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The Investment Engineers

China Fundamental Equities

China: Charting the course to carbon neutrality by 2060

Sustainable Investing Expertise by ROBECOSAM

White paper

For professional investors
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Contents

Introduction

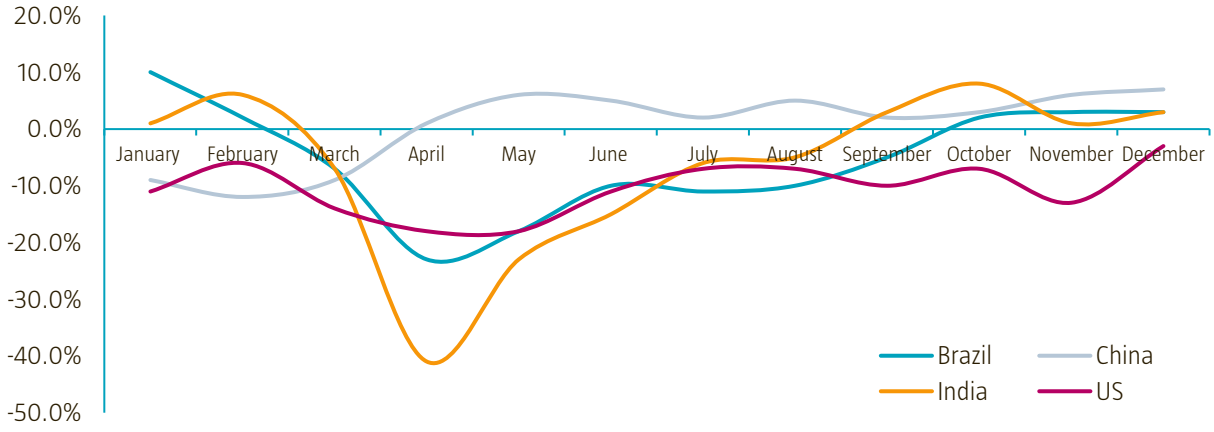
China's unexpected pledge last September to become carbon neutral by 2060 has left many observers both excited and perplexed.

Was it a logical next step after the country's commitment to the 2015 Paris climate agreement, yet another case of political greenwashing at a time when many other countries are falling behind on their pledges or, perhaps, a real game-changing moment for humankind? Maybe it was a bit of all three. Only time will tell.

For now, one thing is certain: China did not need to publicly commit to a peak in carbon emissions by 2030 and to carbon neutrality by 2060, as vague as these objectives may seem at this point in time. This explains why the pledge initially came as a surprise for most of the global community. But it also suggests a genuine, strong commitment to decarbonization from Chinese leaders.

This is important because making the world's largest CO_2 emitter carbon neutral within the next 40 years is no mean feat. The rapid pace at which CO_2 emissions recovered their upward path last year (see Figure 1) in spite of the all the havoc caused by the Covid-19 pandemic is a testament to the disruption needed only to put our economies on the necessary trajectory.

Figure 1 | Monthly evolution of CO_2 emissions in selected major economies, 2020 relative to 2019



Source: IEA, 2 March 2021, "Global Energy Review: CO2 Emissions in 2020", article.

Formidable challenges come with many opportunities

So, while current trends in CO_2 emissions may not be comforting, with a relentless rise seen over the years, the recent change of tune at the highest level clearly warrants close attention. In this note, we analyze the current situation and the likely consequences of this shift for the coming years. We look not only at the formidable challenges associated with the transition, but also at some of the many investment opportunities that should arise from it.

The world's largest emitter by far

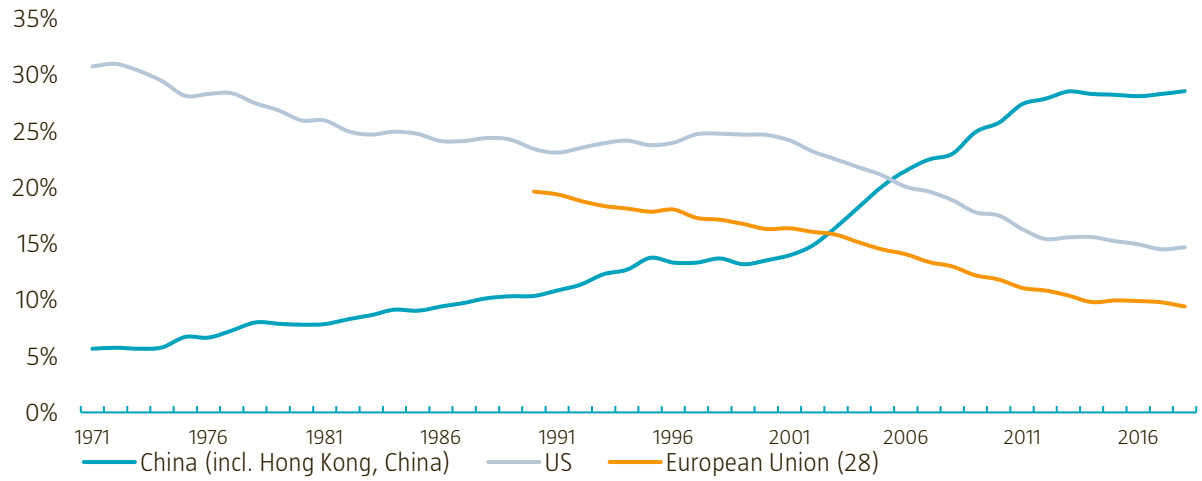
In just four decades, China has moved from being an isolated backward-looking nation to the world's second-largest economy and a key driver of global economic growth.

Since the political and economic reforms initiated in the late 1970s, the country's fast-paced industrialization and urbanization have triggered an unprecedented boom in economic activity, pulling hundreds of millions of people out of poverty. But these developments have come at a heavy environmental cost, in particular in terms of greenhouse gas emissions, including CO_2.

Demographic growth combined with rapid industrialization and the need to modernize and expand depleted urban and transport infrastructures meant a very high reliance on energy and resource-intensive activities, to build cities, roads, railroads, power grids, cars, etc. The vast majority of this development was powered by fossil fuels such as coal, oil and gas.

So much so that China's CO_2 emissions per capita increased more than threefold between 1990 and 2018, from 2.15 to 7.18 metric tons per year, according to the World Bank. The country's CO_2 emissions per inhabitant now stand at levels close to those of large industrialized nations such as Japan and Germany, and are significantly higher than those of developed countries such as the UK, France and Italy.

Figure 2 | China's rising share of global CO_2 emissions



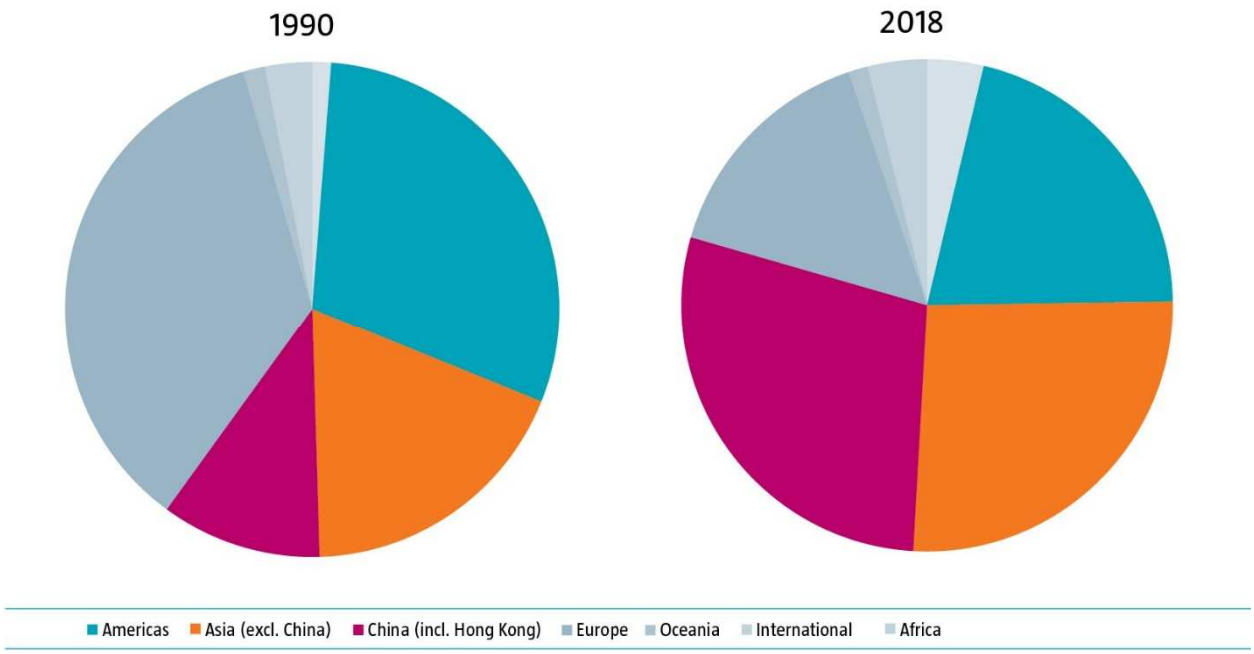
Source: IEA. CO_2 emissions from fuel combustion in metric tons.

From this perspective, President Xi Jinping's announcement to the United Nations (UN) General Assembly in September 2020 that China would strive to be carbon neutral by 2060 should not be seen as a mere technical step following the country's commitment to the Paris Agreement of 2015 on climate change. Admittedly, such a vow may be insufficient to limit global warming to 1.5°C above pre-industrial levels. It only covers CO_2 emissions, and omits other greenhouse gases. Moreover, the '1.5°C scenario' painted by the Intergovernmental Panel on Climate Change (IPCC) prescribes the achievement of global carbon neutrality by 2050 – not 2060 – and GHG neutrality by 2070.

Yet it also represents the most important climate-related pledge made by any country so far, and an essential milestone. For one, China is by far the largest carbon emitter in the world. The country currently accounts for close to 30% of global CO_2 emissions, according to the International Energy Agency (IEA), versus 15% for the US and 9% for the

European Union.[1] Moving such a CO_2 intensive mammoth towards carbon neutrality while ensuring economic prosperity, within the next four decades, will require Herculean efforts and the involvement of both public and private sectors.

Figure 3 | The world's largest global CO_2 emitter by far



Source: IEA. Data for 1990 and 2018. CO_2 emissions from fuel combustion in metric tons.

Colossal investments will be needed to enable the transition, especially in areas such as renewables, the electrification of transport and nuclear power generation. Various projections have been circulating in recent months. The Boston Consulting Group (BCG), for example, recently estimated that the cumulative investments required through 2050 to reach the 1.5°C target are between CNY 90 and 100 trillion (USD 14 -15.5 trillion), or roughly 2% of the country's cumulative GDP over that period.

And yet this whopping figure might not be enough. According to Tsinghua University's Institute for Climate Change and Sustainable Development (ICCSD), an influential Chinese research institute, the investment required to follow the 1.5°C pathway could reach CNY 140 trillion, or roughly USD 21.5 trillion. Arguably, one reason the ICCSD's estimate is high relative to other projections is because the researchers have interpreted the target to include all greenhouse gas emissions, not just CO_2.

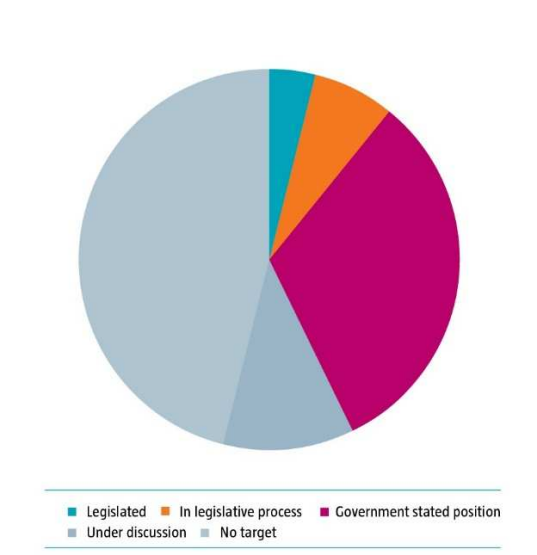
[1] Based on CO_2 emissions from fuel combustion for 2019.

Box 1: China's pledge boosts share of global carbon emissions covered by net-zero targets

While crucial – given the country's share of global CO_2 emissions – China's pledge to become carbon neutral was not the first of its kind. It came after a series of similar pledges from dozens of other countries across the globe. At the end of last year, more than half of global emissions were covered by some form of official net-zero target, according to BlombergNEF.

In most cases, though, pledges made by governments still remained on policy statement status, and were still waiting to be discussed before eventually being turned into law. Still, progress had been made relative to the previous year, as the amount of emissions covered by a final, legislated target and in legislative process both doubled in the course of 2020.

Figure 4 | Global emissions covered by a net zero target at the end of 2020



Source: BloombergNEF, March 2021.

From 10 billion to zero

Despite Covid-19, China's carbon emissions increased 5% in 2020, reaching 9.9 billion metric tons of CO_2 equivalent, according to statistics recently released by the IEA.[2]

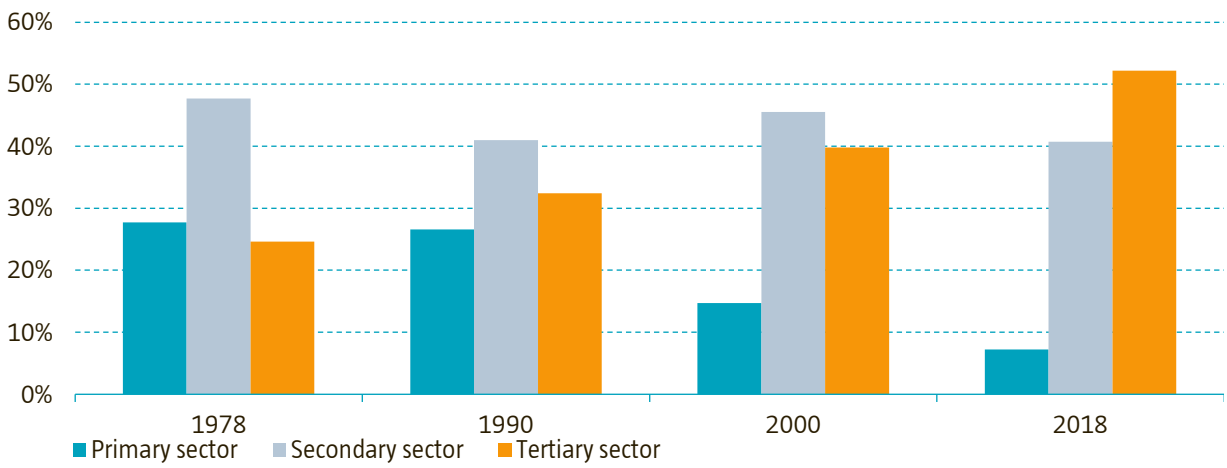
These emissions are expected to hover around 10 to 12 billion metric tons per year over the coming decade, before eventually embarking on their downward journey. These assumptions are broadly consistent with Xi Jinping's September 2020 promise to reach a peak in CO_2 emissions before 2030 and aim for carbon neutrality before 2060.

Net zero carbon emissions will require combined efforts in three directions. Firstly, a shift in the country's gross domestic product (GDP) mix, away from carbon-intensive industries such as manufacturing and construction towards more carbon-light activities such as services. Secondly, a change in the country's energy mix, away from coal and oil towards renewables. Finally, carbon compensation plans – through reforestation and carbon capture, for instance – will also play a key role.

Change in GDP mix

China's economic structure has already been changing for the better. The gradual move away from industrial activities started over a decade ago. Since the peak reached in the mid-2000s, the share of the industrial sector in the country's GDP has declined from 46.9% in 2006 to 40.7% in 2018, according to China's National Bureau of Statistics. Meanwhile, services have risen steadily and accounted for 52.2% of the country's GDP in 2018.

Figure 5 | China's GDP mix



Source: National Bureau of Statistics, China.

These changes are consistent with those typically seen in more advanced economies and are therefore likely to gradually continue over the next four decades. Given the relatively low carbon-intensive nature of the services sector, the transition will automatically help reduce carbon emissions. In fact, China's carbon intensity (kilograms of CO_2 emitted per US dollar of GDP) has been steadily decreasing since the mid-2000s and is now more than 40% lower than in 2005.

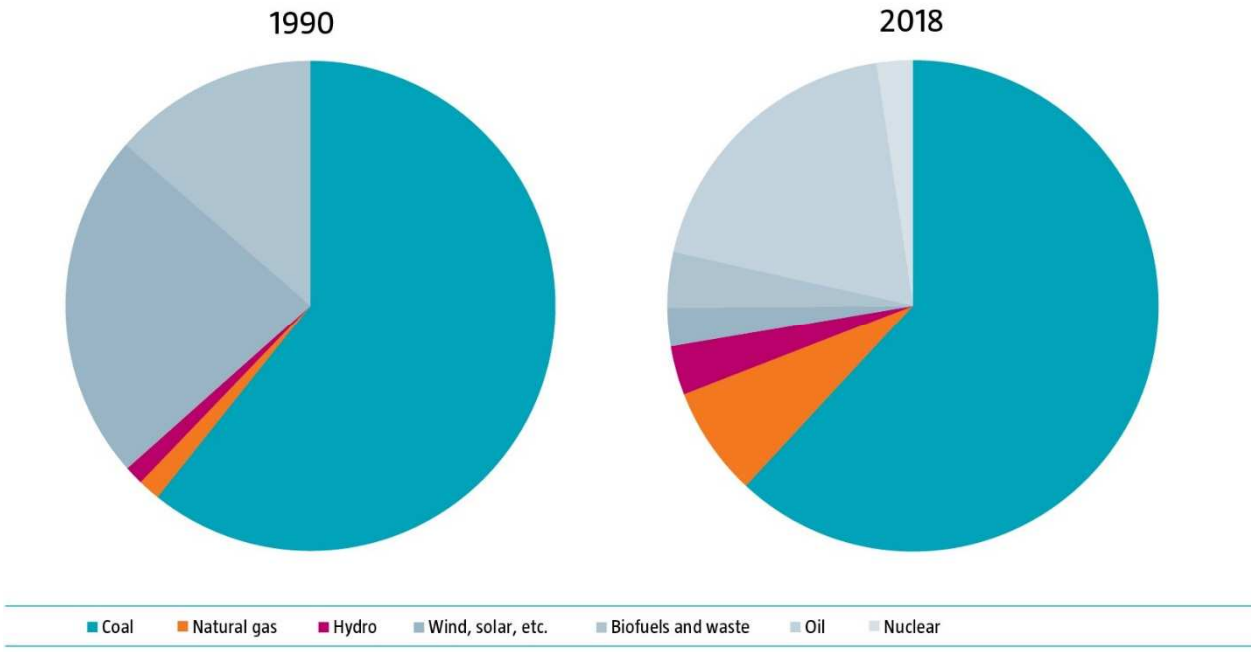
[2] See: IEA, 2021, 'Global Energy Review: CO2 Emissions in 2020', report.

Change in the energy mix

Despite sizable investments in areas such as hydro, wind and solar power over the past decade, China's economy remains heavily dependent on fossil fuels. These account for roughly 88% of the country's total energy supply.[3] In particular, China is extremely reliant on coal, which is arguably the most problematic energy source in terms of carbon emissions. Coal represents approximately 62% of the country's energy supply mix.

China's decision to stick with coal – mainly for power production – is not recent. It is also essentially a matter of strategic energy security for the country, which explains why despite its long-term pledge, China also plans to keep building coal-fired power plants. Although China accounts for over half of the world's coal demand, more than 90% of its consumption is produced domestically. By comparison, the country needs to import roughly 40% of the gas it burns and over 70% of the oil it needs.

Figure 6 | China's total energy supply mix



Source: IEA. Data for 1990 and 2018. In metric tons of oil equivalent.

Engineering such a shift towards carbon neutrality will therefore require radical changes in China's energy mix and a rapid ramping up of decarbonized energy sources, including renewables, such as solar, wind and hydropower, as well as nuclear power. According to the BCG, the share of fossil fuels in China's energy mix – including coal, oil and gas – would have to fall below 25 to 30% by 2050 for the country to be able to achieve carbon neutrality by 2060.[4]

In addition, a healthy dose of skepticism wouldn't be misplaced, given the discrepancies between recent policy projections and the changes actually needed. For instance, in its 'China Renewable Energy Outlook 2019', the National Renewable Energy Center[5] – a thinktank under China's National Development and Reform Commission[6] (NDRC) – saw non-fossil fuel energy accounting for only 65% of the energy mix in 2050, not quite the 70% to 75% minimum estimated by the BCG. Yet this annual report has a history of presenting a bullish case for renewables.[7]

[3] IEA figures for 2018.
[4] Chen, B., Fæste, L., Jacobsen, R., Kong, M. T., Lu, D. and Palme, T., December 2020, 'How China can achieve carbon neutrality by 2060', BCG article.
[5] Energy Research Institute of Academy of Macroeconomic Research, 2019, 'China Renewable Energy Outlook 2019', report.
[6] NDRC is a macroeconomic management agency under the State Council, which has broad administrative and planning control over the economy of Mainland China.
[7] Myllyvirta, L., 14 October 2020, 'Influential academics reveal how China can achieve its 'carbon neutrality' goal', Carbon Brief article.

Carbon compensation schemes

Even with the most radical emissions reduction measures, full decarbonization is unlikely to be achieved without compensation initiatives. From this perspective, carbon capture, utilization and storage (CCUS) techniques will likely become an indispensable part of the government's toolbox. CCUS involves capturing and storing CO_2 emissions from activities such as coal-fired power generation or fertilizer production and then using them in industrial applications.

Typically, CO_2 is used for enhanced oil recovery or the production of methanol, urea and other chemical products. Despite there being few CCUS initiatives across the globe at present, mainly due to a lack of technological maturity, important progress is being made and the number of applications being tested is increasing rapidly. Most large-scale projects currently underway are located in the US and Europe, although China has taken important steps in this regard as well.

Forestation and reforestation are also likely to play a crucial role in offsetting carbon emissions. Besides helping soil and water conservation, as well as climate regulation, forests represent critical carbon storage 'facilities'. For decades, Chinese authorities have been promoting reforestation campaigns across the country, such as the much-exalted 'Green Wall of China',[8] with some blatant failures but also undeniable successes.

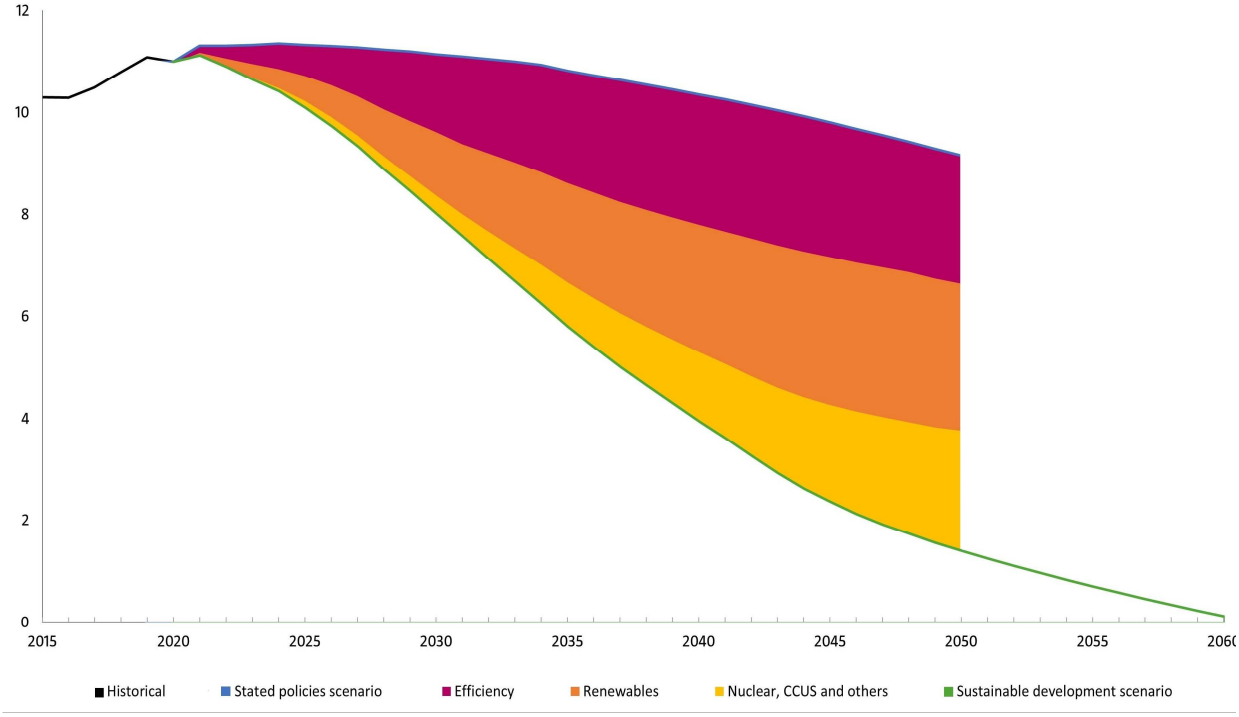
Overall, there has been a sharp increase in forest areas over the past three decades, from 1.57 million km^2 in 1990 to 2.10 million km^2 in 2018.[9] Yet these figures should not be taken at face value. For one, some experts argue that China has actually been exporting deforestation in the meantime, as it has rapidly grown to become one of the world's leading timber importers. So, while the country's reforestation successes may be good news for the planet, they need to be viewed from a broader perspective.

Charting the path to neutrality

China's 'carbon neutrality by 2060' target is broadly consistent with the IEA's Sustainable Development Scenario (SDS).[10] This scenario assumes a global transition to a low-carbon economy consistent with the Paris Agreement, as well as international objectives to achieve universal access to modern energy services by 2030, reduce the severe health impacts of air pollution and tackle climate change by 2030.

[8] The 'Three-North Shelter Forest' Program, also known as the 'Green Great Wall' or 'Great Green Wall of China', refers to a series of human-planted windbreaking forest strips, or shelterbelts, in northern China. These forest strips were designed to hold back the expansion of the Gobi Desert, and to provide timber to the local population. The program started in 1978 and is planned to be completed around 2050, at which point it will be 4,500 kilometers long.
[9] Source: The World Bank.
[10] See: IEA, 2020, 'World energy model documentation – 2020 version', report.

Figure 7 | IEA's suggested path towards carbon neutrality for China



Source: IEA. CO_2 emissions from fuel combustion, in billion metric tons.

The SDS provides insights that can help chart a likely course of action for the next four decades. According to this tool, net zero carbon emissions would require a balanced mix of initiatives, including strong efficiency gains, and a rapid ramping up of renewables and nuclear energy. Moreover, significant additional efforts in terms of carbon compensation – through CCUS and forestation and reforestation initiatives – would also be necessary (see Figure 7).

First signpost: China's new five-year plan

As China embarks on its journey towards net zero, the first steps it takes will be closely monitored. At a one-day UN summit on climate change in December 2020, Xi Jinping provided further details. In particular, he indicated that the country would boost its installed capacity of wind and solar power to more than 1,200 gigawatts by 2030, and increase the share of non-fossil fuels in primary energy consumption to around 25% during the same period, up from a previous pledge of 20%.

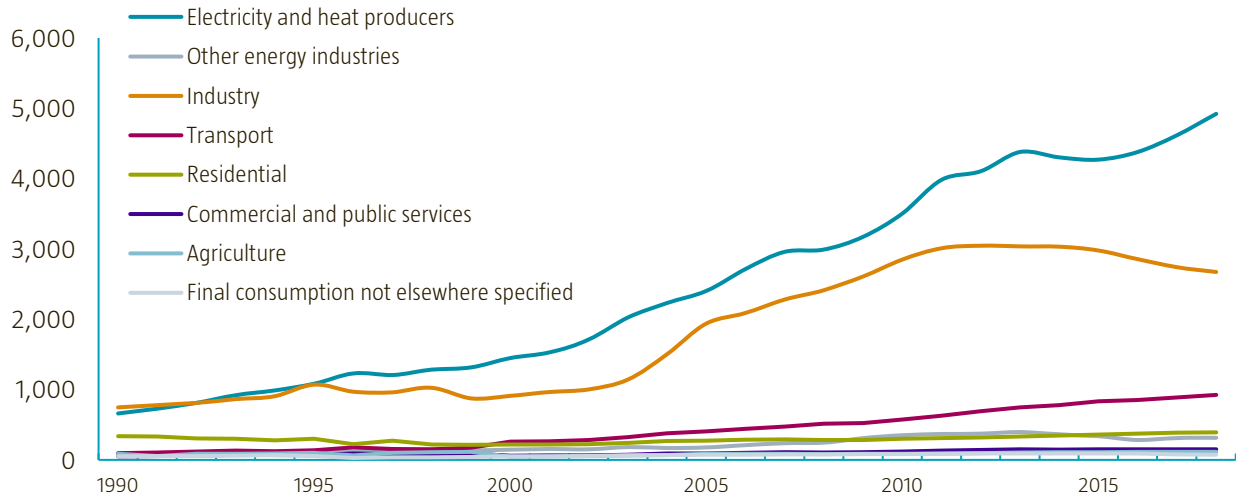
But the real game changer will be China's 14th Five-Year Plan, the detailed draft of which was submitted to the National People's Congress (NPC) for final approval during the 'Two sessions' in March 2021. Setting the course for China's economy in the 2020s, the plan specifically aims for a 20% share of non-fossil fuel energy in the country's energy mix by 2025 – five years earlier than previously projected. China also aims to reduce energy consumption and carbon emissions per unit of GDP by 13.5% and 18%, respectively.

Macro implications by sector

Around 90% of China's CO_2 emissions come from electricity and heat production, industry, and transport, with electricity and heat production representing half of all emissions.

Logically, these areas will be affected most by the transition, with electricity and heat production at the forefront. Yet there are also important differences across these sectors. For instance, while industry emissions peaked almost a decade ago, emissions from electricity and heat production, as well as from transport sectors, have yet to.

Figure 8 | China's historical carbon emissions



Source: IEA. CO_2 emissions from fuel combustion, in million metric tons.

Meanwhile, other less carbon-intensive segments of the economy, such as the residential sector and agriculture, have also seen their carbon footprint rise in recent years. And while these won't play a central role in the country's shift towards carbon neutrality, they too will have to make significant progress with regard to, for example, the energy efficiency of their activities.

Electricity and heat production

Electricity and heat production are by far the biggest culprits when it comes to carbon emissions in China. The main reason for this is the country's strong and long-standing reliance on domestic coal for power generation. Despite the significant push towards renewables over the past decade, coal remains the country's workhorse, which explains why carbon emissions from China's electricity and heat production are still rising.

Yet there are signs that the tide is slowly turning. While coal's share in the country's energy supply has been fluctuating between 60% and 70% since the early 1990s, it has also been falling every year since peaking around 2010. Investments in coal-fired power generation have also been slowing sharply. According to the IEA, global spending on coal-fired power plants fell by 6% in 2019, to the lowest level in a decade, with the greatest drop in China.

Moreover, by triggering a marked decline in coal demand last year, the Covid-19 outbreak may also have helped put the transition on track. The IEA estimates that Chinese coal demand declined around 5% in 2020, despite the country's

relatively swift economic recovery. Coal-fired power generation was hit hard by the initial economic shock, as China's power grid became saturated with other low-marginal cost energy sources such as hydro, wind, solar and nuclear.

In this context, while coal's dominance is far from over (see Box 2), its outlook seems increasingly uncertain and highly dependent on the short-term fluctuations in domestic electricity demand. Coal is slowly being displaced by lower-carbon energy sources such as hydro, wind, solar and nuclear, which have all been less affected by the Covid-19 crisis. All these factors add to an already gloomy picture for coal stakeholders over the next decade.

Box 2: A tougher stance needed to rein in coal investments

Despite the economic havoc caused by the Covid-19 pandemic, China commissioned 55.3 GW of new coal power plants in 2020, according to official estimates.[11] This is in sharp contrast with a declining fleet elsewhere in the world, once closures are taken into account. The rise in coal developments came as Chinese local governments sought to stimulate their economies, while Beijing loosened restrictions on new plant permits.

However, Xi Jinping's carbon neutrality pledge suggests that new coal plants, if built at all, will face fierce competition and a shortened lifetime. Growing anecdotal evidence indicates that the average operating hours for China's coal fleet is on the decline, driving down profits. In fact, several Chinese power companies have already been pushed into bankruptcy over the past few years.

Industry

Carbon emissions from the industrial sector have declined by around 12% since 2012, mainly due to the increased recycling of materials, improved energy efficiency, and a broad-based shift from coal to gas. Producers of steel, nonferrous metals, chemicals and cement are the biggest CO_2 culprits, with these energy-intensive activities accounting for roughly 90% of the total energy consumed by industry in the country.

The Chinese government has set strict targets to increase recycling. For example, that recycled aluminum must make up 27% of aluminum supply by 2025 and 30% by 2030, up from about 20% currently.[12] At the same time, the total coal consumed by the industrial sector has fallen over 21% since 2012. This drop has been accompanied by a marked rise in the total consumption of other energy sources, in particular natural gas and electricity.

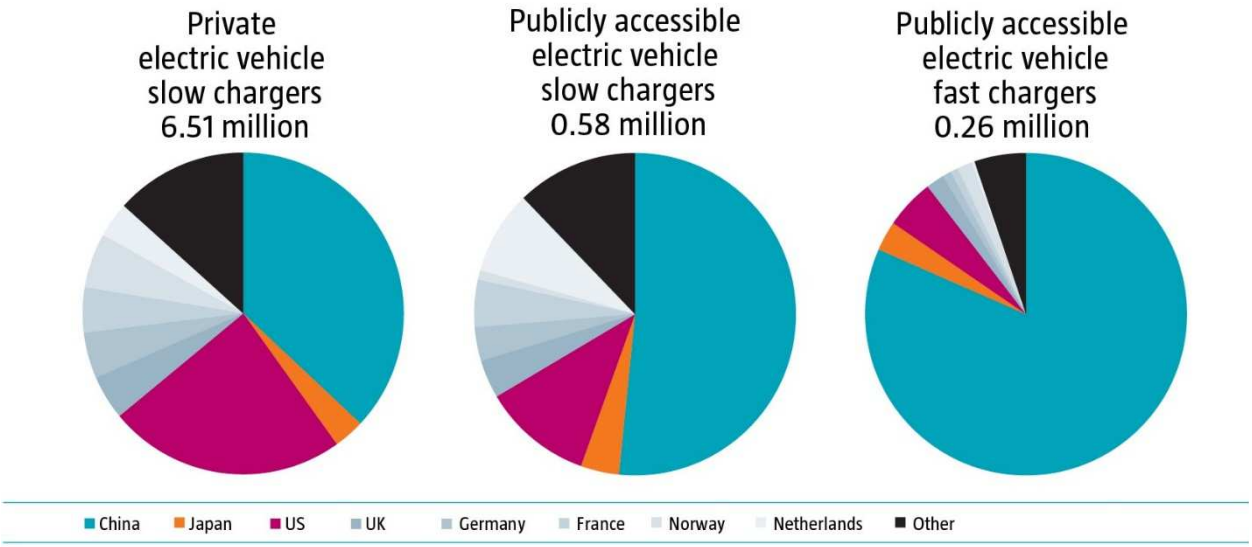
These trends are expected to continue, and eventually accelerate, over the coming years, thus further reducing the sector's carbon emissions. Ongoing innovation – including in CCUS technologies, the use of low-carbon electricity and to make raw material use more efficient – will be crucial in decarbonizing some of the most carbon-intensive activities, such as steel and cement production.

Transport

Apart from the short-lived blip seen in 2009, carbon emissions from the oil-dominated transport sector have been rising steadily over the past three decades, showing no signs of deceleration – up until the Covid-19 outbreak, at least. Domestic transport demand has risen so sharply that even the colossal investments made in the country's rail network have so far served only to slow the growth of the aviation industry.

[11] Source: China National Energy Administration.
[12] BloombergNEF, September 2020, 'China's Long Road to Carbon Neutrality will Reshape World Economy', research rote.

Figure 9 | China leads in the number of charging points



Source: IEA, 'Global EV Outlook', 2020.

In the meantime, the carbon intensity of energy supplied for road transport has remained roughly stable over the past decades. Moving towards a more sustainable transport sector will therefore require even more drastic changes. These include a greater use of public transport infrastructures, an accelerated increase in the use of electric vehicles and a further improvement in the efficiency of conventional oil-powered vehicles.

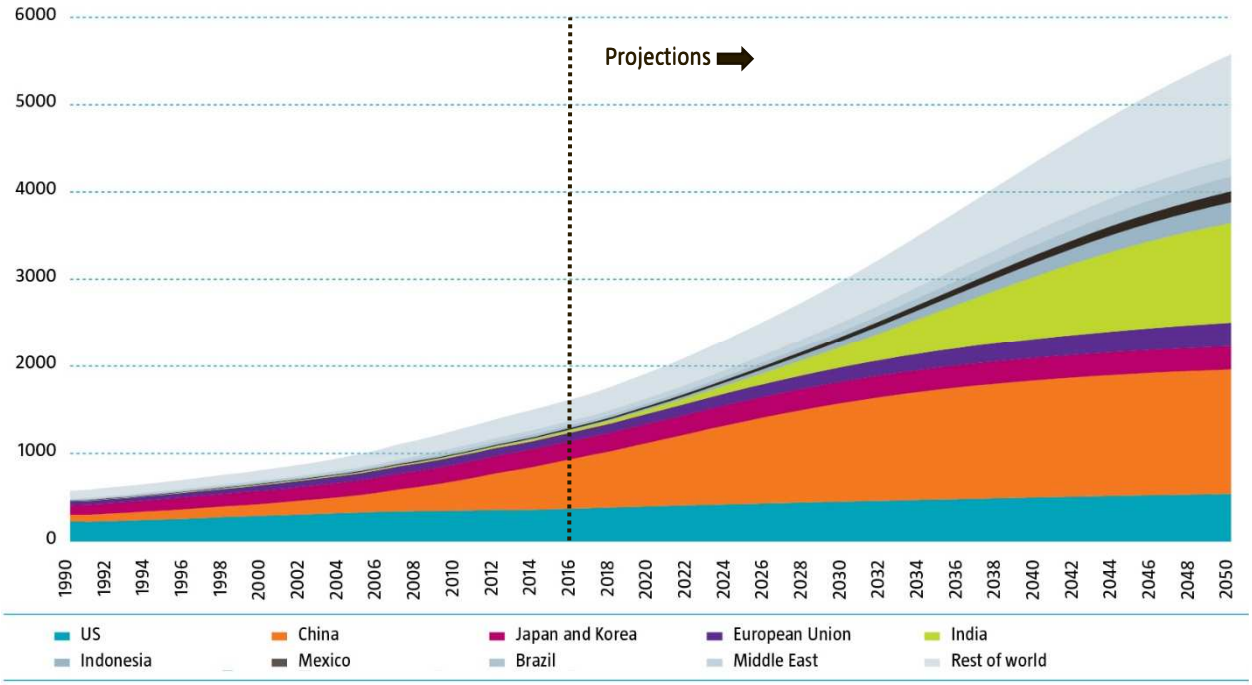
China is already the world's largest market for electric cars, far ahead of Europe and the US. The country also accounts for 95% of the electric bus market, with many cities boasting fully or near-fully electrified bus fleets. But much more is needed. Therefore, the economic recovery program announced by the Chinese government, which allocates substantial funding to expand the infrastructure for charging electric car batteries, is a welcome development.

Residential

Having declined during most of the 1990s, carbon emissions from the residential sector have been rising again over the past two decades, albeit at a slower pace than carbon emissions overall. The sector currently represents roughly 6% of China's total carbon emissions. Increased ownership of home appliances such as, refrigerators, freezers and washing machines, which has more than doubled since 2000, is a key reason behind this increase.

Another important factor has been the rapid take-up of heating, ventilation and air-conditioning (HVAC) systems. China already boasts a significantly higher number of air-conditioning units than the US. Around 60% of Chinese households had air conditioning in 2018 versus 16% in Mexico and Brazil, and only 5% in India. Moreover, the IEA estimates that the number of air-conditioning units installed will double to 1.42 billion over the next 30 years.

Figure 10 | China already dominates the global air-conditioning systems stock



Source: IEA, 'The future of cooling', 2019. In million units.

Putting the residential sector on track for carbon neutrality will require stricter standards and regulations regarding energy efficiency for buildings, appliances and equipment. Scaling up financing for efficiency investments will also be critical. But at least China is not starting from scratch. Important regulations have been implemented in recent years and investments have been rising sharply. Investments to improve the energy efficiency of existing residential buildings efficiency rose to USD 27 billion in 2018, up 33% from 2015.

Agriculture and forestry

Agriculture accounts for a fraction of China's total carbon emissions, and agriculture-related emissions have remained broadly unchanged over the past 30 years. Yet the sector could play a crucial role on the road to decarbonization. Forestation and reforestation initiatives to offset carbon emissions are a case in point. But there are many other areas for potential progress, such as biogas tank construction, changes in fertilizer production and use, and waste disposal management.

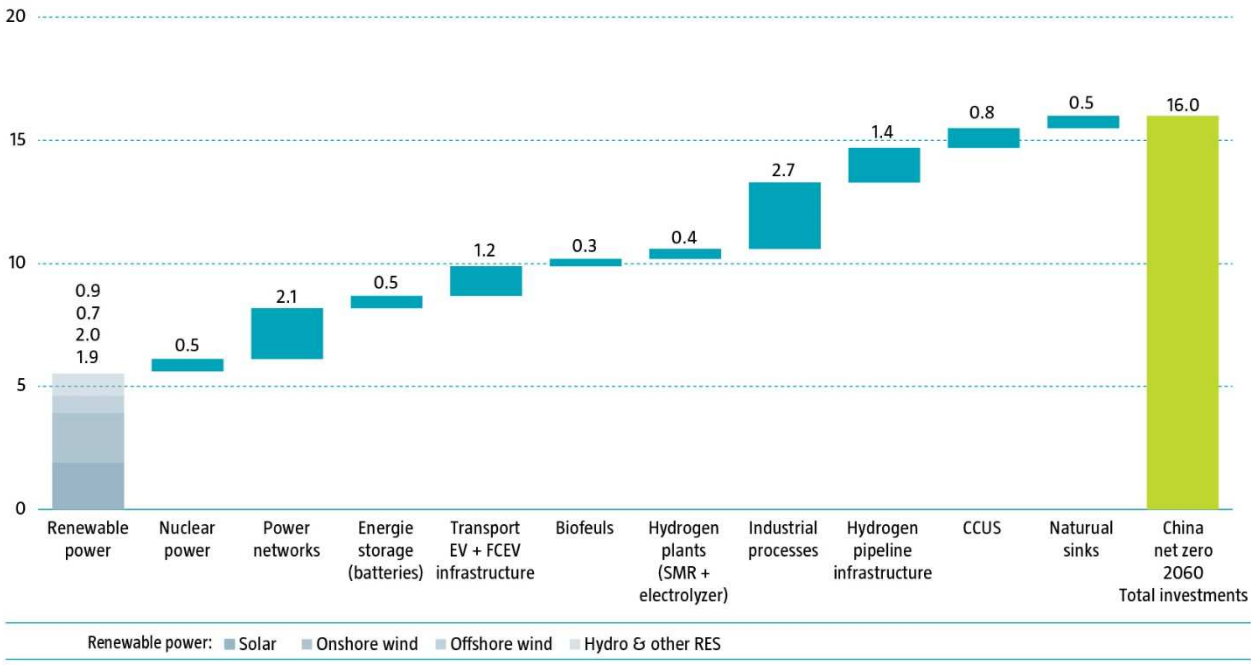
Key implications for investors

Given the changes needed in most sectors to achieve carbon neutrality, the key issue for investors is to identify any major risks they might be exposed to, and to find the most attractive opportunities.

Arguably, the most exposed companies are fossil fuel producers and in particular oil majors. Their core business is fundamentally at odds with decarbonization. But many other industries also stand to suffer from a badly handled transition, including petrochemicals, steel and cement.

Conversely, companies able to support the transition – for example, by enabling the electrification of the transport sector, the more widespread use of biodegradable plastics or improvements in the energy efficiency of industrial processes and buildings – are poised to benefit from the decarbonization trend. In some cases, the likely impact of decarbonization is already well known, but in others, the consequences remain difficult to fully grasp.

Figure 11 | China's path to net zero untangled



Source: Robeco, Goldman Sachs Global Investment Research, January 2020. Estimated investments in trillion USD.

Meanwhile, the investments needed to achieve carbon neutrality will focus primarily on the energy sector. Renewables, in particular, are expected to retain the lion's share (see Figure 11). But electric vehicles are also expected to be among the big winners of the transition. Finally, upgrades in power networks and energy storage technologies, as well as the hydrogen industry – especially 'green' H_2 – are expected to capture a significant portion of total investments too.

Renewables: an essential workhorse for the transition

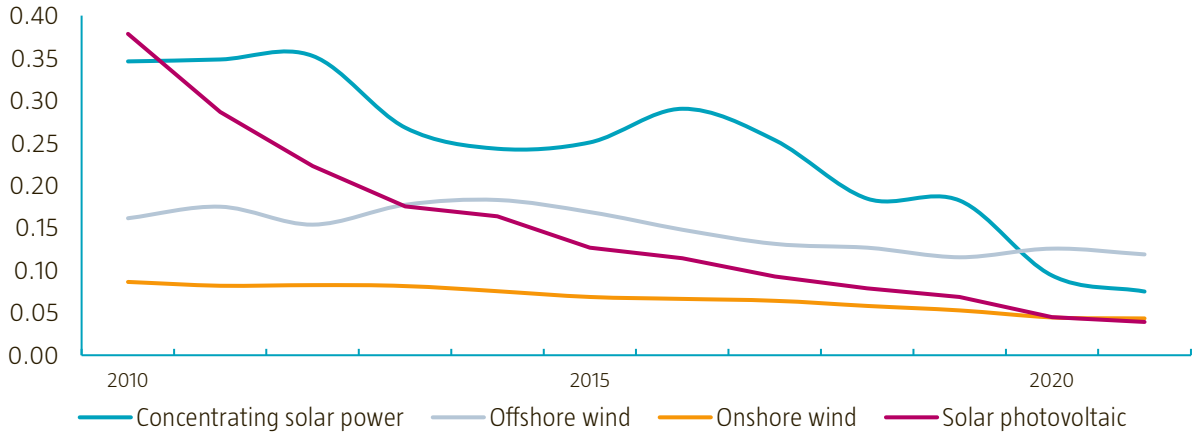
Given China's current heavy reliance on coal for electricity production, making CO_2 emissions peak before 2030 will require a rapid change of course and a huge boost for renewables. Although concerns about the country's recent growth in coal-fired generating capacity are warranted, and moving away from coal will likely be a socially and

financially painful process, there are also reasons to be hopeful. These include China's ongoing power sector reforms and the rising cost competitiveness of renewables.

Since 2015, China has implemented a series of measures and tools, such as power purchase agreements, spot power markets, and a recently introduced a carbon emissions trading scheme to improve efficiency and flexibility in the country's power system. This trend is expected to continue over the coming years, as current pilot initiatives are expanded and new reforms are implemented to facilitate the integration of renewables and avoid local overcapacity issues with thermal power.

Meanwhile, the cost of wind and solar technologies has now become extremely competitive relative to coal-fired power generation, even without subsidies (see Figure 11). In fact, after a decade of heavy subsidies in the renewables sector, China's central government is now shifting to more market-driven mechanisms to support clean power sources. This indicates that the industry in approaching the point at which it can stand on its own two feet.

Figure 12 | Cost of wind and solar projects is falling



Source: IRENA. Global weighted-average LCOE and Auction/PPA price learning curve trends for solar photovoltaic, offshore and onshore wind. USD/KWh.

Besides improving the competitiveness of renewables and the expected push on power sector reforms, Chinese authorities are also likely to toughen their stance on the expansion of coal plants. One way to do this would be to raise the operating costs of coal power plants via the new emissions trading scheme. Some experts already anticipate that not all approved coal-related projects will actually materialize.[13]

Importantly, announcements made by Xi Jinping himself in December 2020 suggest there will be an ambitious ramping up of clean power generation over the coming decade, with the share of non-fossil fuels (renewables and nuclear energy) in primary energy now expected to reach 25% by 2030, compared to an earlier target of 20%. Given the gradual exhaustion of additional hydropower potential and slowing nuclear power additions, these targets imply a rapid step-up of wind and solar capabilities.[14]

New energy vehicles: perpetual motion

Global road transport is today on the cusp of a revolution, with electrification at the core of the decarbonization challenge. China has already taken the driver's seat on this journey. The country's dominance in new energy vehicles[15]

[13] MacroPolo, October 2020, "Forecast 2025: China Adjusts Course", The Paulson Institute, report.
[14] Myllyvirta, L., 15 December 2020, "Analysis: China's new 2030 targets promise more low-carbon power than meets the eye", Carbon Brief article.
[15] NEVs are vehicles which are not fueled by an common energy sources, such as unleaded petrol or diesel fuel, for example. These include in particular, plug-in electric vehicles, either plug-in hybrid electric ones or an all-electric plug-in battery electric ones.

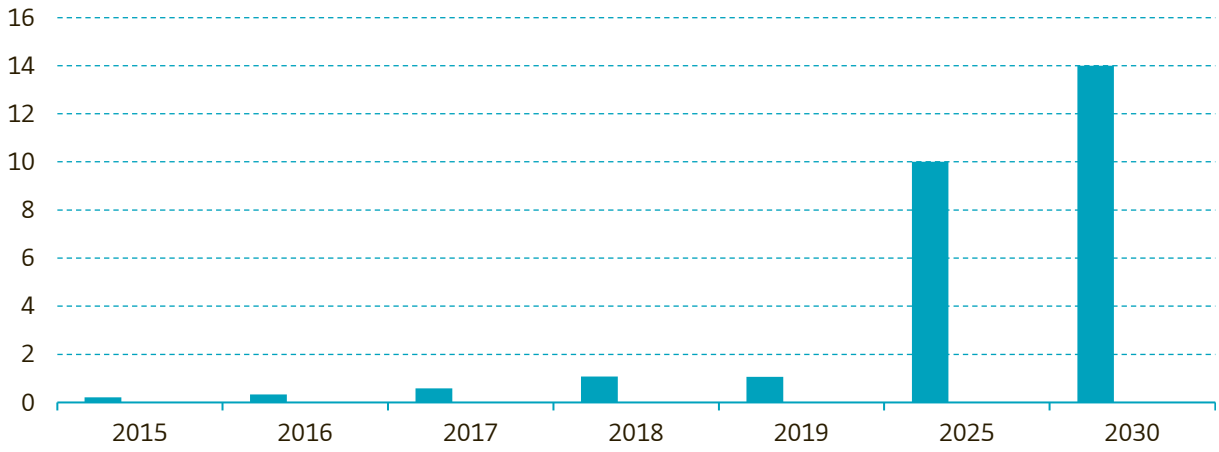
(NEVs) is striking. Despite the Covid-19 shock, sales in NEVs rose 10.9% last year to 1.37 million units,[16] thus accounting for more than half of global sales. China also boasts the world's largest number of public charging points by far (see Figure 12).

Beijing made clear that it wants to continue leading the way in NEVs with the recently approved plan for the NEV industry from 2021 to 2035. According to the plan, NEV sales are expected to account for 20% of overall new car sales by 2025, up from 5.4% last year.[17] This 20% NEV sales target for 2025 is lower than the previously stated target of 25%, as it takes into account the rough patch experienced in 2019 and 2020.

China wants purely electric automobiles to account for the majority of new cars by 2035, but it is also banking on hydrogen-powered vehicles (see the following section on energy storage technologies). The Chinese Government has released plans to promote the development of hydrogen technologies, in particular to reduce the costs of production, storage and transportation.

Under the IEA's SDS, electric vehicle sales would be expected to grow almost tenfold by 2025, to approximately 10 million units, and then reach 14 million units by 2030. This would mean a 60% penetration rate across all transport modes by 2030. While such figures may sound very optimistic, particularly after the slump seen in 2019 and 2020, more cautious estimates still set the 2025 sales target at around seven million units.[18]

Figure 13 | Projected EV sales under IEA's sustainable development' scenario



Source: IEA, Robeco. In million units.

China's dominance in NEVs expands well beyond the mainstream passenger car segment. The global deployment of electric buses and two-wheelers, for example, is also expected to be largely driven by Chinese demand. Many of the world's leading electric bus manufacturers, such as BYD and Yutong, are based in China. Meanwhile, electric two-wheelers already account for roughly 50% of the country's total two-wheelers fleet, and this proportion is likely to rise above 90% by 2030.

From a technical perspective, pure battery and hybrid vehicles will be the key decarbonization technology for short and medium-haul vehicles – mainly passenger vehicles and small trucks. Pure battery vehicles will be essential in achieving decarbonization, but hybrid should remain the largest segment over the next decade. Meanwhile, for heavy duty, long-haul trucks, clean hydrogen is likely to become the preferred option, given its faster refueling time and lower weight.

Energy storage technologies: unreserved potential

[16] China Association of Automobile Manufacturers, 6 January 2021, 'China's auto market sees strong recovery in 2020', press release.
[17] Yu, C., 4 November 2020, "High-quality growth of new energy vehicle sector prioritized", China Daily article.
[18] Citi, February 2021, "Electric vehicle transition - EVs Shifting from Regulatory- to Supply Chain-Driven Disruption", Citi GPS report.

While renewables will play the most critical role in the transition toward carbon neutrality, additional storage technologies will be also needed to address intraday and seasonal variability issues inherent to wind and solar energy, and to decarbonize all parts of the economy. From this perspective, two complementary technologies – batteries and hydrogen – are likely to play a key role given their ability to convert electricity into chemical energy and vice versa.

In recent years, the widespread use of lithium-ion batteries in consumer electronics combined with a sharp decline in production prices have led to a massive expansion of this technology. The deployment of electric vehicles is now further accelerating this expansion. Lithium-ion batteries are also increasingly seen as indispensable in the integration of wind and solar power into broader electricity systems.

China is already the world leader in terms of battery manufacturing, accounting for around 70% of global capacity, followed by the US (13%), South Korea (7%), Europe (4%) and Japan (3%).[19] Despite the dramatic Covid-19 air pocket experienced in 2020, production recovered rather quickly, on the back of a strong economic rebound. Given the strong push expected in both renewables and NEVs, demand for storage batteries seems poised to grow significantly over the coming decades.

Meanwhile, hydrogen also constitutes a promising technology in reducing the CO_2 emissions of the fossil fuel-dependent sectors of the economy, such as steelmaking, heavy-duty vehicles, international shipping and the production of cement.

Hydrogen can be produced using high-temperature steam to convert methane into hydrogen and CO_2 ('gray' H_2), or using the same process but capturing and storing or reusing the related carbon emissions ('blue' H_2). It can also be obtained through electrolysis, either by burning fossil fuels (also 'gray' H_2) or through the use of renewable electricity to feed the process ('green' H_2).

Therefore, hydrogen can ultimately be produced and consumed without releasing any greenhouse gases, and as such can be used as a clean energy source for activities that are difficult to electrify. Such characteristics explain why China has such high hopes and ambitions for hydrogen, with many ongoing research and development programs and pilot projects. For one, the country has already become the largest fuel-cell bus and truck market in the world.

These developments are set to accelerate over the coming decades. For instance, China expects to have one million hydrogen fuel-cell vehicles on the road by 2030, with at least 1,000 hydrogen refueling stations. More generally, the China Hydrogen Alliance, a trade group representing the hydrogen sector at large, estimates hydrogen could account for up to 10% of China's total energy mix in 2050 compared with less than 1% today.[20]

[19] Gül, T., Fernandez Pales, A. and Paoli L., May 2020, "Batteries and hydrogen technology: keys for a clean energy future", IEA.
[20] China Hydrogen Alliance, 2018, 'White Paper on China Hydrogen and Fuel Cell Industry', white paper.

Conclusion

China's unexpected pledge last September to become carbon neutral by 2060 will have radical repercussions on the country's economic course for the coming decades.

While 2060 may seem like a long shot, the repercussions for investors are already gradually starting to materialize. Many companies stand to suffer from a badly handled transition, not just fossil fuels-reliant energy producers but also energy-intensive businesses, like petrochemicals, steel and cement. At the same time, investment opportunities are also taking shape, with renewables, NEVs and energy storage solutions as the likely big winners of the transition.

China's push towards a greener economy is already one the key investment themes our Fundamental Chinese equities strategies focus on. And it seems poised to remain so for many years, given the sweep changes needed to complete a full transformation.

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