Electronic Supplementary Material to:
The Chinese Carbon-Neutral goal: Challenges and Prospects*

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Integrated Assessment Models and scenarios used for the carbon-neutral goal

The 1.5°C scenario of the Intergovernmental Panel on Climate Change (IPCC) corresponds broadly to net-zero anthropogenic CO_2 emissions by 2050 (IPCC, 2018). In our analysis, four scenarios from Integrated Assessment Model (IAM) projections were used to evaluate China's carbon-neutral goal.

The linked Integrated Policy Assessment Model of China (IPAC) model (Jiang et al., 1998, 2010, 2018, 2019) is an integrated model developed by the Energy Research Institute (ERI) of the National Development and Reform Commission (NDRC) to analyze global, national, and regional energy and environment policies. It includes three sub-models: (1) the

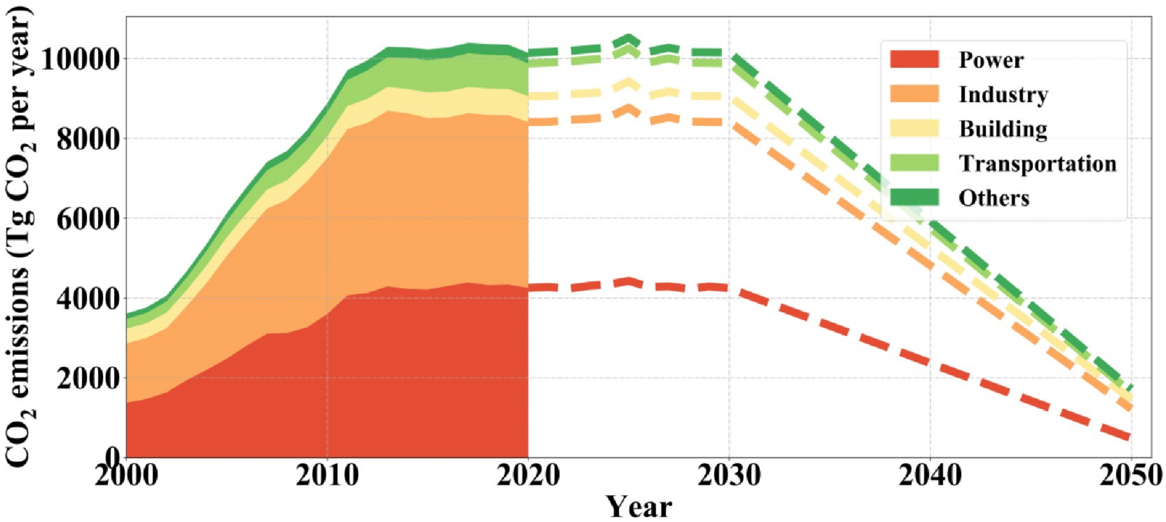

Fig. S1. Trajectories of China's primary energy sources in the four proposed scenarios.

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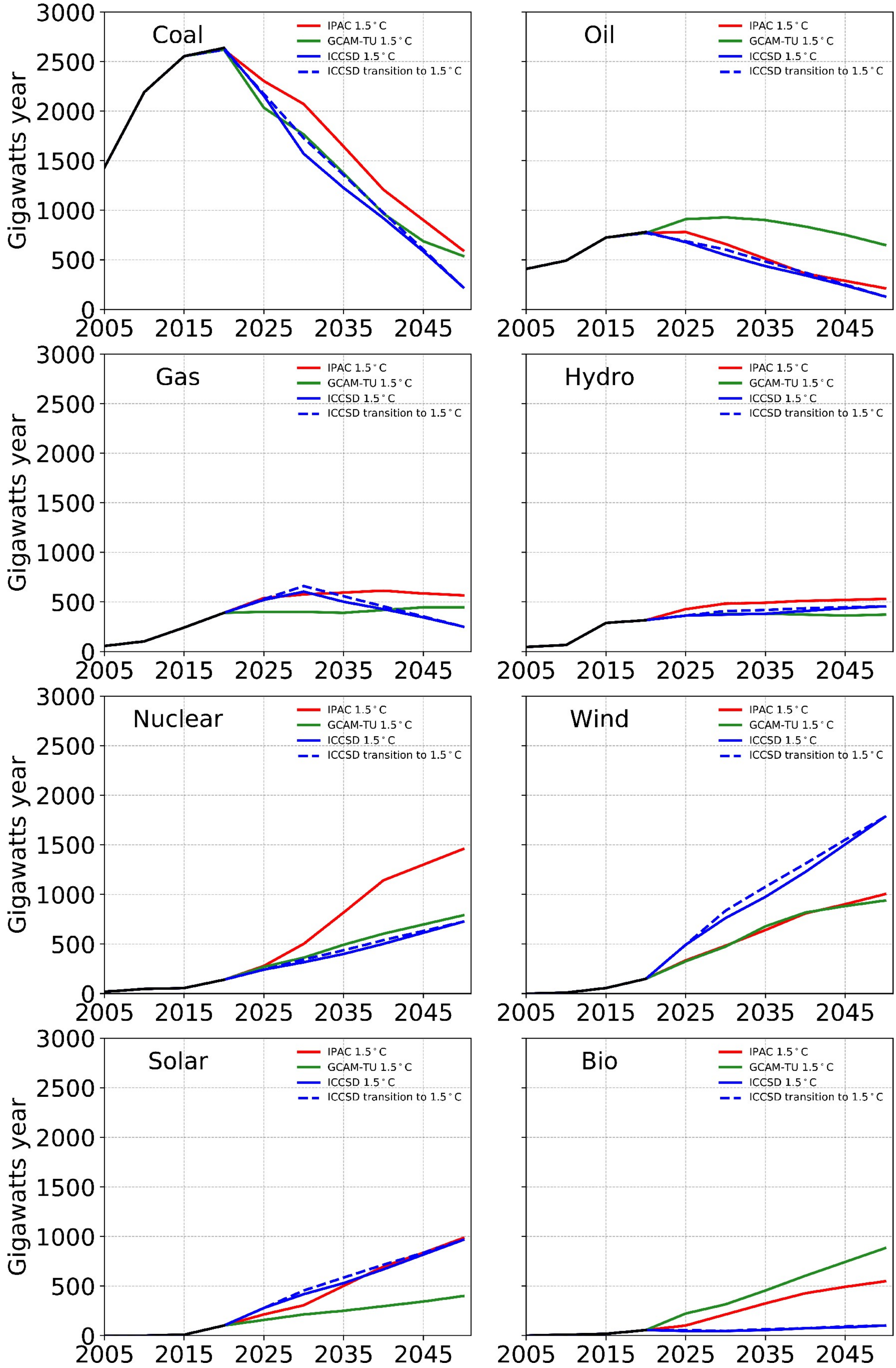

Fig. S2. CO_2 emissions trajectories from the four scenarios..

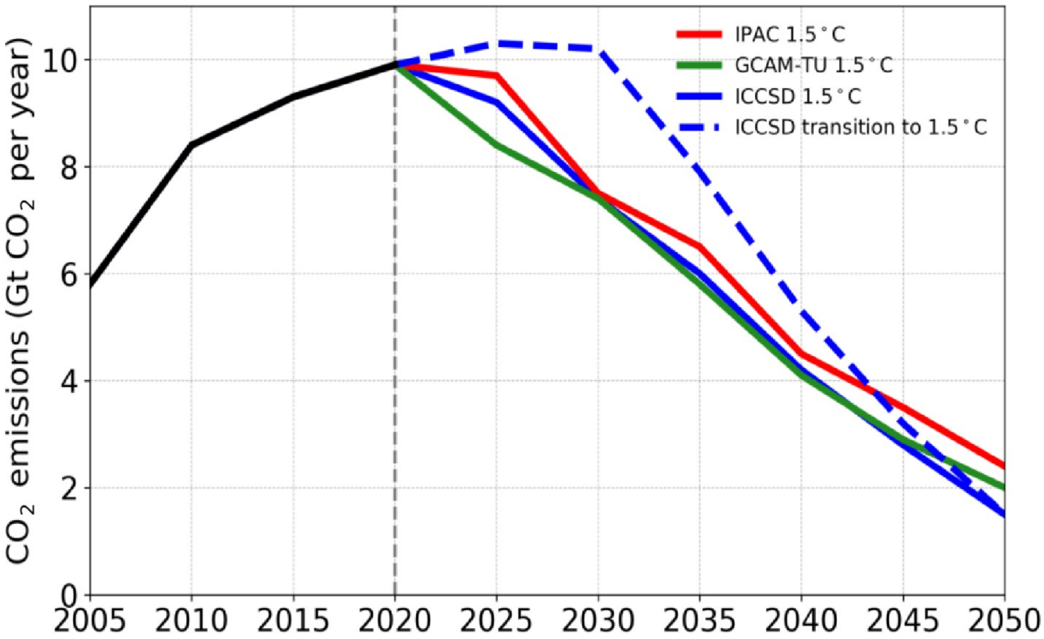

Fig. S3. Sectoral CO_2 emissions from 2000–50. See Han et al., 2021 for details.

IPAC-Emission global model, (2) the IPAC-CGE model; (3) and IPAC-AIM/technology model. The IPAC-Emission model focuses on energy and land-use activities, and it was revised to include CH_4, N_2O, HFC, PHC, and SF_6 to simulate more gas emissions. The IPAC-CGE model is a general equilibrium model for China. It is mainly responsible for analyzing the economic impacts of different energy and environmental policies. It includes major sectors such as household, government, agriculture, energy, and other production sectors. IPAC-AIM/technology is the main component of the IPAC model, which selects technologies with the lowest costs to provide the energy service. It includes 42 sectors and their products and almost 600 technologies, including existing and potential technologies.

The Global Change Assessment Model Tsinghua University (GCAM-TU) model (Zhou et al., 2021) is adapted from the US GCAM (Edmonds and Reilly, 1983; Kyle et al., 2010), which is a global integrated assessment model with 32 divided regions, including China, and it is a long-term, partial-equilibrium model is designed to address issues on the behavior and interactions between energy, water, agriculture, land use, economy, and climate. The model has been developed at the US Department of Energy's Pacific Northwest National Laboratory (PNNL) since the 1980s and has been widely used in energy consumption and CO_2 emissions research (Pan et al., 2018; Zhou et al., 2018a, 2021). It is an open-source model with transparent and verifiable parameters and data (Zhou et al., 2018a, b). The GCAM-TU adjusted the parameters and local policies to make it more suitable to simulate China's energy and CO_2 emissions (Zhou et al., 2021). Specifically, the energy consumption and CO_2 emissions of China, as well as other major regions, in both the base year and the target year of the nationally determined contribution (NDC) were adjusted. Energy supply and demand data, including the power sector in the base year (2015), were recalibrated using China's latest energy statistics. The future trends of the supply and demand of both energy and electricity were adjusted according to the latest domestic research results.

The ICCSD and ICCSD 1.5°C "transition pathway" from Tsinghua University have synthesized results from 18 research topics under a major project using multiple models (Project Comprehensive Report Preparation Team, 2020). The macro-analyses are based on trend analyses, while the study used sectoral models for sector-based emissions and projections. There were four basic scenarios: (1) Policy scenario; (2) Reinforced policy scenario; (3) 2°C scenario; (4) 1.5°C scenario. Considering the inertia in the energy system, two more pathways are proposed to 'transition' from the reinforced-policy scenario to the 1.5°C and the 2°C scenarios, implying more gradual changes before 2030 and more drastic changes after. Here we analyze the two carbon-neutral consistent pathways: the standard ICCSD 1.5°C scenario and the ICCSD transition to the 1.5°C scenario.

Among these models, while IPAC has long been a main in-house model used for economic and energy planning at NDRC, the other models have direct linkage with widely used global IAM models. Compared to most global models, they have adapted parameter values and assumptions more specific to China, thus potentially providing greater insight into China's carbon-neutral pathways.

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