and security of supply.

Of course, these goals are not necessarily mutually exclusive. The significant disruption to global supplies of oil and gas so far this year have provided further impetus to non-fossil fuel power generation, such as renewables and nuclear. At the same time, policy makers may reassess the value of security of supply offered by more expensive green solutions such as hydrogen, green gases or carbon capture, and the importance of diversity of energy sources rather than the lowest cost option.

The European Commission's REPowerEU strategy, which accelerates the push for net zero, has gained further traction given it also targets more energy independence from Russia. The new plan aims to have 1,236 gigawatts (GW) of wind and solar generation capacity online by 2030, up from about 350 GW of installed capacity today. In addition, the plan targets that around 20% of European gas demand will come from alternatives, such as biogas and green hydrogen, by 2030.

In the U.S., the recently approved Inflation Reduction Act (IRA) is a game changer for clean energy technology. The long-term extension of wind and solar tax credits creates tailwinds for renewables, with wind and solar capacity likely to exceed our current 2030 assumption of 510 GW, up from 225 GW at the end of 2021. New federal production tax credits for existing nuclear power generation units and standalone storage are also significant for those sectors. Finally, the green hydrogen tax credit is very substantial, and could make green hydrogen economic a decade sooner than expected.

Diverging paths to net zero

In this edition of Infrastructure & Energy Outlook, we look ahead at how the energy transition could affect the energy mix to 2030.

Among the main recurring themes -- the speed at which countries are transitioning away from fossil fuels is diverging between developed and developing markets. Coal, for instance, which is almost being phased out in Europe and on a constantly declining trajectory in the U.S., will continue to be crucial to economic growth in Asia-Pacific. China and India alone account for 70% of the world's coal demand, and relatively younger coal fleets in Asia mean that coal will likely serve as a baseload for decades to come, while increases in renewables may only be able

to cover for the region's rapid power demand growth. This, together with prioritizing energy security, will complicate the energy transition in Asia-Pacific, and also explains China's ongoing pilot projects to capture emissions from coal fired generation.

When it comes to nuclear, there are very few new investments in the U.S. and Europe, although more support has recently emerged to slow down phase-outs. In contrast, China is accelerating nuclear growth -- with its nuclear capacity projected to reach 105 gigawatts (GW) by 2030, surpassing both the U.S. (92 GW) and Western Europe (76 GW). Indeed, the current proportion of nuclear generation in developed countries (60%) versus that in developing countries (40%) is likely to reverse over the next two decades.

We expect oil will continue to play an important role, with global demand set to continue to grow until 2030. While demand for oil has already peaked in developed markets in 2019, global demand growth this decade is being driven by a growing global middle class in developing nations and increased demand for mobility. Post-2030 we expect demand for oil is more likely to plateau than abruptly decline, given its vital economic role and the time needed to transition away from oil-related assets and infrastructure.

Natural gas, meanwhile, is set to retain its bridging role as Europe and the U.S. transition to low-carbon energy. In Europe, the outlook has become more uncertain given its policy goal to move away from Russian supplies by 2027 -- the bulk of which will need to be offset by increased LNG imports. Gas-fired generation, which accounts for 36% of global gas demand, is clearly facing competition from renewables, but natural gas will remain important in plugging seasonal fluctuations in energy demand, as batteries only provide short-time energy storage solutions. Moreover, the industrial use of gas as a raw material -- which represents almost 40% of global demand -- will be more difficult to substitute, as it is often linked to industrial processes for chemicals, building materials and plastics.

Looking ahead

In 2020, renewable energy sources still only provided 13% of global primary energy consumption. But renewables now account for the majority of annual investments in power generation globally, and its share in primary energy will continue to climb, rising to 18% by the end of the decade, according to S&P Global Commodity Insights (Platts). In other words, by 2030, renewable energy will equate to 60% of primary energy coming from oil – compared to just 25% a decade ago.

The energy transition is well underway. But it will take time and the path ahead will not be straightforward: climate events could accelerate the path to net-zero, but supply-demand balances of the broader energy system need to be managed. Crucially, going forward, economic costs and security of supply will likely play a more important part in policy trajectories.

"Climate events could accelerate policy actions towards net-zero, but transitioning away from predominantly hydrocarbon-based economies and infrastructure will take time and supply-demand balances of the overall energy system need to be managed."

Oil Demand Driven By Developing Markets As Energy Transition Gathers Pace

S&P Global Ratings: Thomas A Watters; Simon Redmond; Paul J O'Donnell; Karl Nietvelt; Massimo Schiavo;
S&P Global Commodity Insights: Dan Klein; Roman Kramarchuk

"We expect global oil demand growth to continue into the next decade, peaking at 112 million barrels per day (mbpd), up from 101 mbpd this year as developing markets keep expanding."

Global oil demand growth is set to continue this decade. It had already peaked in developed countries in 2019, before the pandemic, but further growth will now be fueled by developing countries. Oil demand is currently set to reach its highest level in 2037 -- 112.5 million barrels per day (b/d) -- based on S&P Global Commodity Insights (Platts)' reference case (see chart 1), versus the 101 million b/d projected for this year.

That said, a host of factors could place the actual peak at any time between 2030 and 2040, since oil demand is projected to stay relatively flat after 2030. On the one hand, efficiency gains and electrification will continue to depress oil demand growth. However, a growing global middle class and related increase in transportation demand will outweigh these measures over the next decade or more. In addition, S&P Global Commodity Insights (Platts) believes the petrochemicals sector will likely remain a vector of growth on the back of steady demand for chemicals in many non-fuel applications.

Transitioning Away From Oil Will Take Time

Changes to consumer behavior and mobility prompted by COVID-19, as well as ongoing economic volatility, have resulted in the trajectory of demand growth being about 5 million b/d lower than the pre-pandemic projection in S&P Global Commodity Insights (Platts)' reference scenario. However, even considering this sizable decline, the current oil demand trend is far from consistent with limiting global warming to 2 degrees, let alone to 1.5 degrees -- or indeed lower in line with the Paris Accord. Global oil demand needs to peak by 2025 for global emissions to be in line with S&P Global Commodity Insights (Platts)' 2 degree trajectory by 2050. Under this less likely pathway, oil consumption would still exceed 87 million b/d by 2040.

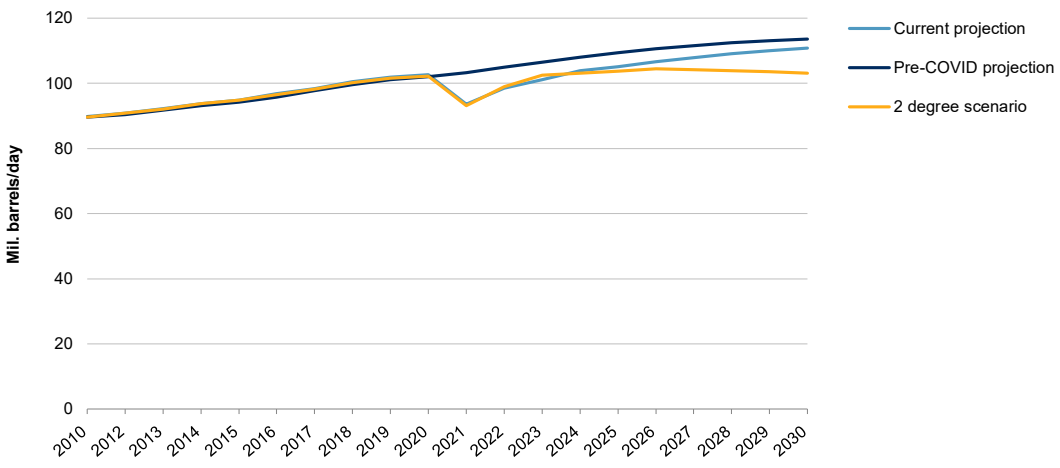
The impact of the energy transition will therefore likely be more gradual when it comes to oil -- particularly considering that it underpins a major part of the global economy. Moreover, there are limited immediate alternatives to oil in some use cases, unlike for coal and gas, which renewables can replace in power generation, for instance. Equally important is that transitioning existing capital stock and hydrocarbon infrastructure will take decades, particularly in developing countries, given the costs involved.

Long-Term Oil Prices Could Vary Widely Between $40 And $80 Per Barrel

Looking beyond current market tightness and the inevitable recalibration period, economic cost fundamentals indicate that the price of oil should settle near $55 per barrel (/bbl) in real terms according to S&P Global Commodity Insights (Platts) (see chart 2). However, should geopolitical tensions and disruptions to oil supplies last, long-term oil prices could certainly climb to average $80/bbl or more, at least temporarily.

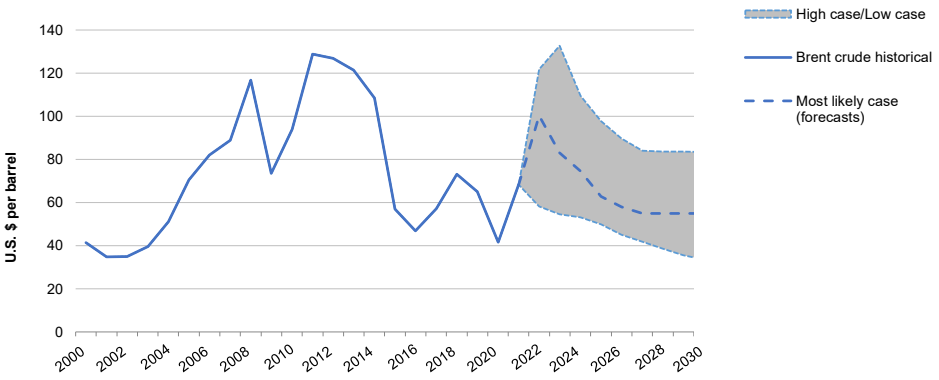
Upward pressure on long-term oil prices could also be influenced by increased climate-related costs for producers, such as voluntary or compliance-related carbon costs, or requirements for higher returns on investments. On the other hand, the reduction of oil production costs and further policy efforts to push down oil demand could see oil prices fall to the low $50s or even to $40/bbl (in real terms) under a 2

Oil Demand To Rise Through The 2030s, Despite COVID-19 Impact



Source: S&P Global Commodity Insights (Platts)

Crude Prices: Where Do They Go From Here?
Brent crude since 2000



Source: S&P Global Commodity Insights (Platts).

degree scenario, with only supply at the lowest cost able to compete in a smaller oil market.

Investors Are Calling For Action On The Energy Transition

S&P Global Ratings sees additional pressure on oil companies from financial markets as a result of environmental considerations. As a highly capital-intensive industry, oil relies heavily on the capital markets for development, and we observe that the investment community is currently using its influence to push oil companies to reduce Scope 1 and 2 greenhouse gas emissions.

Rather than a sudden cut-off of investment or funding, we anticipate a gradual increase in standards and requirements from the investment community and shareholders. Some banks have even implemented policies that prevent them from supporting new oil developments, but sometimes this does not preclude refinancing debt relating to existing projects. Some sovereign wealth and pension funds, on the other hand, are divesting investments in the oil industry altogether, but this is so far not a widespread phenomenon. The current energy crisis has made it clear that striking a balance between security of oil supplies, price affordability, and decarbonization is a trilemma.

Oil Majors Are Adapting To Evolving Conditions

Factoring in the above heightened risks, S&P Global Ratings revised its credit view on industry risk for the oil sector in January 2021. Nevertheless, large, diversified oil and gas companies still have strong investment-grade credit ratings, reflecting their continued cash-flow strength over the next decade. Even if oil demand undergoes a climate-induced decline in the long term, cyclical oil supply-and-demand dynamics benefit from the Organization of the Petroleum Exporting Countries' (OPEC) ability to adjust supplies, as well as from inherent adjustments, in that existing oil fields face a natural decline of 4-5% per year, which compares with a 1.5% per year average reduction in S&P Global Commodity Insights (Platts)' 2-degree scenario.

Oil and gas producers are also implementing operational changes to respond to the energy transition, and this is where companies in the U.S. and Europe tend to differ in their approach. Those in Europe are more likely to concentrate on renewables development, focusing on solar and wind. U.S. companies, on the other hand, are more likely to reduce their carbon footprint by using carbon capture, biofuels, and low-carbon oilfield services such as electricity-powered rigs.

"Credit risks for the oil sector will be partly mitigated by OPEC's ability to adjust supplies and by the typical annual 4%-5% natural decline of oil fields."

Thermal Coal Will Remain Important In Asia-Pacific

S&P Global Ratings: Abhishek Dangra; Simon Redmond; Karl Nietvelt; Massimo Schiavo;
S&P Global Commodity Insights: Roman Kramarchuk

"Demand for thermal coal is set to decline after peaking in 2024 as coal-fueled power is increasingly replaced with renewables in Europe and the U.S."

The reduction of coal demand will be slow and uneven across regions. Currently, coal accounts for about 25% of primary energy globally (and about two-thirds of the power sector's generation), but this is set to reduce to 21% by 2030, and trend down thereafter, according to S&P Global Commodity Insights (Platts)' reference scenario. That said, China and India together account for 70% of the world's coal demand, and the steep rise in power demand expected in the two countries as their economies expand implies that coal generation is not being displaced by renewables. Indeed, unlike in the U.S. and Europe, renewable resources are not sufficient to meet the increase in demand. Other industrial sectors, such as cement and steel, are also slower to transition, but the focus on decarbonization is increasing.

In Europe And U.S., Rising Renewables Leads To Falling Coal Use

In the U.S., the share of coal in power generation is set to fall to 12% by 2030 under S&P Global Commodity Insights (Platts)' reference scenario, from close to 20% a few years ago. However, the U.S. is also paying increased attention to the reliability of power, which could lead to deferrals of some coal retirements--as recently announced by the mid-continent region operator, MISO--to help mitigate the risk of blackouts, with diversity of the power mix playing a key role.

In Europe, climate and emissions reduction policies are the key reasons for the abrupt drop in coal-fired power to less than 5% of the mix in 2030 from 15% in 2020. The risk of Russian gas interruptions has, however, temporarily delayed the retirement of certain coal plants, with some destined to act as a reserve and therefore stay active for a short while longer than expected. The German government, for example, is considering setting up a 10-gigawatt (GW) coal-fired power generation capacity reserve, while many Eastern European countries are currently still heavy users of coal, with limited prospects for renewables development.

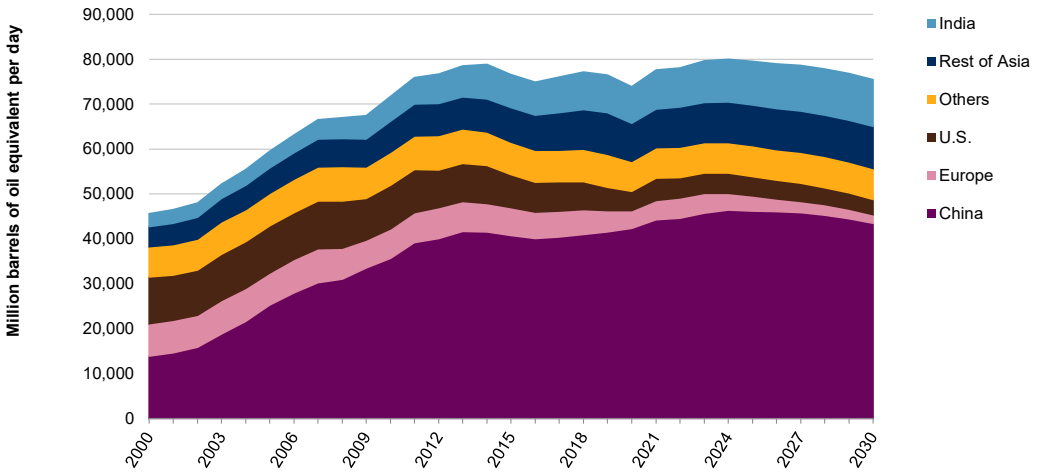
The Transition Is Taking A Different Trajectory In Asia-Pacific

Economic realities in the Asia-Pacific region mean that any significant reduction in coal consumption will prove challenging. Large Asian economies are experiencing a strong rise in electricity demand, which is set to continue over the coming decades to sustain economic growth. When it comes to meeting new demand, coal is still seen as the most affordable option for base-load power. At the 26th U.N. Climate Change Conference (COP26) in November 2021, China and India were the two major hold-outs on coal, agreeing only to phase down rather than phase out the fossil fuel. In China, coal-fired generation will remain relatively flat and elevated this decade, although its share is set to reduce to 51% of power generation by 2030 from two-thirds today, with faster growth in renewables. In India, coal-fired generation will still expand substantially this decade to meet soaring demand. This is despite over 40 countries pledging to phase out coal at COP 26.

Asia's fairly new coal-fired generation fleet is another reason for its reluctance to turn its back on the energy source. The average age of a coal plant in the U.S. and Europe is between 40 and 50 years, and most are now approaching the natural end of their useful life spans. By contrast, in Asia, much of the fleet has been built in the last 10 years, making significant plant closures unlikely before 2030.

The energy transition is also now more complex because of security of supply and geopolitical considerations, exacerbated by the ongoing Russia-Ukraine conflict. In line with such concerns, China has declared that, although its decarbonization efforts will continue, energy security is its first priority.

Global Coal Demand



Source: S&P Global Commodity Insights - Global Integrated Energy Model.

Carbon Capture And Storage May Hold The Key To Long-Term Coal Usage In China

For now, without strong carbon pricing or policy mandates, CCUS technology is unlikely to be applied in power generation. That said, according to China's official "CCUS annual research report," carbon capture is China's indispensable "strategic choice" for reducing carbon-dioxide (CO2) emissions and ensuring energy security in the future. China's emissions reduction from CCUS could be 0.6 billion tons-1.4 billion tons in 2050. The success of meeting net zero goals for countries like China, India, and Indonesia hinges significantly on the future economic and technical feasibility of CCUS technology.

According to the research report, carbon capture, utilisation and storage (CCUS) technology would add Chinese renminbi (RMB) 0.26 to 0.4 per kilowatt hour (/kwh) (roughly $40 to $60 per megawatt hour (/MWh)) to the cost of coal-fired power generation. This is almost the same as China's historical coal-fired power tariff of RMB 0.35-0.40/kwh, and compares to current power prices of RMB 0.50-0.60/kwh. Put differently, for CCUS technology to be competitive, it would require a carbon price of $40-$60 per ton of CO2, whereas Chinese carbon prices currently trade at less than $10 per ton. For reference, according to the International Energy Association, the cost of CCUS technology varies widely between $40 and $120 per ton of CO2.

Policy Approaches Differ Between China And India

China has pledged to achieve peak carbon emissions by 2030 and may well meet this target earlier, given its track record of overdelivering on its five-year renewables targets. Carbon emission growth in the country has started slowing since 2012, when larger rollouts of wind and solar capacity began. The lingering impact of COVID-19, which is still leading to lockdowns in Asia, could help make targets more attainable, since energy demand is currently somewhat lower than anticipated, though coal use has also rebounded faster than expected.
S&P Global Ratings believes that India, on the other hand, will likely miss its 2022 renewable energy capacity targets, and its ambitious 2030 targets would be even harder to achieve with the country set to continue increasing coal use until 2050.

China's policy approach is multi-faceted, serving to discourage coal-fired generation while encouraging renewables growth. With the launch of China's carbon market in the summer of 2021, coal-fired power plants will need to comply with emissions targets. By contrast, India's policies are aimed at making renewables and other alternatives more attractive rather than penalizing coal use. In our view, India still lacks comprehensive energy transition policies and a clear commitment to phase out coal.

Coal-Related Sectors Face Mounting Credit Risks And Financing Costs

Financial markets are independently taking action on the energy transition, and often ahead of policymakers. The pool of funding for coal projects is shrinking, with an increasing number of governments, financiers, and investors devoting more attention to climate risks. Although leading rich and developing nations have agreed to stop financing overseas coal-fired power plants, the current focus on energy security and higher energy prices is creating some hesitation.

Domestic bank funding is still available in China and India but, like all other funding channels, is steadily decreasing. With investor appetite diminishing, some coal projects are struggling to refinance, with access to capital--and not just its price--increasingly becoming an issue, heightening the risk that some assets may become stranded, or even default.

“The success of meeting net zero goals for countries like China, India, and Indonesia hinges significantly on the future economic and technical feasibility of carbon capture, usage, and storage (CCUS) technology.”

Gas' Role Varies By Sector And Region Amid Security Of Supply Concerns

S&P Global Ratings: Emmanuel Dubois-Pelerin; Aneesh Prabhu; Laura C Li; Karl Nietvelt; Massimo Schiavo;
S&P Global Commodity Insights: Roman Kramarchuk

"Demand for gas should keep rising through 2030--fueled by Asia, with demand growth stable in the U.S. and still highly uncertain in Europe."

In light of surging global gas prices, security of supply concerns, and a weakening economic outlook, prospects for gas demand growth are uncertain but supported by strong demand in Asia-Pacific. Natural gas used to meet incremental power generation needs may be the area where demand softens most. By contrast, the use of gas as a raw material in chemical production will be difficult to substitute. The industrial sector represents almost 40% of demand globally, with the power sector accounting for 36% of global gas use. However, in different sectors, this can vary widely by geography. In Europe, for instance, about 40% of gas supplied has historically been used for residential or commercial heating – almost double the global average.

Natural gas, which emits roughly two times less carbon dioxide per unit of energy than coal when burnt, has long been seen as an alternative to coal-fired generation. In the future, renewables will increasingly help displace coal in Europe and the U.S. However, gas still has an important role to play in providing a diverse and reliable power source, helping to back up intermittent supply from renewables and covering seasonal fluctuations in demand. Over time, battery and other storage solutions will also increasingly fill such gaps.

Asia-Pacific Will Fuel Global Gas Demand In The Next Two Decades

In contrast to the turmoil in European gas markets and stable demand patterns in the U.S., demand for oil looks set to increase in China, the Middle East, and South and South-East Asia alongside ongoing economic growth, according to S&P Global Commodity Insights (Platts) (see chart 2). That said, Asian gas demand, met largely by liquefied natural gas (LNG) imports, is sensitive to both high prices and weather. Further investments in new gas import infrastructure in the region could become less appealing in the current high price environment. Moreover, in China, locally procured coal and locally built nuclear power plants have a competitive advantage over imported gas, since security of supply remains a priority, and gas is a more expensive fuel source.

Europe's Green Gas Goals Can Strengthen Security Of Supply By 2030

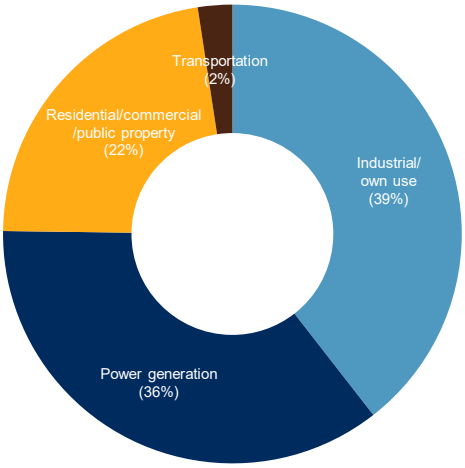
We see REPowerEU's 2030 green gas objectives -- such as increasing the use of renewable natural gas/biomethane and low-carbon hydrogen -- as key to reducing emissions and risks to supply security. Furthermore, these are low-carbon energy sources that, in contrast to renewable power, can be stored and help cover seasonal fluctuations.

A key challenge will be bringing costs down for biomethane and green hydrogen this decade. That said, Russia's invasion of Ukraine, the resulting spike in gas prices, and concerns about security of supply may have created a more viable route. If the EU can achieve its 2030 REPowerEU goals for green gases, it could cover 20% of European gas demand by 2030 in two ways: first, through a biogas target of 35 bcm by 2030 -- 10x higher than today's level and equating to roughly 8% of European gas demand. Second, through green hydrogen targets of 10 million tonnes of domestic production and 10 million tonnes of imports by 2030 to replace gas, coal, and oil in hard-to-abate sectors, with specific financing and carbon contracts for difference (CFDs) to support green hydrogen. This combined 20 million tonne target is indeed ambitious but, if achieved, could equate to about 60 bcm of natural gas equivalent, or about 14% of current European gas demand.

Economies Will Turn To LNG To Bolster Security Of Supply

The gas market has been stretched since demand rebounded after the lifting of COVID-19-related lockdowns. The Russia-Ukraine conflict has further compounded supply issues, highlighting the importance of security of energy supply and diversification. Europe has shown itself to be particularly vulnerable to supply

Global Gas Demand By End Sector



Source: S&P Global Commodity Insights (Platts)

issues given its heavy reliance on Russian gas, and we expect it will increasingly use LNG to make up for the loss of gas volumes from Russia. It will likely rely significantly on the U.S. for its LNG supply, especially given other Atlantic and Mediterranean liquefication resources are often strained. S&P Global Commodity Insights projects that U.S. global LNG volumes will rise to 170 million metric tonnes per annum (mtpa), equivalent to 240 bcm, by 2027-2030 from 100 mtpa today.

Meanwhile, in China, security of energy supply remains a top priority, especially after power supply shortages in late 2021, caused by high coal prices and environmental restrictions. Although China has increased its own gas production, it will inevitably rely on LNG imports while implementing its decarbonization initiatives. Its LNG imports are likely to pick up gradually in the remainder of 2022 with the rollout of LNG terminals and new long-term LNG contracts to be fulfilled, even though they declined by 9% year-on-year in the first five months of 2022 after COVID-19 and high prices hit domestic demand. At the same time, China has increased pipeline gas supplies from Russia this year.

The Risk Of Stranded Gas Assets Remains

Investments in the gas value chain may have gained greater acceptance in the wake of Europe's energy crisis, with access and affordability considerations trumping climate considerations. In the long term, however, visibility on gas investments remains limited given Europe's strong decarbonization objectives. By contrast, in the U.S., competitive domestic gas – despite being a fossil fuel – is likely to enjoy more prolonged support, but also faces a decline as the share of renewables increases.

Companies contracting new LNG volumes to address a potential abrupt loss of Russian gas need to manage their exposure to long-term purchase commitments that affect their decarbonization goals, while taking steps to address the risk of stranded gas assets. They also need to consider that the consumption of natural gas in Europe could drop sharply in the longer term.

Consequently, we expect investments in gas to work as a means to provide further options down the line, such as power plants or pipes that can be repurposed for hydrogen supply and re-routed to other regions, or gas used for blue hydrogen when accompanied by carbon capture. Alternatively, given the risk of stranded assets, future investments may require short payback times--which high market prices may facilitate--or additional support through regulatory returns, such as capacity payments for gas-fired back-up power plants to improve grid reliability.

> "Russia's invasion of Ukraine and subsequent concerns regarding gas supply and interruption risk are accelerating Europe's shift to renewables and greener gases."

Impact of Russian gas crisis on gas prices in Europe and the U.S.

Europe's aim of moving away from Russian gas appears daunting, with gas prices set to stay at record highs for several years. The European gas market is currently undergoing a disruptive shift amid Russia's invasion of Ukraine, with the need to reduce dependence on Russian gas becoming more urgent than the need to decarbonize. The European Commission's REPowerEU plan envisages eliminating Russian gas imports by 2027. Initially, this would mean relying on alternative gas sources, mainly LNG. Doing so will be challenging, bearing in mind that, last year, Russian gas imports accounted for 39% of EU imports and one-third of total European demand. Europe needs to secure sufficient LNG volumes and rapidly expand import infrastructure to replace 140 billion cubic meters (bcm) of piped Russian gas. The impact on gas prices is unprecedented.

Over the past year, the U.S. natural gas price has become increasingly influenced by global natural gas dynamics. It has soared to $9 per million cubic feet (/mcf)--broadly comparable to $9/mmBtu--from historical averages of $2/mcf-$3/mcf, as more feed gas is routed to liquefaction plants for export to Europe. However, the recent increase in natural gas prices is, in the first instance, because gas-to-coal switching is not happening in many regions. Historically, changing to coal-fired generation has helped ease natural gas prices. Now, however, coal prices have also escalated due to limited coal operations; inventories are low and we see no new coal-related investments. We ultimately expect to see U.S. gas exploration and production companies increase supply, but in a measured way.

Nuclear's Path Is Diverging In Developed And Developing Nations

S&P Global Ratings: Claire Mauduit-Le Clercq; Emmanuel Dubois-Pelerin; Aneesh Prabhu; Gabe Grosberg; Laura C Li; Karl Nietvelt;
S&P Global Commodity Insights: Roman Kramarchuk; Bruno Brunetti

"The gas and power crisis in Europe has increased the focus on security of energy supply, possibly leading to greater support for nuclear."

Energy security has again risen to the top of Europe's priorities in the face of rising gas and energy prices following Russia's invasion of Ukraine and the EU's subsequent pledge to reduce reliance on Russian gas. Meanwhile, European Parliament has just approved the labelling of nuclear as green under the EU Taxonomy, underscoring the view of certain countries that nuclear should be part of the response to decarbonization and security of supply.

Yet, in the near term, nuclear generation in the EU is set to decline, notably given Germany's plan to close nuclear power plants by year-end 2022 and lower nuclear availability in France because of technical issues. Similarly, nuclear generation in the U.S. is trending down, with the focus on extending plants' lifespans rather than on costly and risky new nuclear projects.

In contrast, China's nuclear capacity should reach 105 gigawatts (GW) by 2035, surpassing both the U.S. (92 GW by 2030) and Western Europe (76 GW). The current proportion of nuclear generation in developed countries (60%) versus that in developing countries (40%) is likely to reverse over the next two decades (see chart 1).

Nuclear To Decline In Europe And The U.S. But Ramp-Up In China

Once Germany completes its plan to exit nuclear by year-end 2022 and further plants in Belgium are closed, S&P Global Commodity Insights (Platts) expects some stabilization of nuclear power output after 2025 in Western Europe. This is in view of one new build in France and one in the U.K., Belgium's recent plans to extend the operation of two reactors to 2035, and France's announcement that it would keep most of the remaining plants online into the next decade. In the U.S., some state and regulatory support is emerging to keep nuclear plants operating longer.

Blackouts due to extreme weather in the U.S., for instance, have demonstrated the importance of firm power and a diverse power mix.
Still, the share of nuclear generation in Europe and the U.S. is decreasing, and will most likely reach about 15% of power generation by 2035 after close to 20% in 2020, according to S&P Global Commodity Insights (Platts)' reference scenario. Apart from policy reasons and the prioritization of renewables growth, another reason for this is that few nuclear new builds are being contemplated given their high costs and risks, notably for private investors and shareholders.

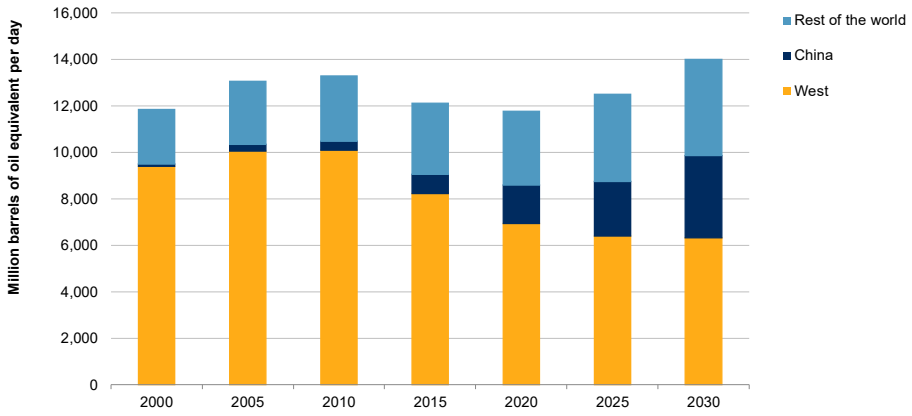
In contrast, we do not expect China, the developing nation that most expands its fleet, to waver from its nuclear power ambition any more than it has so far. China's 14th five-year plan (2021-2025) implies 70 GW of operational units by 2025 (up from 55.7 GW currently), which could rise to 145 GW by 2035. As such, the share of nuclear is forecast to double to close to 10% of China's power mix by 2035. Most of China's nuclear generation and new-build projects are executed by state-owned enterprises, which also explains the different momentum.

Without Direct State Backing Or A Contractual Framework, New Builds Entail Significant Credit Risk

Financial considerations remain an additional hurdle for nuclear power alongside concerns about safety and nuclear waste management. Given the elevated costs of building a nuclear plant, which can be as high as $10,000 per kilowatt (/kW) of installed capacity, the focus in Europe and the U.S. is on legacy fleet preservation. In China, however, new builds not only benefit from much lower capital costs, which we estimate to stand at around $2,500/kW, but are facilitated by indigenous technology, integrated supply chains, and access to cheap financing, since the nuclear industry is run by state-owned enterprises.

S&P Global Ratings believes that, without visibility through long-term fixed-price mechanisms or regulation, building and operating nuclear plants on a merchant basis entails significant credit risk. This is because of the very high upfront capital costs and construction risks, combined with rising interest rates and increasingly volatile long-term power prices. What's more, the rising share of renewable generation and its low marginal production costs will likely undermine long-term power prices in Western Europe, according to S&P Global Commodity Insights (Platts)' forecasts. Direct state involvement or financial and policy support is therefore a

Share Of Nuclear In Global Primary Energy Generation



Source: S&P Global Commodity Insights - Global Integrated Energy Model

key determinant of the future of nuclear, in our view. Generally, private investors and operators appear to be averse to taking on construction risks linked to nuclear new builds unless these risks are strongly mitigated by explicit state backing and/or regulatory or contractual support mechanisms.

Some Policy Support For New Projects Or Lifespan Extensions Is Building

In this respect, the U.K. government has committed to a long-term contract for difference for Hinkley Point C, with a guaranteed price of £92.50 per megawatt hour (MWh) over a 35-year period. The U.K.'s potential additional Sizewell C project should benefit from a more extensive regulated asset base framework, with regulated revenue during construction and significant risk-transfer mechanisms. Despite this more beneficial framework, S&P Global Commodity Insights (Platts) sees significant challenges for the U.K. in achieving its 24 GW target by 2050.

France has announced its intention to revise previous plans to reduce the share of nuclear generation to 50% by 2035 from over 70%, but this is not yet part of its energy policy. Consequently, we expect France's current nuclear capacity of just over 60 GW to remain flat through 2030. We understand that France is planning to commission new nuclear reactors by 2035 to offset the closures of plants. The funding and revenue framework of such new investments will, however, be key, since the balance sheet of national integrated power utility EDF has become strained. Furthermore, we expect the possible price re-regulation of EDF's existing nuclear plants to remain a topic of discussion with the European Commission. The near-term hurdle for EDF, however, is how to address major outages at its nuclear fleet and improve the operational reliability of aging plants.

In the U.S., a 2021 bipartisan infrastructure bill includes the Department of Energy granting nuclear plants at risk of closure $6 billion over five years to keep them operating. California has asked whether two nuclear units could qualify for the grant, even though it has prioritized the growth of renewables. Six other U.S. states have stepped in to provide financial support or other assistance to as many as 20 at-risk nuclear reactors, representing almost 20 GW (21% of total U.S. nuclear capacity). State subsidies can involve zero-emission credits or power purchase agreements, and have typically totalled up to $100 million per year for each reactor. At the federal level, a proposed tax provision (section 136109) contemplates the granting of a production tax credit of up to $15 per MWh to existing nuclear power plants through the end of 2026.

China's nuclear power industry is in a new development phase compared with Europe and the U.S. The fleets are much newer than in the rest of the world--averaging nine years--with newer technology and better operating efficiency thanks to the expertise and indigenous technology developed over the past three decades. Nuclear power will likely continue its stable development in China because it is an essential low-cost solution to decarbonize the economy, particularly in coastal provinces. Policy has remained consistent to ensure there is sufficient remuneration of capital invested by the three state-owned nuclear power generation companies (a new one was approved recently). This is important to fostering sufficient new builds at a pace that ultimately outstrips power demand growth.

"In the U.S., various states have contemplated incentives to extend the lifespan of nuclear plants to support the reliability of the power grid."

Nuclear Is Still An Important Zero-Carbon, Firm Power Source

Nuclear generation is one of the least carbon-intensive ways to produce power, and given the urgency to reduce emissions, it features in several countries' energy transition plans. For instance, 1 GW of power from nuclear generation instead of from gas-fired combined cycle plants could help save close to 3 million tonnes of carbon dioxide emissions per year (or potentially double that amount when compared with coal plants).

What's more, even if the rollout of renewables was to become the primary means to decarbonize the power industry, power supply from renewables remains intermittent, requiring dispatchable backup sources. However, despite nuclear's advantage in generating base load power, it may not be a good candidate for widespread use. This is because some nuclear plant fleets lack flexibility, while in other cases – such as EDF in France – they do not consistently operate at full planned capacity.

Renewables Remain The Cornerstone Of Future Power Generation

S&P Global Ratings: Trevor J D'Olier-Lees; Emmanuel Dubois-Pelerin; Aneesh Prabhu; Laura C Li; Karl Nietvelt; Massimo Schiavo;
S&P Global Commodity Insights: Bruno Brunetti; Morris Greenberg; Steve Piper; Richard Sansom

"Renewables are forecast to increase to 60% of power generation in Europe by 2030, and possibly approach 40% in the U.S. and China."

Renewable energy sources (solar, wind, and hydro) account for the majority of annual investments in power generation. Yet they still represented just 13% of global primary energy consumption in 2020, according to S&P Global Commodity Insights (Platts). Climate policies, cost competitiveness, and the strategies of power companies and investors will likely help increase this share to 18% by 2030 (two-thirds wind and solar, one-third hydro). This means that, by then, renewable energy could equate to 60% of the primary energy previously sourced from oil, versus about 25% a decade ago.

The growth and importance of renewables in the power generation mix, however, is significantly higher. S&P Global Commodity Insights (Platts)' reference scenario puts the share of renewables in 2030 at more than 60% of the power mix in Western Europe, up from around 35% today, and 38% each in the U.S. (up from 23%) and China (up from 30%). As part of that increase, the projected expansion of solar and wind capacity is even more impressive, almost doubling this decade to 47% by 2030 in Europe (versus 25% in 2020), 32% in the U.S. (up from 12%), and 24% in China (up from 11%).

Capacity Additions Lag Energy Demand Growth And A 2-Degree Pathway

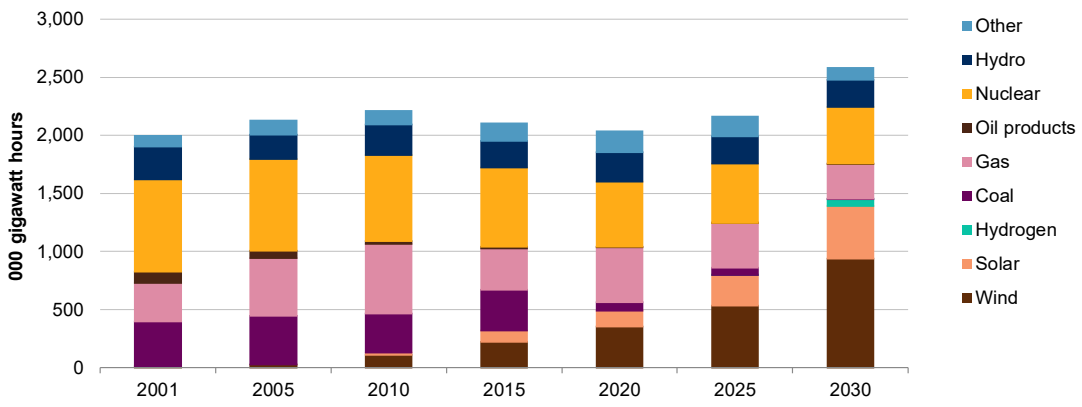
Despite ongoing growth in renewables, gas and coal-fired power generation continues to rise. This is due to steadily increasing power demand in developing markets (notably China and India), combined with global electrification trends – such as switching to electric vehicles – and demand from a growing number of data centres, including for bitcoin mining. What's more, in many markets there are still few incentives to build new renewables capacity to replace older fossil-fuel power plants that are fully depreciated, and the cost of carbon is not fully accounted for, in our view.

Accelerating the expansion of renewables generation, in line with limiting global warming to less than 2 degrees per year, would require significant additional momentum beyond market economics. S&P Global Commodity Insights' (Platts') 2-degree scenario would require renewable energy generation from solar, wind, and hydro in 2050 to be almost double that expected in the reference case.

Supportive Policies Remain Needed To Foster Growth

Renewable power generation has become competitive, especially in the current environment, where fossil fuel prices are at record highs. However, we see that the solar and wind power industry still requires wide-ranging policies that foster further growth, including investment in auxiliary technologies such as storage, grid upgrades, and interconnections. For example, attaining permits for renewables projects is often cited as a major hurdle in the U.S. and Europe. To address this, and in view of the urgency resulting from the Russian gas crisis, Europe's recent REPowerEU plan now includes a proposal for "renewables go-to zones"

Western Europe's Power Generation Mix



Source: S&P Global Commodity Insights - Global Integrated Energy Model

and initiatives to limit legal recourse against new generation plants and grid build-ups, as seen in Germany.

S&P Global Ratings believes policies to facilitate long-term price visibility for renewables investments are key to reducing credit risks and financing costs. In the U.S., credit-supportive price visibility is often provided through power purchase agreements with utilities, which often result from renewable portfolio standards set by states. In Europe, a competitive auction process is mostly used for renewables, which has yielded a fixed price outcome or contracts for difference (CFDs) over 15-20 years and essentially acts as a swap of a long-term spot price into a fixed price, rather than as a subsidy. Even though the cost of renewables has decreased, and is now competitive relative to that of other power generation sources, any unmitigated exposure to long-term power prices (and hourly capture rates) would unlikely be in line with investment-grade credit characteristics. This is because such exposure would make cash flows of renewable projects subject to significant uncertainty, similar to those of other merchant-type power projects. S&P Global Commodity Insights (Platts) expects power prices in Western Europe to decline sharply over the next decade, assuming gas prices start to return to normal levels. This is because of the rising share of zero- or low-marginal-cost plants in the generation mix.

Reliance On China For Equipment And Raw Materials Poses Risks

Recent supply chain issues have hampered renewables growth, but we believe this should be more manageable in the medium term. Despite accounting for about half of global annual installations, China dominates the global solar supply chain. High dependence on China for raw materials key to the energy transition has also been underscored by the International Energy Agency.

There is, however, no one-to-one comparison with dependence on oil- or gas-producing countries, as once renewable power plants are installed, the dependence on China reduces significantly because wind and solar are indigenous fuel sources. Still, U.S. and European governments are already considering alternative suppliers outside China, as well as the onshoring of key strategic investments, including batteries and related lithium mining semiconductors, and photovoltaic solar panels.

Key Renewables Objectives By 2030

As more fossil fuel plants close due to age or environmental mandates, and the share of renewables in the power mix expands, there will be a need for flexible dispatchable power that addresses the intermittent nature of renewables. Low-carbon solutions, including batteries, can address short-term supply needs but are unlikely to cope with major seasonal fluctuations in energy demand.

However, these solutions still come with a high price tag, which needs to be added to the cost of renewable generation to arrive at an all-in cost of providing firm power that is available at all times. The more likely interim solution, therefore, may be to steadily increase the contribution from renewables, while adding gas-fired peaking plants or providing a capacity payment mechanism to existing gas- or coal-fired plants to allow them to act as back-up capacity and be available during periods of low power output from renewables.

Likewise, interconnections will play a key role in reducing intermittency risks, since they link markets with different resource mixes. In Europe, for example, there is significant renewables generation in Denmark (74% of total generation in 2021), but grid stability is supported by a comprehensive interconnection network across the region, which is now even being expanded into the U.K. The development of such networks, however, requires long commissioning time frames.

Affordable and reliable power is likely to be an increasing area of focus for all countries.

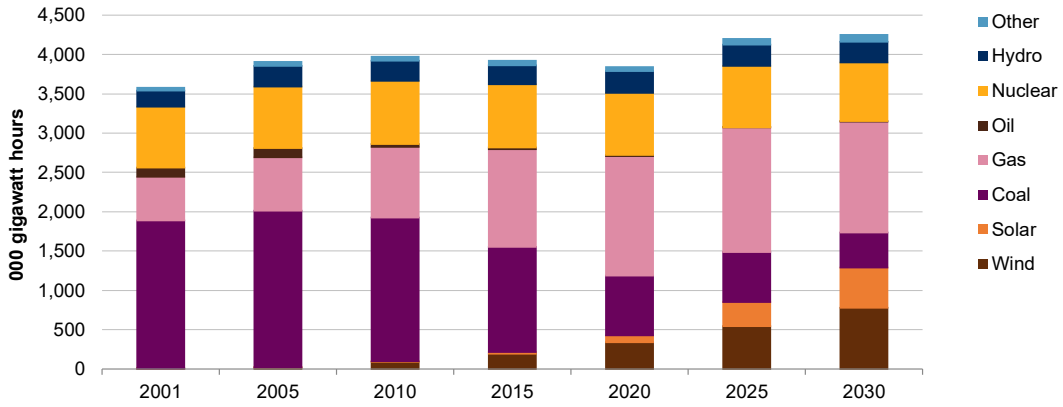
- The European Commission and Parliament have just approved certain (peak) natural gas power plants to be designated as green sustainable investments.

- In the U.S., California--where renewables now account for 33% of power generation--could delay the closure of the Diablo Canyon nuclear plant after the state faced rolling blackouts and increased fluctuations in renewables output. Other states that have a lower proportion of renewables are also running into issues. The mid-continent region operator, MISO, has just issued a warning about blackouts for Michigan and there have been some deferrals of coal retirements.

- China is supporting coal supply in 2022 to ensure power stability, but factoring into the equation an affordable energy transition. Last year, the country's commercial and industrial sectors experienced power shortages. China is using a combination of tariffs and measures such as "dual-control" to fuel growth of renewables while still supporting firm power from coal.

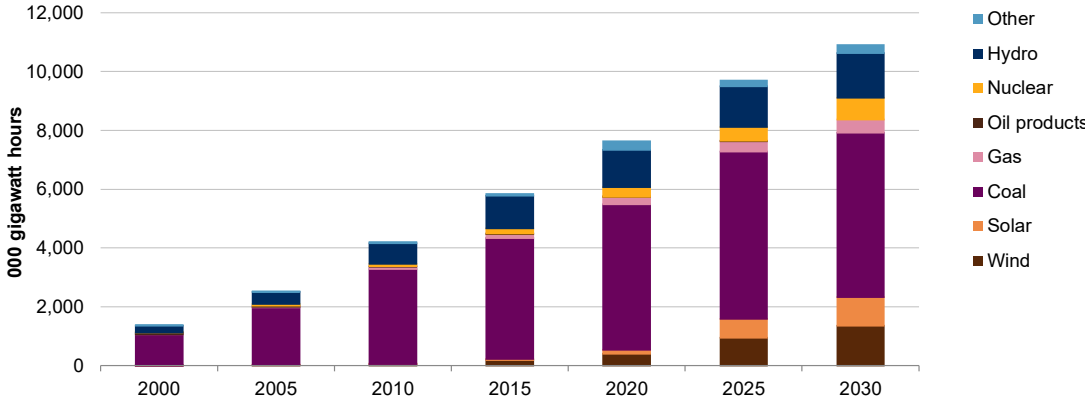
"Continued policy support remains important to reduce credit risks from volatile and potentially declining long-term power prices as the share of zero- or low-marginal-cost plants increases."

U.S. Power Generation Mix



Source: S&P Global Commodity Insights - Global Integrated Energy Model

China's Power Generation Mix



Source: S&P Global Commodity Insights - Global Integrated Energy Model

Key renewables objectives: Europe, the U.S., China

Russia's invasion of Ukraine has added new impetus for Europe to double down on its energy transition targets. The goal of reducing dependence on Russian gas and promoting energy independence now complements the region's push toward net zero. The REPowerEU strategy has raised the target for the share of renewables (including hydro) to meet energy demand to 45%, compared with 40% in the previous "Fit for 55" plan. To this end, REPowerEU aims to have 1,236 gigawatts (GW) of wind and solar generation capacity online by 2030, up from about 350 GW of installed capacity today.

In the U.S., the increasing bifurcation of political views is hampering support for climate-oriented policies. A recent U.S. Supreme Court decision curtailed--though did not end--the Environmental Protection Agency's ability to regulate power sector GHG emissions under the Clean Air Act. From the standpoint of renewable energy growth, the budget reconciliation agreement, known as the Inflation Reduction Act of 2022, opens the door to clean energy investments over the next decade, including new and expanded clean energy tax credits. This notwithstanding, renewables growth in the U.S. should remain underpinned by cost competitiveness and the decarbonization strategies of many utility companies. Moreover, state legislation, such as renewable portfolio standards, is not affected by the court's decision. Based on S&P Global Commodity Insights' (Platts)' reference case, we foresee installed wind and solar capacity reaching 510 GW by 2030, up from 225 GW at the end of 2021.

We expect that China will deliver on or surpass the target in its recently-announced 14th five-year plan. The plan includes a target of renewables (excluding hydro) to cover 18% of primary energy consumption by 2025. This requires 1,100 GW of installed wind and solar power capacity, almost double the currently installed capacity of about 640 GW (330 GW from wind and 307 GW solar photovoltaic) at year-end 2021, and is already close to the official target of 1,200 GW by 2030. Given that China has been adding 100 GW of renewables capacity per year, its 2030 target is therefore well within reach and likely to be exceeded. The power market is mainly led by state-owned enterprises with limited funding issues.

Uniper

On May 19, we lowered our rating on German-based gas supplier Uniper to 'BBB-' from 'BBB' based on the risk of Russian exposure.

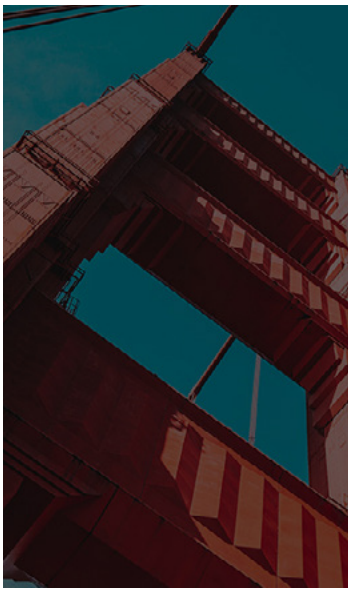
Uniper procures more than 50% of its gas from long-term contracts with Gazprom, and its above-average exposure to Russia is weakening its business profile.

On July 22, German Chancellor Olaf Scholz announced a package to support Uniper, including the government taking a 30% equity stake (€267 million) in the company and the upsizing of a KfW line to €9 billion from €2 billion currently, and promising further government support if needed.

Therefore, on July 29, we affirmed our 'BBB-' long-term issuer credit and issue ratings on Uniper and removed its ratings from CreditWatch with negative implications, where they were placed on July 5, 2022.

The negative outlook reflects our view that Uniper will continue to operate under an uncertain environment and our view that the government might need to expand its support to Uniper.

More information can be found on Capital IQ in the ratings update titled: : Uniper Downgraded To 'BBB-' On Exposure To Russia, Fortum Affirmed At 'BBB'; Outlooks On Both Negative,
Uniper 'BBB-' Ratings Affirmed Following German Government Support Package; Outlook Negative



Cheniere Energy Inc.

On February 17, we raised our issuer credit rating (ICR) on Cheniere Energy Inc. (CEI) to 'BB+' from 'BB', in light of improved financial metrics due to strong performance as well as significant debt repayment.

New trains and higher liquefied natural gas prices provide a foundation for strong forecast cash flow generation. Furthermore, the company's commitment to delivering through capital allocation sets the stage for further strengthening of metrics consistent with an investment-grade rating.

The positive outlook reflects our expectation of continued strong cash flow and debt repayment consistent with CEI's stated capital allocation policy, and also reflects our expectation that the company will continue with its stated deleveraging plans.

More information can be found on Capital IQ in the ratings updates titled: Cheniere Energy Inc. Rating Raised To 'BB+' From 'BB' On Strong Cash Flow And Deleveraging; Outlook Positive

Centrais Eletricas Brasileiras S.A.

On June 15, we affirmed our 'BB-' global scale issuer credit and issue-level ratings on Brazilian electric utility Centrais Eletricas Brasileiras S.A., following the conclusion of Electrobras' privatisation process, lowering government voting rights to 10%.

Eletrobras' new corporate governance standards limit the government's influence on the company's administrative and strategic decisions. As such, we revised our assessment of the link between Eletrobras and the Brazilian government to strong from very strong.

The stable outlook reflects our expectation that Eletrobras will continue deleveraging through higher EBITDA generation from the 5.7 gigawatt (GW) new concessions and the gradual migration of 7.5 GW of energy currently under the quota regime to independent contracts starting in 2023.

More information can be found on Capital IQ in the ratings updates titled: Centrais Eletricas Brasileiras S.A. – Eletrobras 'BB-' Ratings Affirmed Following Privatization; Outlook Remains Stable

Autostrade per L'Italia and Atlantia

On June 7, we raised our issuer and issue rating for Autostrade per L'Italia (ASPI) by two notches to 'BBB-' following completion of the disposal of Atlantia's 88.06% stake in the company.

The disposal settles the dispute regarding the ASPI concession that arose after the Genoa bridge collapsed in August 2018, removing the risk that the concession might be terminated early. The change of control makes ASPI a government-related entity (GRE) under our criteria, and a national strategic asset critical to Italy's trade-driven economy.

The positive outlook mirrors that of Italy (BBB/Positive/A-2) and our opinion that the company is likely eligible to receive extraordinary government support if necessary.

On July 25, we raised our long-term issuer and issue ratings on Atlantia to 'BB+' from 'BB' following the settlement on ASPI.
In our view, the disposal lifted the liquidity risks stemming from the ASPI concession and we see limited legacy risk.

The stable outlook reflects our expectation that the company will be able to maintain FFO to debt above 9% while continuing to manage solid infrastructure assets.

More information can be found on Capital IQ in the ratings updates titled: Autostrade per l'Italia SpA Upgraded To 'BBB-' Following Completion Of Change Of Control; Outlook Positive;
Atlantia And Aeroporti di Roma Upgraded On ASPI Disposal Amid Voluntary Tender Offer By Edizione; Outlook stable

Melbourne Airport and Southern Cross Airports

On July 28, we affirmed our 'BBB+' long-term issuer ratings on Australia Pacific Airports Corp. (APAC) and Southern Cross Airports Corp. Holdings Ltd., and revised our Outlook for both from stable to negative.

Rising passenger numbers should increase the earnings and cash flow of both Australian airport operators, supporting a recovery in credit metrics.

The stable outlook reflects our expectation that APAC's ratio of funds from operations (FFO) to debt should rise to about 8.5%-8.9% in fiscal 2023 – while Sydney airport's cash flow should support a recovery in its FFO of around 8% in the same period – as a result of strong passenger recovery.

More information can be found on Capital IQ in the ratings updates titled: Melbourne Airport Outlook Revised to Stable On Progressive Traffic Recovery; 'BBB+' Rating Affirmed;
Southern Cross Airports Outlook Revised To Stable On Strengthening Traffic Recovery; 'BBB+' Ratings Affirmed

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