PRI Principles for Responsible Investment

DELIVERING CARBON NEUTRALITY IN CHINA

UN environment programme | finance initiative

United Nations Global Compact

An investor initiative in partnership with UNEP Finance Initiative and Global Compact

INTRODUCTION

President Xi Jinping announced at the UN General Assembly in September 2020 that China will target carbon neutrality by 2060. This represents a hugely significant statement of long-term ambition and priorities. The Government of China has begun to take steps which would establish low carbon development and a transition to carbon neutrality as central features of China's long term strategy for sustainable development and prosperity – and to cement a role for China as a global leader, economically and politically, in the worldwide transition to net zero emissions.

Building on the 2060 carbon neutrality announcement, in October 2020 five key Chinese government bodies (Ministry of Ecology and Environment, National Development and Reform Commission, People's Bank of China, China Banking and Insurance Regulatory Commission, and China Securities Regulatory Commission) published new guidance to promote Climate Investment and Finance. This sets out aims including development of new standards and regulations, encouraging private and international capital for climate finance, and strengthening international collaboration on climate finance. Such steps will help to provide an enabling environment for investors to manage climate-related financial risks and contribute to China's low-carbon transition.

PRI has developed this roadmap of climate policies for China, based on research by Vivid Economics as part of PRI's Inevitable Policy Response (IPR) project, and drawing on other leading sources of research. The policy recommendations address the overall climate ambition and key sectors for decarbonisation: power, road transport, buildings, and industry. This report also describes priority climate-related financial policies for China. Together, these recommendations represent essential near-term actions to help set China on a pathway to carbon neutrality by 2060 in a way that is economically and technologically achievable, and ultimately beneficial in helping to deliver sustainable development.

Investors globally recognise the urgency and importance of major economies establishing targets and plans to deliver net zero emissions in line with the goals of the Paris Agreement. As analysis from PRI's Inevitable Policy Response Project shows, delayed, disruptive and disorderly policy response to climate change risks undermining the value of financial assets as well as increasing the difficulty of reducing emissions at the required rate. On the other hand, timely and ambitious action creates certainty for markets to seize the opportunities for growth and job creation that are provided by the sustainable and low-carbon industries of the future. For these reasons, investors are increasingly both supportive of policy action to reach net zero and ready to contribute capital and collaborate with policymakers to design and implement policies that facilitate low-carbon investment flows at scale.

FIVE PRIORITY POLICY AREAS

Overall climate ambition

- Carry out and publish an assessment and impact analysis of climate change on Chinese economy and society and the pathways to meeting the target of carbon neutrality by 2060, including interim targets, and develop a comprehensive roadmap of polices to deliver on those goals.
- Enhance the effectiveness and coverage of the Emissions Trading Scheme by: setting the GHG emissions caps at a level consistent with achieving the carbon neutrality goal; introducing a mechanism to correct for any surplus allowances; announcing a timeframe for the power sector and for additional sectors (e.g. petrochemicals, chemicals, building materials, steel, nonferrous metals, paper, and domestic aviation).

Zero-carbon power

- Develop and implement a plan for zero or near-zero carbon electricity that is aligned to the 2060 goal for carbon neutrality, including interim targets for 2025 and 2030.
- Announce an end to approvals of all new unabated coal power plants, and a mid-term target to phase out all unabated coal power.
- Develop and implement an enabling regime to unlock investment in energy storage, demand response and high voltage transmission between regional electricity markets.
- Build on recent progress with electricity market reforms and implement economic dispatch across regional power markets.

Industry

- Set strengthened mandatory energy efficiency targets for industrial plants in the fourteenth Five-Year Plan, widening coverage beyond the 30,000 businesses covered in thirteenth Five-Year Plan.
- Develop and implement strategies for low-carbon steel, chemicals, and cement. Strategies should set an objective of decarbonising energy intensive industry, and provide a roadmap to shift to electric, hydrogen, and CCS production technologies to meet this objective on a timeline aligned with Paris Agreement goals.

Buildings

- New buildings - publish a comprehensive thermal efficiency plan for new buildings, including: setting new thermal efficiency standards for the period to 2025; a commitment to strengthening standards every five years; extension of new building thermal efficiency standards to rural buildings.
- Existing buildings - set a target for retrofit of all residential, commercial and public buildings by 2050; and develop policy mechanisms (investment subsidies, owner obligations) to achieve the target and interim targets to track progress.

Road transport

- Announce an end to the sales of fossil fuel cars and vans by 2040, and set out a long-term policy regime to deliver 100% zero emission vehicles by this date.
- Develop and implement a comprehensive heavy road transport decarbonisation strategy, including: setting clear targets for emissions reductions and providing a programme of RD&D and demonstration projects for low-carbon trucks.

OVERALL CLIMATE AMBITION

CURRENT SITUATION

China is the world's largest emitter of CO_2 emissions. In 2018, China's CO_2 emissions totalled 9.5 Gt CO_2 - 29% of the global total. As China has industrialised, CO_2 emissions have risen sharply, growing from 3.1 $GtCO_2$ in 2000 to 8.8 Gt by 2012. Since 2012, China's CO_2 emissions growth has been lower due to an economy-wide shift away from heavy manufacturing and energy-intensive industry, slower economic growth, a coal-to-gas shift, and renewable energy uptake.[1]

China's per capita CO_2 emissions are below many industrialised countries. In 2018, China's per capita emissions from fossil fuels were 7 tons per person, which was lower than the US and Japan's per capita CO_2 emissions of 16 and 9 tons per person, respectively.[2] Between 2005 and 2019 China reduced CO_2 emissions per unit of GDP by 48.1%.[3] CO_2 contributes around 80% of GHG emissions in China (other GHGs include methane, nitrous oxide and fluorinated gases).[4]

In its first NDC under the Paris Agreement, China pledged to peak CO_2 emissions by 2030, alongside three other targets: (i) lowering carbon emissions per unit of GDP by 60-65% below 2005 levels by 2030; (ii) increasing the share of non-fossil fuels in primary energy consumption to around 20% by 2030; and (iii) increasing the forest stock volume by around 4.5 billion by 2030 relative to 2005 levels.[5]

In order to achieve the new goal of carbon neutrality by 2060, China will need to increase the scope and ambition of climate policies and emissions reduction targets across key sectors of the economy. There are clear signals that the 14th Five-Year Plan will provide a framework for such changes, and some new policies have already been announced, including a range of proposals to promote climate investment and finance.

The Government has not yet announced detailed plans or policy frameworks to indicate how and at what speed China will make progress towards carbon neutrality. New analysis has been published by Tsinghua University, which provides high level insights into a range of potential decarbonisation pathways including some which would deliver carbon neutrality by 2060.[6]

The IEA estimates that China's energy-related CO_2 emissions under current policy will be over three times those of an emissions pathway consistent with the Paris Agreement.[7] In order to achieve emissions reductions in line with the Paris Agreement, China's emissions will need to peak before 2030 and then to decrease rapidly at a rate of 8-10% up to 2050 according to Tsinghua University. This would see CO_2 emissions reaching net-zero by 2050 while overall GHG emissions would reach net zero by 2060.

China launched its national emissions trading scheme (ETS) in 2017 building on the successful implementation and operation of seven regional ETS markets.[8] Companies are yet to begin the full

[1] Sandalow, D. (2019). *Guide to Chinese climate policy 2019*.
[2] Sandalow, D. (2019). *Guide to Chinese climate policy 2019*.
[3] http://climatecooperation.cn/climate/mee-plans-to-include-more-sectors-in-the-national-ets-during-14th-fyp/
[4] UNFCCC (2018). *The People's Republic of China Second Biennial Update Report on Climate Change*.
[5] Sandalow, D. (2019). *Guide to Chinese climate policy 2019*.
[6] Tsinghua University Institute for Climate Change and Sustainable Development (ICCSD) (2020), *China Low-Carbon Development Strategy and Transformation Pathways*.
[7] IEA (2019). *World Energy Outlook 2019*.
[8] ICAP (2020). *China - Beijing pilot ETS.*

trading of allowances as of November 2020, but recent statements by senior Chinese Government officials confirm that preparations are well advanced, with trading expected to start soon.[9]

Initially, China's national ETS will cover the power sector but work is already under way in preparation for expanding to additional sectors including chemicals, steel, concrete, nonferrous metals, paper, and domestic aviation.[10] China is yet to announce the CO2 emission reduction targets for the ETS. It is important to set CO2 emissions targets for the ETS to align carbon pricing policy with China's overall climate governance and targets.[11]

KEY POLICY RECOMMENDATIONS

- **Carry out and publish an assessment and impact analysis of climate change on Chinese economy and society and the pathway to meeting the target of carbon neutrality by 2060, including interim targets, and develop a comprehensive set of polices to deliver on those goals. The analysis should consider:**
  - a national assessment of climate change on the Chinese economy, key infrastructure, food security and society
  - the overall carbon budget
  - the delivery actions that will be needed to decarbonise each sector
  - the timespan over which each sector can decarbonise
  - the overall costs of climate action
  - the distribution of costs spatially and by income groups
  - the co-benefits of actions to achieve net zero
  - the challenges to achieving net zero
  - the immediate priorities to achieve net zero.

- **Enhance the effectiveness and coverage of the Emissions Trading Scheme by:**
  - setting the GHG emissions caps at levels consistent with a pathway towards the net zero, and at least ten years ahead to ensure the ETS provides a forward-looking price signal
  - introducing a mechanism to correct for surplus allowances
  - announcing the timeframe for coverage of the power sector plus seven additional sectors - petrochemicals, chemicals, building materials, steel, nonferrous metals, paper, and domestic aviation.

ZERO CARBON POWER

CURRENT SITUATION

Electricity generation contributes around 51% of China's energy-related CO_2 emissions. These CO_2 emissions totalled 4.9 $GtCO_2$ in 2018, a 40% increase on 2010 levels.[12]

[9] http://climatecooperation.cn/climate/mee-plans-to-include-more-sectors-in-the-national-ets-during-14th-fyp/
[10] ICAP (2020). *China National ETS*.
[11] IEA (2020). *China's Emissions Trading Designing efficient allowance allocation Scheme*.
[12] IEA (2019). *World Energy Outlook 2019*.

Despite China's clear progress on deploying renewables the country remains heavily reliant on coal power, at 66% of total supply in 2018, and continues to construct new coal plants.[13] China has an existing capacity cap on coal power of 1,100 GW for 2020 compared to deployed capacity of 1,040GW in 2019.[14] Electricity generation from natural gas has grown strongly in recent years but it contributed only 4% of total generation in 2018.[15]

Renewables contributed 26% of China's electricity generation in 2018 compared to 19% in 2010. Hydropower remains the largest source of renewable power in China, accounting for 17% of generation in 2018. The overall share of solar PV and wind for electricity generation has grown rapidly over the last decade, from 1% in 2010 to 8% in 2018 (5% wind, 3% solar).[16]

Feed-in tariffs have been highly successful at driving renewable deployment in China, with onshore wind and solar PV growing from a combined 50 GW of capacity in 2011 to around 410 GW in 2019.[17] The 13th Five-Year Plan targets renewable capacity of 680 GW by 2020.[18] China exceeded this target in 2018, two years ahead of schedule. Government plans to replace feed-in tariffs with subsidy-free auctions in 2021, allowing wind and solar developers to bid for a fixed 20-year guaranteed purchase of power contract.[19] Government has already awarded 64 GW of subsidy-free renewable capacity between 2017 and 2020.[20]

Power market reforms in China have been slow in recent years. China dispatches electricity generation based on a fixed energy volume allocation to producers, rather than an economic dispatch based on merit order).[21] This favours high-cost incumbents at the expense of renewables, which would be competitive on a merit order system given their low operating costs. A transition to a market priced electricity system continues to be a Government priority, with China's draft National Energy Law in 2020 emphasising the ambition to move to competitive energy markets.[22]

China is a global leader in deploying ultra-high voltage transmission lines, and plans an additional $27 billion in ultra-high voltage transmission lines in 2020.[23] Despite China's progress on ultra-high voltage transmission lines and pumped hydro energy storage, progress has been more limited in other areas required to deliver grid modernisation, such as battery storage and demand-side response.

If the electricity grid is inflexible, dispatch centres may need to curtail high percentages of renewable output during periods of energy oversupply. Overall electricity grid flexibility remains low, with this inflexibility a key driver of high renewable curtailment rates of 7% and 3% in 2018 for wind and solar, respectively.[24]

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[13] IEA (2019). *World Energy Outlook 2019*.
[14] Reuters (2020). *China to cap 2020 coal-fired power capacity at 1,100 GW.*
[15] IEA (2019). *World Energy Outlook 2019*.
[16] IEA (2019). *World Energy Outlook 2019*.
[17] IRENA (n.d.). *IRENA statistics*.
[18] NDRC (2016). *The 13th Five-Year Plan for Economic and Social Development of The People's Republic of China (2016–2020)*.
[19] Sandalow, D. (2019). *Guide to Chinese climate policy 2019.*
[20] Bloomberg New Energy Finance (2020). *China clinches subisdy-free shift with 45 GW renewables*.
[21] IEA (2019). *China Power System Transformation. Assessing the benefit of optimised operations and advanced flexibility options*.
[22] Colombia Center on Global Energy Policy (2020). *Trends and Contradictions in China's Renewable Energy Policy*.
[23] Power Technology. (2020). *China Develops $26bn Ultra High Voltage Electrical Grids to Stimulate Economic Recovery.*
[24] IEA (2019). *China Power System Transformation. Assessing the benefit of optimised operations and advanced flexibility options*.

Although China has closed hundreds of inefficient coal-fired power stations in recent years, a lot of new coal capacity totalling around 140 GW was under construction in January 2020.[25] Given coal plant lifetimes of 50 years or more, this new coal capacity may be still operational well into the second half of the 21st century. This would be incompatible with achieving the objectives of the Paris Agreement, which requires unabated coal-fired power plants to phase out by mid-century at the latest.[26]

Current policy is insufficient to effectively deliver emissions reductions in the power sector consistent with the objectives of the Paris Agreement. The IEA estimates that renewable generation under current policy (prior to implementing the 2060 carbon neutrality announcements) will be 36% below that of an emissions pathway consistent with the Paris Agreement by 2040.[27] The most ambitious of the scenarios recently set out by Tsinghua University to align emissions reductions with the Paris Agreement has non-fossil fuel generation producing 90% of China's electricity by 2050. Decarbonising the electricity system will require a reduction in coal generation, an expansion of low-carbon generation capacity, and deployment of technologies to increase the flexibility of the electricity system.

KEY POLICY RECOMMENDATIONS

- **Develop and implement a plan for zero or near-zero carbon** electricity that is aligned to the 2060 goal for carbon neutrality, including interim targets for 2025 and 2030**.**
- **Announce an end to approvals of all new unabated coal power plants.**
- **Set a medium-term target to phase out all unabated coal power generation,** consistent with the carbon neutrality goal, and including interim targets for 2025 and 2030.
- Through direct procurement or market mechanisms, **develop and implement an enabling regime to unlock investment in energy storage, demand response and high voltage transmission between regional electricity markets.** China needs to promote greater electricity grid flexibility to balance the power market as renewable deployment increases.
- **Build on recent progress with electricity market reforms and implement economic dispatch across regional power markets,** ensuring that the cheapest, cleanest sources of generation are dispatched before more costly and polluting fossil generation.

Assessment and impact analysis

Carbon Tracker estimates that 40% of China's coal power stations were already losing money in 2018, which could rise to 95% by 2040 due to the costs of complying with air pollution regulations and a rising carbon price. If China's power station owners retire their plants in line with the Paris Agreement they could save $390 billion.[28] A phase out of coal-fired power stations can also deliver significant health benefits associated with lower air pollution.

[25] The Economist (2020). *A glut of new coal-fired power stations endangers China's green ambitions*.
[26] Climate Analytics (2016). *Implications of the Paris Agreement for coal use in the power sector.*
[27] IEA (2019). *World Energy Outlook 2019*.
[28] Carbon Tracker (2018). *40% of China's coal power stations are losing money*.

In 2015 there were around 5.8 million jobs in the coal mining and processing sector in China.[29] A coal phase out would place these upstream mining and processing jobs at risk due to lower coal demand, and policy will need to provide support and new employment opportunities for workers in declining high carbon sectors. However, employment in the sector is already declining due to resource depleted mines in the northeast of the country, with employment likely to have fallen by over 2 million in 2020 relative to 2013 levels.[30]

The abatement cost of renewable power is low. Between 2010 and 2018, the levelized cost of generation for solar PV and wind fell by 77% and 35%, respectively.[31] Renewable power sources have already achieved cost parity with fossil incumbents in some provinces,[32] and will likely achieve nationwide cost parity with coal power stations in China by 2026.[33]

As the proportion of renewables increases Government will face costs to balance the electricity grid, such as through deploying additional battery storage capacity or maintaining back-up fossil power generation. While solar and wind are now the cheapest forms of electricity, new nuclear, carbon capture and storage and hydrogen generators may also be needed to achieve a near-zero carbon electricity system.

Renewable energy investment can generate substantial employment opportunities. It is estimated that $1 million of investment in the solar and wind sector can generate between 87 and 99 direct and indirect jobs.[34] In 2018, there were 4.1 million jobs in China associated with the renewable energy sector (IRENA, 2019), indicating the large opportunities for employment in the low-carbon supply chain, including for manufacturing of renewable energy equipment.

Full grid flexibility, including widespread use of demand response, electricity storage and EV smart charging, can deliver net benefits of $64 billion annually in 2035 in China, including operational cost falls and avoided capital expenditure on peak-load generation. In addition, this full grid flexibility in China can reduce CO_2 emissions in the power sector by 14% compared to an inflexible system.[35]

Investment in inter-regional transmission capacity can improve the trading of electricity nationwide and adequately connect areas of high renewable potential with China's demand centres, reducing renewable curtailment. The IEA estimates that greater inter-regional trading of electricity can reduce renewable curtailment rates to zero by 2035 if combined with economic dispatch, compared to 33% under business-as-usual, leading to a fall in power sector CO_2 emissions of 15% by around 650 million tonnes per year.[36]

[29] Cheng, H. and Eikeland, P. O. (2015). *China's political economy of coal Drivers and challenges to restructuring China's energy system*.
[30] China Dialogue (2017). *2.3 million Chinese coal miners will need new jobs by 2020*.
[31] He, G., Lin, J., Sifuentes, F., Liu, X., Abhyankar, N. and Phadke, A. (2020). *Rapid cost decrease of renewables and storage accelerates the decarbonization of China's power system*.
[32] Carbon Brief (2019). *Solar now 'cheaper than grid electricity' in every Chinese city, study finds*.
[33] Wood Mackenzie (2019). *China's renewables cost to fall below coal power by 2026*.
[34] Chen, Y. (2018). *Renewable energy investment and employment in China*.
[35] IEA (2019). *China Power System Transformation. Assessing the benefit of optimised operations and advanced flexibility options*.
[36] IEA (2019). *China Power System Transformation. Assessing the benefit of optimised operations and advanced flexibility options*.

ROLE FOR INVESTORS

As China aims to meet more ambitious decarbonisation targets, the market for low-carbon power will continue to grow. This will increase the profitability of firms in the low-carbon supply chain and shift investment opportunities away from fossil fuel-based power. Investors will have opportunities to provide financing and investment to firms in the renewables supply chain, including the developers and installers of renewables and the manufacturers of equipment in renewable technologies.

China is by far the world's largest market for renewable energy investment, with investment totalling over $80 billion in 2018. The IEA estimates China's annual investment needs in renewables to reach $150 billion between 2025-30 to meet the objectives of the Paris Agreement.[37] In 2018, private investors contributed 67% of solar PV investment and 22% of wind power investment in China.[38] However, the proportion of private investment in China remains substantially lower than the global average of around 90%.[39]

A transition to economic dispatch will prioritise the lowest cost sources of power and therefore reduce the curtailment rate of renewables.[40] This should improve the business case of renewable investment and unlock additional investment opportunities to deploy renewable capacity.

An enabling regime that delivers electricity grid flexibility can unlock investment opportunities across grid modernisation technologies. These investment opportunities are likely to be diverse, including: electricity storage capacity; transmission and distribution infrastructure; software companies; and manufacturers of equipment for grid modernisation technologies like batteries. Although the state grid has dominated investment until now, the Government has announced it supports private investment for grid modernisation technologies in the future.[41]

INDUSTRY DECARBONISATION

CURRENT SITUATION

Industry contributes 28% of China's energy related CO_2 emissions, and emissions from industry have been reduced by 7% from 2010 to 2018. Under the 13th Five-Year Plan, China has mandatory energy efficiency requirements covering 70% of industrial energy use. These have been complemented by the Green Industry Development Plan (2016-2020) targeting an 18% decrease in energy intensity in industry by 2020 relative to 2015.[42] These measures have been highly effective.

Policy action to commercialise zero carbon industrial production technologies has been more limited. There is no policy in place to decarbonise the key emissions intensive industrial sectors, including iron and steel, cement, and chemicals. Although there have been demonstration projects for carbon

[37] IEA (2019). *World Energy Investment 2019*.
[38] Century New Energy Network (2019). *The era of leading photovoltaic power plant investment in private enterprises is over!*
[39] IRENA. (2018). *Renewable Energy Finance*.
[40] IEA (2019). *China Power System Transformation. Assessing the benefit of optimised operations and advanced flexibility options*.
[41] Caixin. (2019). *In Depth: Why Outside Investors Aren't Energized by China's Power Grid*.
[42] New Climate Policy Database (2016). *Green industry development plan (2016-2020) China 2016*.

capture and storage (CCS) in China, there is no overarching policy framework for CCS in China, or for hydrogen.[43]

Current policy for industry will not achieve the objectives of the Paris Agreement. The IEA estimates that current policy (prior to implementing the 2060 carbon neutrality announcements) will lead to China's industrial emissions being around 2.3 $GtCO_2$ by 2040, which is over 3 times those of an emissions pathway consistent with the Paris Agreement.[44]

KEY POLICY RECOMMENDATIONS

- **Set strengthened mandatory energy efficiency targets for industrial plants in the fourteenth Five-Year Plan,** widening coverage beyond the 30,000 businesses covered in thirteenth Five-Year Plan.
- **Develop and implement strategies for low-carbon steel, chemicals, and cement.** Strategies should set a clear objective of decarbonising energy intensive industry, and set out roadmap to shift to electric, hydrogen, and CCS production technologies to meet this objective on a timeline aligned with Paris Agreement goals and China's 2060 carbon neutrality commitment.

Assessment and impact analysis

Many industrial energy efficiency investments have attractive rates of return globally with a payback period less than five years.[45] While there is no comprehensive analysis of the industrial energy efficiency payback opportunity in China, an IFC survey of China's energy service companies (ESCOs) market indicates the business case for energy efficiency is often strong, with payback periods of two to three years common.[46] Industrial energy efficiency gains in China can raise international competitiveness in energy-intensive sectors.

There are still barriers to industry improving energy efficiency, including a lack of information, technical expertise, or financing. The majority of ESCOs are privately owned, and many struggle to access external financing to facilitate energy efficiency investment.[47] Policy support can help overcome these barriers. For example subsidies or public guarantees for industrial energy efficiency investments to reduce perceived risk.[48]

The abatement costs are likely to be high for some sectors. Abatement costs could total around $60 per tonne of CO2 for steel plants and $130 per tonne of CO2 for cement production globally.[49] Nonetheless, in the long-term, decarbonising industry can increase efficiency and protect the competitiveness of Chinese industries as its trading partners impose penalties on high-emitting products.

[43] Global CCS Institute (2018). *Carbon capture and storage in de-carbonising the Chinese economy*.
[44] IEA (2019). *World Energy Outlook 2019*.
[45] AEA (2012). *Next phase of the European Climate Change Programme: Analysis of Member States' actions to implement the Effort Sharing Decision and Options for further Communitywide Measures*.
[46] IFC (2017). *China Energy Service Company (ESCO) Market Study*.
[47] Ge, JFeng, WZhou, NLevine, MSzum, C. (2017). *Accelerating Energy Efficiency in China's Existing Commercial Buildings Part 1: Barrier Analysis*; and IFC (op cit).
[48] International Energy Charter (2018). *China energy efficiency report*.
[49] Energy Transitions Commission (2018). *Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century*.

The European Commission have proposed the EU implements a carbon border adjustment, which would place a carbon price on imports into the EU single market.[50] If the EU and other major trading partners implement border carbon adjustments, the competitiveness of businesses that rely on conventional high-carbon manufacturing processes may be affected. In contrast, a shift to zero-carbon manufacturing can help avoid these penalties and improve competitiveness.

Industry is a large contributor to harmful air pollution throughout China, which can be mitigated if the sector decarbonises. For example, the metal mining, smelting, and processing sector, and non-metal products sector collectively contribute around 61% of dust emissions, which is a key cause of harmful air pollution such as PM2.5.[51]

ROLE FOR INVESTORS

Investors can finance industrial investment in energy efficiency measures, for example energy management systems, buildings fabrics, heating and cooling systems, and ventilation. In addition, larger investors can invest in businesses that supply this market, including ESCOs and the manufacturers of materials and energy efficiency technologies.

The market size for industrial energy efficiency is likely to be large in China. The IEA estimates that 41% of energy savings in China by 2030 could come from industry.[52] This represents around 8% of China's 2018 final energy consumption and indicates industrial energy efficiency investment is likely be a very large market to at least 2030.

Investment opportunities will shift to low-carbon manufacturing processes in the steel, cement, and chemicals sectors. Investment opportunities to cut carbon emissions from these industries will be concentrated in four routes: electrification, the use of biomass, the application of CCS, and the use of hydrogen. The opportunities will vary across sectors given their substantial differences. For example, cement production could use one of electrification, biomass, and hydrogen for heat production with CCS to capture process emissions; while steel-making could rely heavily on scrap-based production in an electric arc furnace with CCS to capture process emissions (Energy Transitions Commission, 2018).

Globally, investors may need to increase their capacity to appraise energy efficiency investments, including in China. Many investors have up to now lacked technical capacity to assess energy efficiency investments and may inadequately measure their risk and returns (Carbon Trust, 2018). This capacity building could include recognising how energy efficiency investments can reduce other investment risks, for example energy efficiency investment can improve a businesses' cash flow, thereby lowering the risks for loans to those businesses (Energy Efficiency Financial Institutions Group, 2017).

[50] European Parliament (2020). *Carbon border adjustment mechanism as part of the European Green Deal*.
[51] Wang, Y., Lai, N., Mao, G., Zuo, J., Crittenden, J., Jin, Y. and Moreno-Cruz, J. (2017). *Air pollutant emissions from economic sectors in China: A linkage analysis*.
[52] IEA. (2018). *Energy efficiency in China*.

ROAD TRANSPORT

CURRENT SITUATION

Road transport accounts for 10% of China's energy-related CO_2 emissions, and those emissions have grown 61% from 2010 to 2018, reflecting rapidly growing car ownership.[53]

There were 1.1m sales of electric cars in China in 2019, representing 50% of all global sales.[54] China's electric car sales have grown rapidly to reach over 1 million by 2019,[55] which represents a 4.9% market share of China's passenger car market.[56] China has a target to reach 5 million electric vehicles (EVs) on its roads by 2020.[57]

China launched its Electric Vehicle Subsidy Scheme in 2009 to promote the growth of new energy vehicles, spending $7.7 billion on EV subsidies in 2017.[58] Since 2016, Government has reduced the subsidies for EVs as part of a tapered phase out of direct purchase incentives in the market.[59] Policymakers intended to end purchase subsidies for EVs in 2020, but have extended these subsidies to 2022 as part of the response to the COVID-19 pandemic.[60]

China plans to strengthen mandatory fuel economy standards for cars from 2021-25.[61] These 'Phase 5' standards mandate that automotive producers must reduce their average fuel consumption of new passenger vehicles to 4l per 100km by 2025,[62] which would represent the third strictest standard globally, behind the EU and Japan.[63] China is also in the process of tightening mandatory fuel economy standards for heavy road transport.

There is a strong public investment programme for EV charging infrastructure. Both central and local government provide funding and financial incentives to deploy EV charging points nationwide. This has led to China having 82% of the global capacity of publicly accessible fast chargers in 2019.[64]

Although officials are considering a phase out for internal combustion engine (ICE) cars, Government has made no official policy commitment. At the sub-national level, Hainan has announced a 2030 official target for a shift to all clean energy vehicles.[65] The IEA estimates that transport emissions under current policy (prior to implementing the 2060 carbon neutrality announcements) will be 2.4 times those of an emissions pathway consistent with the Paris Agreement by 2040.[66]

[53] Gan, Y., Lu, Z., Cai, H., Wang, M., He, X. and Przesmitzki, S. (2019). *Future private car stock in China: current growth pattern and effects of car sales restriction*.
[54] IEA (2020). *Global EV Outlook 2020*.
[55] IEA (2020). *Global EV Outlook 2020*.
[56] IEA (2020). *Global car sales by key markets, 2005-2020*.
[57] IEA (2020). *Global EV Outlook 2020*.
[58] Forbes. (2018). *What China's Shifting Subsidies Could Mean For Its Electric Vehicle Industry*.
[59] IEA (2020). *Global EV Outlook 2020*.
[60] Reuters. (2020). *China to cut new energy vehicle subsidies by 10% this year*.
[61] ICCT (2019). *Comments on China's proposed 2021-2025 fuel consumption limits, evaluation methods, and targets for passenger cars*.
[62] ICCT (2019). *Comments on China's proposed 2021-2025 fuel consumption limits, evaluation methods, and targets for passenger cars*.
[63] ICCT (n.d.). *Chart library: Passenger vehicle fuel economy*.
[64] IEA (2020). *Global EV Outlook 2020*.
[65] ICCT (2019). *Hainan's Clean Energy Vehicle Development Plan (2019-2030)*.
[66] IEA (2019). *World Energy Outlook 2019*.

KEY POLICY RECOMMENDATIONS

- **Announce an end to the sales of fossil fuel cars and vans by 2040, and set out a long-term policy regime to deliver 100% zero emission vehicles by this date. An effective long-term policy regime is likely to include a combination of tapered price support for electric vehicles, as well as tightening fuel economy or CO_2 standards.**

- **Develop and implement a comprehensive heavy road transport decarbonisation strategy. The strategy should set a clear target year to decarbonise heavy road transport; set out a programme of RD&D and demonstration projects to commercialise low-carbon trucks; and identify policy options to drive mass-market deployment once commercialisation is achieved.**

Assessment and impact analysis

The abatement cost for electric cars and vans is low but there may be some need for public subsidy until they achieve cost parity with fossil fuelled incumbents, especially if fuel taxes remain low and so extend the period of cost competitiveness of ICE vehicles. EVs are expected to achieve cost parity with fossil fuelled cars and vans globally during the mid-2020s.[67]

China has an early competitive advantage in low-carbon vehicles, producing around half of the EVs sold globally and supplying nearly 20% of EV global exports.[68] Extensive domestic deployment of electric vehicles would provide manufacturers with a large domestic market, supporting sustained innovation and improving prospects for strong export success. High uptake of electric cars, vans and trucks can also deliver substantial health and environmental benefits through lower air pollution. A shift away from fossil fuelled vehicles can also increase energy security by reducing China's dependency on imported oil.

A long-term transition from fossil fuelled trucks to battery EVs is likely to impose no additional ownership costs by 2030 over the range where it is technical feasible. For longer range journeys fuel-cell vehicles can be a more cost effective transportation mode than diesel and biofuel vehicles by 2030.[69]

If vehicle manufacturers are to commercialise low-carbon HDVs, then there will need to be high innovation in battery and fuel cell technologies. This innovation can complement RD&D efforts in other sectors. For example, in the case of battery technologies, innovation for heavy road transport that produces batteries with higher density can have positive spill-over effects for the decarbonisation of power, with cost effective storage capacity critical to integrate renewables into the electricity grid.

ROLE FOR INVESTORS

As the domestic market transitions away from fossil fuel cars and vans, the market for consumer vehicle finance will also shift from conventional vehicles to electric vehicles. Furthermore, there will be growing opportunities to invest in electric vehicle charging infrastructure.

[67] ICCT (2019). *Global and U.S. electric vehicle trends*.
[68] McKInsey (2017). *China's electric-vehicle market plugs in*.
[69] Energy Transitions Commission (2018). *Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century*.

In 2019, China had sales of 25m cars, which was the largest car market globally.[70] Given current car ownership in China is substantially lower than many developed countries there is potential for substantial market growth over the long-term.[71] McKinsey estimate that cumulative investment in electric charging infrastructure in China could amount to at least $19 billion to 2030.[72]

Government has led the investment for public charging infrastructure to date, with investors often unable to make profitable investments given the limited market size for EVs. Once EVs become widespread, the demand for charging stations will rise substantially. This rise in future EV demand can enable investors to make profitable investments in charging infrastructure and have a greater role in charging point expansion.[73] There is early evidence of a growing role for investors in China's charging infrastructure market, for example BP and Didi Chuxing have announced a joint venture to construct, develop and operate charging stations in China.[74]

Investment opportunities will shift to low-carbon vehicle manufacturing capacity as the market for ICE vehicles declines. In 2018 Government announced a series of reforms to remove limits on foreign ownership of commercial vehicle manufacturing capacity in 2020 and for passenger vehicles by 2022 (PwC, 2018; King & Wood Mallesons, 2020).[75][76]

Investors will have an opportunity to provide finance to freight companies to purchase zero-carbon trucks. This is likely to be a large financing opportunity given the high truck volumes in China, which amounted to sales of over 1.2m in 2018.[77] Investors can also invest in the expansion of associated infrastructure, which is likely to include a combination of electric charging points, hydrogen refuelling stations and hydrogen production plants.

Investors will have long-term opportunities to invest in low-carbon truck manufacturing capacity. Once low-carbon trucks have commercialised, investment opportunities will include the repurposing of existing ICE truck manufacturing capacity for low-carbon production and new manufacturing capacity, especially to produce electric batteries and fuel cells.

ENERGY EFFICIENT BUILDINGS

CURRENT SITUATION

Buildings contribute 6% of China's energy-related CO_2 emissions. In 2018 they totalled 0.6 $GtCO_2$, which amounted to a 25% increase from 2010 levels.[78]

[70] IEA (2019). *Coal Information*.
[71] McKinsey (2019). *Winning the race: China's auto market shifts gears*.
[72] McKinsey (2018). *Charging Ahead: Electric Vehicle Infrastructure Demand*.
[73] Hove, A. and Sandalow, D. (2019). *Electric vehicle charging in China and the United States*.
[74] BP (2019). *BP and DiDi join forces to build electric vehicle charging network in China*.
[75] King & Wood Mallesons (2020). *The Impact of China Removal of Foreign Ownership Restrictions in Auto Sector*.
[76] PwC (2018). *The Opening-up of Chinese Automotive Industry and its Impact*.
[77] Business Wire. (2019). *China Heavy Truck Industry Report, 2019-2025 Featuring 15 Chinese Heavy Truck Manufacturers*.
[78] IEA (2019). *World Energy Outlook 2019*.

Government policy is driving a coal-to-gas shift for both urban and rural heating, targeting 70% clean heating in Northern China by 2021 as part of the Clean Winter Heating Plan (2017-21), which defines 'clean heating' to include natural gas and low-carbon heat technologies such as heat pumps.

Government policy also mandates new building thermal efficiency standards for urban areas and all non-domestic buildings, with voluntary standards in rural areas, and some variation across China's five climatic zones. Mandatory thermal efficiency standards have been strengthened over time. In recent years, Government has funded large-scale retrofitting of buildings in Northern China. Under the 12th Five-Year Plan (2011-15), government support enabled the retrofitting of over 700 million square metres of existing residential properties in Northern China, with public subsidies covering more than 80% of the retrofitting costs.[79]

However, the IEA estimates that current policy alone (prior to implementing the 2060 carbon neutrality announcements) will lead to emissions in the buildings sector that are around 3 times those of an emissions pathway consistent with the Paris Agreement by 2040.[80] A strengthening of the existing mandatory thermal efficiency standards in building envelope can reduce energy consumption in buildings by 13% by the end of the 21st century in China relative to the baseline scenario.[81] In addition, there is potential for high energy efficiency gains in rural areas.

KEY POLICY RECOMMENDATIONS

- **New buildings -** publish a comprehensive thermal efficiency plan for new buildings. The plan should be underpinned by a detailed review of cost-effective thermal efficiency potential, set thermal efficiency standards reflecting this potential for the period to 2025, and commit to strengthening standards every five years. Plan should also include an immediate extension of new building thermal efficiency standards to rural buildings**.**
- **Existing buildings -** build on recent successes delivering building retrofits in Northern China, set a target for retrofit of all residential, commercial and public buildings by 2050, and develop policy mechanisms (investment subsidies, owner obligations) to achieve the target and interim targets to track progress**.**

Assessment and impact analysis

More stringent thermal efficiency standards can make new homes more energy efficient, reducing energy use and lowering energy bills for consumers. Retrofitting can deliver household and business energy bill savings for China by reducing heating demand. For example, retrofitting the properties of high energy users in Chongqing could save 40-68% of their annual space-conditioning energy consumption.[82]

Strengthening thermal efficiency standards will raise the construction costs for new builds, but the size of those costs is uncertain as yet due to a lack of published analysis. If the rise in construction costs is moderate, they can likely be borne by homebuyers and developers in urban areas, as expert

[79] Paulson Institute (2017). *Financing Energy-Efficient Buildings in Chinese Cities*.
[80] IEA (2019). *World Energy Outlook 2019*.
[81] Yu, S., Eom, J., Evans, M. and Clarke, L. (2014). *A long-term, integrated impact assessment of alternative building energy code scenarios in China*.
[82] Tsang, C., Spentzou, E., He, M. and Lomas, K. J. (2018). *Evaluating energy savings retrofits for residential buildings in China*.

interviews noted they have done so historically. Rural households in China have far lower average income than their urban equivalents. Therefore, Government will inevitably be concerned about a potential cost burden on rural households to meet mandatory thermal efficiency standards. Public subsidy is needed to alleviate some of the construction cost rises in rural areas.

Many energy efficiency measures are highly cost-effective, but policy mechanisms may be needed to overcome market failures and barriers associated with energy efficiency investment. A survey of Chinese businesses to identify the barriers they face in improving energy efficiency found a lack of technical expertise and access to finance as two of several key barriers.[83] As such, Government may require policy mechanisms, such as subsidies or landlord obligations, to deliver higher energy efficiency across the buildings sector and fully unlock the investment potential.

Investment in retrofitting will create employment for installers of the energy efficiency measures and the companies that manufacture the materials. Investment in retrofitting can also act as an effective economic stimulus in response to the COVID-19 pandemic given its high economic multipliers and job creation alongside positive climate impact.[84]

ROLE FOR INVESTORS

Investors can provide financing to developers for all sizes of construction projects, including small residential properties and large office spaces. China is the world's largest market for construction investment globally, representing around 20% of the total.[85] The IFC estimate that the cumulative investment potential for the construction of new green buildings in China may be around $13 trillion by 2030. Given around 85% to 90% of construction investment in China is available to the private sector, investors have a critical role to provide financing to enable higher thermal efficiency in buildings.[86]

Investors will have an opportunity to provide loans to households and businesses to invest in energy efficiency improvements to building fabrics, heating, and energy management systems. In addition, investors can provide capital for energy efficiency investment through energy service companies (ESCOs). As the retrofitting market value rises, there will be growing opportunities to invest in businesses in the energy efficiency supply chain. These opportunities are likely to include further financing for ESCOs and the manufacturers of energy efficiency materials and technologies.

[83] Ge, JFeng, WZhou, NLevine, MSzum, C. (2017). *Accelerating Energy Efficiency in China's Existing Commercial Buildings Part 1: Barrier Analysis*.
[84] Hepburn, C., O'Callaghan, B., Stern, N., Stiglitz, J., & Zenghelis, D. (2020). *Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?* (Oxford Smith School, Working Paper No. 20–02).
[85] World Resources Institute (2019). *China Is Investing $13 Trillion in Construction. Will It Pursue Zero Carbon Buildings*?
[86] IFC (2019). *Climate Investment Opportunities in Emerging Markets. An IFC Analysis*.

CONTACTS

Nan Luo
Head of PRI China

Margarita Pirovska
Head of Asia Policy and Multilateral Policy

Sagarika Chatterjee
Director of Climate Change