

# Achievements, challenges and global implications of China's carbon neutral pledge

Hong Yang (✉)<sup>1</sup>, Xianjin Huang<sup>2</sup>, Jianlin Hu<sup>3</sup>, Julian R. Thompson<sup>4</sup>, Roger J. Flower<sup>4</sup>

<sup>1</sup> Department of Geography and Environmental Science, University of Reading, Reading RG6 6AB, UK

<sup>2</sup> School of Geography and Ocean Science, Nanjing University, Nanjing 210023, China

<sup>3</sup> Collaborative Innovation Center of Atmospheric Environment and Equipment Technology, Jiangsu Key Laboratory of Atmospheric Environment Monitoring and Pollution Control (AEMPC), School of Environmental Science and Engineering, Nanjing University of Information Science & Technology, Nanjing 210044, China

<sup>4</sup> Department of Geography, University College London, London WC1E 6BT, UK

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**Abstract** China has been committed to achieving carbon neutrality by 2060. China's pledge of carbon neutrality will play an essential role in galvanising global climate action, which has been largely deferred by the Covid-19 pandemic. China's carbon neutrality could reduce global warming by approximately 0.2–0.3 °C and save around 1.8 million people from premature death due to air pollution. Along with domestic benefits, China's pledge of carbon neutrality is a “game-changer” for global climate action and can inspire other large carbon emitters to contribute actively to mitigate carbon emissions, particularly countries along the Belt and Road Initiative (BRI) routes. In order to achieve carbon neutrality by 2060, it is necessary to decarbonise all sectors in China, including energy, industry, transportation, construction, and agriculture. However, this transition will be very challenging, because major technological breakthroughs and large-scale investments are required. Strong policies and implementation plans are essential, including sustainable demand, decarbonizing electricity, electrification, fuel switching, and negative emissions. In particular, if China can peak carbon emissions earlier, it can lower the costs of the carbon neutral transition and make it easier to do so over a longer time horizon. China's pledge of carbon neutrality by 2060 and recent pledges at the 26<sup>th</sup> UN Climate Change Conference of the Parties (COP26) are significant contributions and critical steps for global climate action. However, countries worldwide need to achieve carbon neutrality to keep the global temperature from growing beyond the level that will cause catastrophic

damages globally.

**Keywords** Carbon neutrality, Carbon peak, Renewable energy, Negative emission, Carbon capture, Utilisation and storage, Nature-based solution

## 1 China's pledge of carbon neutrality

China experienced rapid economic development during the last four decades, accounting for approximately 28% of global emissions. In September 2020, China pledged to be carbon neutral (or achieve net zero emissions) by 2060. Carbon neutrality can be achieved by either eliminating carbon emissions entirely or balancing these emissions with carbon removals (negative emission). China's neutrality pledge can potentially galvanise global efforts to combat climate change, but the Covid-19 pandemic interrupted forward planning and diverted climate change and disaster resilience funding. Nevertheless, a potentially significant step forward was made at COP26 when almost 200 countries agreed on the Glasgow Climate Pact to limit global warming by curbing fossil fuel usage and China and USA agreed to work together to limit global temperature rise to 1.5 °C.

## 2 Potential game-changer for global climate action

China's 2060 carbon neutral goal could potentially reduce the rate of global warming by 0.2–0.3 °C ([Climate Action Tracker, 2020](#)). It is also estimated that reduced air pollution in China could save approximately 1.8 million

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✉ Corresponding author

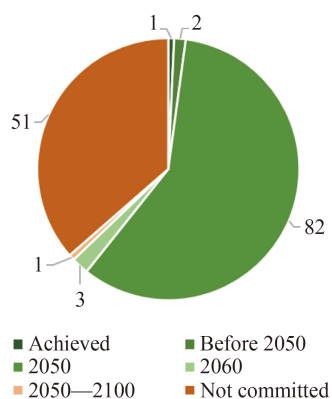
E-mail: [h.yang4@reading.ac.uk](mailto:h.yang4@reading.ac.uk)

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people from premature deaths (China Dialogue, 2020). China's pledge of carbon neutrality is a potential "game-changer" for global climate action that could motivate other large carbon emitters to reduce their carbon emissions. Under Chinese the Belt and Road Initiative (BRI) other countries will be drawn-in to China's energy and carbon footprint. Approximately US\$160 billion of investments in coal-fired power plants was planned as part of the BRI during the period 2014–2020. China has re-evaluated these plans with the collaboration of BRI partners. In September 2021, China announced that it would stop building new coal power plants overseas, including the large 6.6 GW Hamarawein plant in Egypt. However, as of October 2021, out of 140 BRI countries, 51 still have to commit to becoming carbon neutral (Wallach, 2021) (Fig. 1). China is a leader in renewable energy technologies and its plans to achieve carbon neutrality include reducing renewable energy costs and creating globally positive "spill overs" to benefit BRI partners and countries beyond.

### 3 China's achievements and challenges to cut carbon emissions

Since the 2015 Paris Climate Conference, at which China ambitiously pledged to reach carbon peak by 2030, China has made significant progress towards reducing carbon emissions. This included optimising and upgrading many industrial facilities, developing renewable energy, improving energy use efficiency, building national and regional carbon trade markets, and increasing forest carbon stocks. The energy share of non-fossil fuels rose from 27.3 % in 2015 to 33.9 % in 2020 (Chinese Government, 2021). China's installed renewable energy capacity is now the world's largest. Further transition to renewable energy industries is projected to increase job creation rates by 1.5–3 times whilst also improving environmental conditions and delivering public health



**Fig. 1** Timing of achieving carbon neutrality by countries in China's Belt and Road Initiative (BRI) (total: 140). Data are from Wallach (2021).

benefits. Between 2005 and 2019, the carbon intensity (CO<sub>2</sub> emissions for each kilowatt hour of electricity produced) of China's economy fell by 48.1%. China's forest cover increased from 16.5 % of total land area in 2000 to 23.0% in 2018, with annual carbon sequestration by forests reaching an estimated 4.34 billion tons (National Forestry and Grassland Administration, 2018).

Despite this progress, China, unlike Europe and the USA, is still in a phase of rapidly rising total carbon emissions. During the period of 2008–2018, the average annual growth rate of these Chinese emissions was 2.6 %, nearly 2.4 times the world average (BP, 2020). Approximately 62 % of China's electricity is still coal generated. Shifting China's economy from such heavy dependence on fossil fuels in four decades will clearly be challenging. China will also need measures to ensure the economic security and well-being of coal industry workers and to satisfy energy demands of the rural populations who currently depend overwhelmingly on coal-based electricity (Mallapaty, 2020).

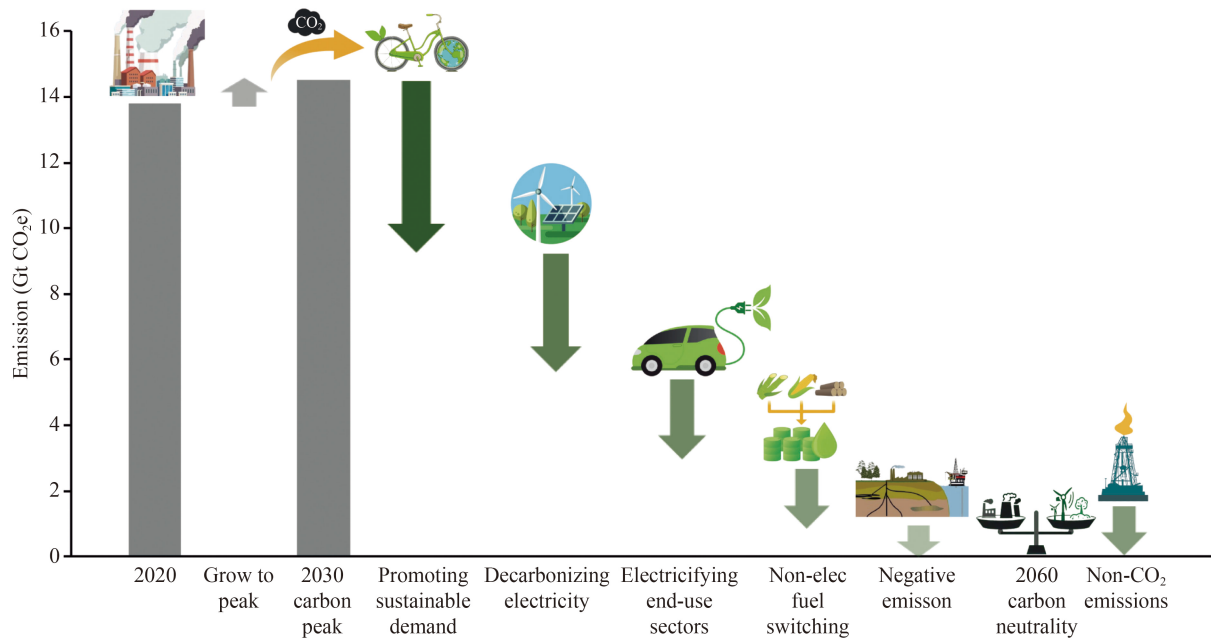
### 4 China's journey to carbon neutrality

Before achieving carbon neutrality in 2060, achieving carbon peak by 2030 is crucial (Fig. 2). Meeting the ultimate target of being carbon neutral by 2060 requires China to make enormous changes in its energy, transportation, industrial, construction, and agricultural sectors coupled with large-scale financial investments and major technological advancements. Strong policies and implementation plans are needed to sustain energy demands by decarbonising electricity, including electrifying new networks, enabling energy switching options, and developing negative emission pathways (Fig. 2) (Yu et al., 2020).

To support sustainable demand, improving energy use efficiency, optimising energy structures, enhancing urban planning, and promoting lifestyle changes will all be required (Fig. 2). The Covid-19 pandemic brought several positive changes, including reduced passenger numbers and vehicle use with the move to more home working, more use of carbon-free transportation such as cycling and reduced overall carbon emissions, but their long-term persistence in the post-Covid-19 era will need support.

Decarbonising electricity generation is an enormous challenge requiring phasing out of coal power and expansion of renewable energy, perhaps including nuclear (Fig. 2). It is estimated that a nine-fold increase in wind, 16-fold increase in solar, doubling of hydropower and a six-fold increase in nuclear power would be required to meet China's carbon neutrality target (Mallapaty, 2020).

Expanding electrification must include rapidly increasing the electric vehicle fleet, using electricity for industrial heat production and household heating, as well



**Fig. 2** Roadmap of carbon deceleration, carbon peak and carbon neutrality in China. Carbon emissions in 2020 and predicted for 2030 were obtained from Climate Action Tracker (2021). Other data are from Yu et al. (2020).

as other domestic requirements (Fig. 2). Cities account for approximately 80% of China's energy usage, so that implementing best practices in energy conservation in all urban buildings is essential. In locations where electrification is not currently feasible or economically viable, such as remote upland areas, switching to low-carbon fuels such as sustainably produced biofuels or, better still, promoting locally installed renewable energy generation should be prioritised (Fig. 2).

Off-setting remaining carbon emissions will require sequestering carbon through carbon removal technologies and/or promoting natural ecosystems (e.g., forests, wetlands and marine environments) (Fig. 2). The use of carbon capture, utilisation and storage (CCUS) technologies to capture CO<sub>2</sub> released from burning fossil fuels or biomass and storing it underground must be expanded. In particular, bioenergy with carbon capture and storage (BECCS) has gained increasing attention because of its advantage of a carbon-neutral alternative to fossil fuels. Most completed or operating BECCS projects involve ethanol plants. For example, the *Cargill Wheat Processing CO<sub>2</sub> Purification Plant* sequestered around 100 kt CO<sub>2</sub>/yr. Direct air capture (DAC) provides an impactful and engineered approach by removing CO<sub>2</sub> from air using solid sorbents or liquid solvents. Metal-Organic Frameworks (MOFs) are new advanced materials for DAC sorbents, creating new possibilities for carbon capture. Mg-IRMOF-74-III functionalized with azopyridine can uptake CO<sub>2</sub> at the rate of 89 cm<sup>3</sup>/g. Currently, China has only one large CCUS facility at an oil field in Jilin Province. Many more will be needed, allied with research

to increase efficiencies and lower costs.

Substantial new measures are also needed to reduce non-CO<sub>2</sub> emissions (Fig. 2). At COP26, China, along with the USA, announced plans to measure and cut CH<sub>4</sub> emissions from fossil fuel energy and waste sectors. Additional targeted interventions in agriculture and the construction industries are required to reduce other greenhouse gases such as N<sub>2</sub>O and fluorinated gases.

Deceleration of fossil fuel consumption is also absolutely critical (Yu et al., 2020). If China achieves peak carbon emissions before 2030 as currently planned (Fig. 2), the transition to carbon neutrality would be cheaper and more manageable (Hepburn et al., 2021).

## 5 Conclusions

China's commitment to carbon neutrality by 2060 is critically important for addressing the global warming emergency. China has a potentially major role to play in tackling climate change and needs to adopt and strengthen key strategies by curbing the construction of coal power plants, achieving peak carbon emissions by 2030 or earlier and advancing energy transforming technologies. All signatory countries to the COP26 Glasgow Climate Pact need to coordinate energy policies, and cooperate internationally and economically, if carbon emissions are to be reduced to net zero. Failure to do so will allow current climate driven changes to the world's ecosystems and the human populations to potentially reach catastrophic proportions.

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