COMMITTED POLICY BRIEF

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China

China's Energy Transition: Progress, Challenges, and Alignment with the Paris Climate Goals

- China is progressing in its energy transition: current projections show that it is likely to reach soon the peaking point of emissions.
- The expansion of renewable energy consumption and capacities, as well as the share of electric vehicles, are exceeding considerably China's national targets, due to significant reductions on costs.
- Fossil fuels continue to play a central role in China's energy mix. However, decreasing costs of low-carbon energies are making future fossil capacity additions economically unattractive.
- Transition policies are crucial to reconcile the near-future perspectives with cost-effective and low-carbon development, to align China's energy and emissions pathways with the Paris Agreement goals.

Reaching net-zero emissions by 2060 remains challenging for China and will require more ambitious climate policies in the near-term.

COMMITTED: Climate pOlicy assessment and Mitigation Modeling to Integrate national and global TransiTion pathways for Environmental-friendly Development

The goal is to reinforce global climate change mitigation efforts by supporting the work of researchers and experts from Asia on national and sectoral greenhouse gas emissions modelling. This is done by strengthening capacity building for GHG emissions modelling and exchanging best practices and know-how between leading modellers from the EU and Asia working closely with the government.

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China’s role in the global mitigation pathway

The outcome of the 1st Global Stocktake reiterated that collective global efforts on mitigation of and adaptation to climate change are not on track towards achieving the Paris Agreement target of limiting global warming to 1.5 °C [1]. This has led to the recognition of specific efforts such as tripling renewable energy capacity globally by 2030, increased efforts towards the phase-down/out of unabated coal power, and transitioning away from fossil fuels in the energy system. With a share of 30% in global emissions, the role of China’s mitigation pathway is particularly decisive for the overall global climate effort and chances to stay within the limits of the Paris temperature goals. China’s current Nationally Determined Contribution (NDC) aims to have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060 [2]. According to recent analyses [3], China’s CO_2 emissions fell on a year-on-year basis in the second quarter of 2024. This could indicate that China’s emissions could have reached a peaking point in 2024.

Up until 2030, the IPAC model results point to stagnating emissions under current policy[1] efforts, while the IMAGE model results project still increasing emissions (Figure 1). In order to stay within the Paris global goals, China’s policy efforts need to be raised and enacted even earlier. Beyond 2030, both models agree on a declining trend in emissions, indicating a potential emission peaking point around 2030. However, to reach China’s net-zero goal by 2060, not only the moment and level of emission peaking will be crucial, but especially the speed of emission reductions thereafter, enabled by a strong and comprehensive policy framework.

Expansion of renewables and nuclear

According to China’s 14th Five-Year Plan (FYP) on Renewable Energy Development, the renewable energy generation should reach about 29.3 EJ (1 billion tons of coal equivalent) by 2025 [4]. Figure 2 provides an overview of China’s energy mix, according to the IPAC model. As shown in the figure, under the current policies scenario the “FYP” target is projected to nearly be reached, with 28.6 EJ in 2025. The increase in the share of renewables (currently at 32% of total power generation) primarily relies on the expansion of solar photovoltaic (PV) and wind capacities, which have grown substantially since 2020: added capacity of 216 GW for solar PV and 76 GW for wind, leading to an overall level of 1.05 TW, in 2023 [5]. Therefore, China is moving fast towards its solar PV and wind capacity target of 1.2 TW by 2030, and getting closer to reaching its renewable electricity generation share target of 33% by 2025.

In recent years, the expansion of renewables in China has been strongly driven by the declining costs of solar PV and wind power generation. In 2023, the power generation cost of solar PV was 0.021 USD/kWh, which is a 95.5% decrease from 2010 levels. Moreover, the production cost of solar PV modules has reached 0.15 USD/Watt in China in 2023, with a year-on-year decrease of 42% [6]. The modules cost is continuing to decline in 2024, and the levelized cost of electricity (LCOE) of solar PV is currently lower than fossil fuel power generation, providing an economic advantage for manufacturers in China. Similarly, the cost of wind power generation has been reduced by 60% in China during the past decade. Onshore wind power fully achieved grid parity in 2021. The lowest newly installed onshore wind cost reached 0.021 USD/kWh in 2023 in China, while it was 0.047 USD/kWh for offshore wind power generation [7]. Nuclear also plays an increasingly larger role in China’s energy mix as of 2035. IPAC results expect nuclear power capacity to reach 560GW in 2050 under the LTS scenario.

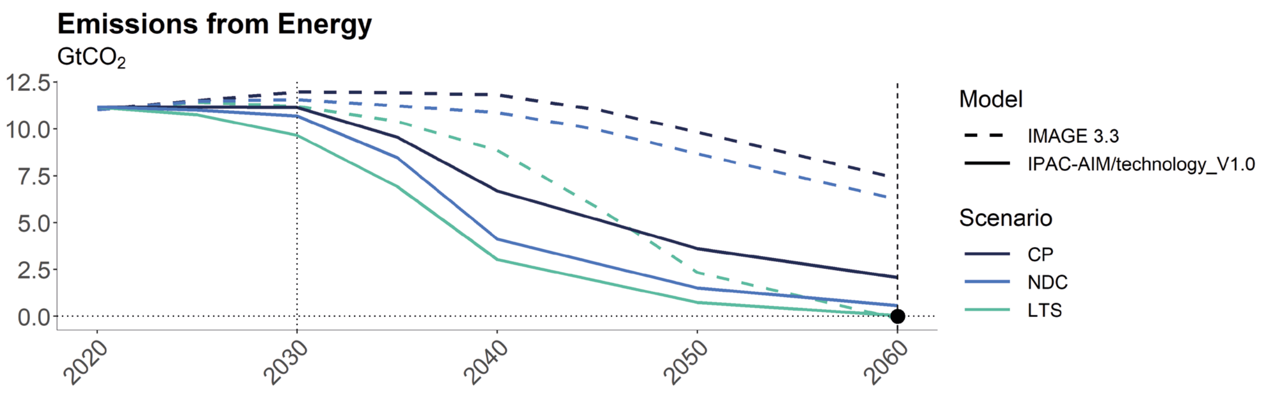

Figure 1: CO_2 emission pathways for China’s energy system under CP (Current Policies), NDC, and LTS (Long-Term Strategy) scenarios, for two models: IPAC-AIM/technology (national) and IMAGE (global). Black dot indicates zero CO_2 emissions for the net-zero year (2060).

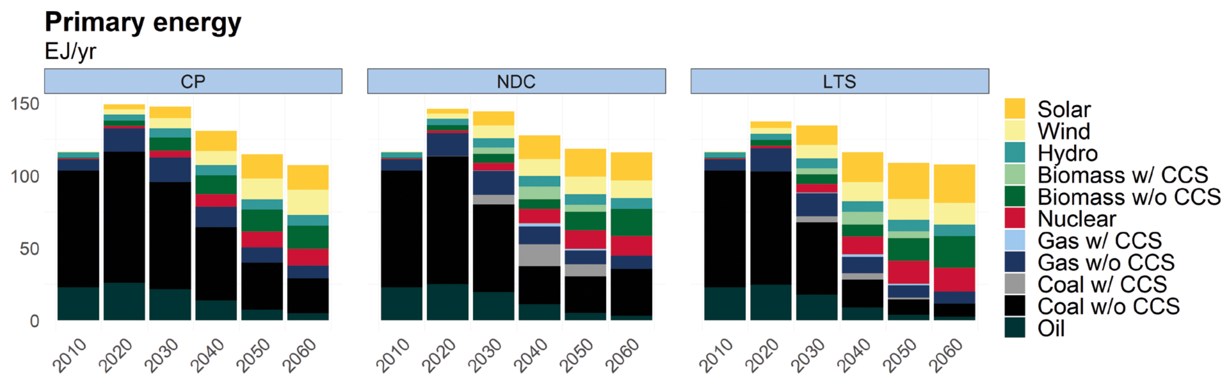

Figure 2: Primary energy demand in China under Current Policies and LTS scenarios (IPAC-AIM/technology model).

The share of fossil fuels is likely to peak around 2025, before total demand peaks in 2030. The expansion of renewables and nuclear power in the energy mix is expected to drive away fossil fuels, especially if the climate commitments, such as the NDC and the carbon neutrality pledges (LTS), are implemented. In such scenarios, the participation of coal, oil and gas is expected to drop below 20 EJ/year.

Key decarbonization strategies

Based on the renewable expansion, the electrification of end-use sectors will be one of the key decarbonisation strategies for China. While the final energy demand is projected to grow until 2030, the electricity share is projected to increase until 2060 in the country. This supports China's ongoing efforts in electrifying end-use sectors, specifically industry, transport, and buildings. In the transport sector alone, sales of new energy vehicles (i.e., electric vehicles, plug-in hybrid vehicles and fuel cell vehicles) in China reached 8.9 million in 2023, accounting for more than 60% of the global sales [8]. This is due to the declining prices of such vehicles in China, mostly driven by the continued decline in battery costs [9].

Next to electrification, green hydrogen is likely to play a key role in China's climate mitigation pathway. The Medium and Long-term Plan for the Development of Hydrogen Energy Industry (2021-2035) puts forward that annual hydrogen production from renewable energy is expected to reach 100,000 to 200,000 tons by 2025 (14.2 – 28.4 PJ) [10]. According to IPAC's projections, green hydrogen could reach 10EJ in 2050, in the LTS scenario which seems overly positive given the current policy plans and unlikely to reach without a long-term-oriented, economy-wide hydrogen strategy.

Further considerations

Despite the outlined expansion in renewables and decarbonisation strategies in China, fossil fuels continue to play a considerable role in China's energy mix in the near-term. In particular, current coal-based power capacities have been increasing for the past few decades [11] and under current policies no decline is projected. A key factor is the perceived need to guarantee energy security in light of increasing energy demand forecasts until around 2035. However, the reduction in costs of technology of zero-carbon energies makes fossil capacity additions increasingly less viable. Therefore, transition policies bridging the question of energy-security and cost-effective, low-carbon development in China are crucial for setting the near-term (2030/2035) targets, as well as to progress towards the 2060 net-zero target, and ultimately align with the global long-term Paris Agreement goals.

Approach

IMAGE is a recursive-dynamic framework suited for large-scale and long-term (up to the year 2100) assessments of interactions between human development and the natural environment, and integrates a range of sectors, ecosystems, and indicators [12]. IPAC-AIM/technology is a national-scale, linear programming-based, cost optimisation model that takes a bottom-up approach and contains a detailed framework for energy technology selection in the energy-economy-environment system [13].

The scenarios under analysis all follow the Shared Socioeconomic Pathway SSP2 assumptions and scenario design according to the ELEVATE modelling protocol [14].

[1] Current policies are defined as currently implemented policies adopted by governments (through legislation) or non-binding targets backed by effective policy instruments. Ambitions and pledges are not included.

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More information about the COMMITTED project: www.elevate-climate.org/committed

Zhejiang University of Technology (ZJUT) is a research-focused university supported by the Zhejiang Provincial Government and China's Ministry of Education. The Zhejiang Carbon Neutral Innovation Institute, and Zhejiang International Cooperation Base for Science and Technology on Carbon Emission Reduction and Monitoring, under ZJUT, research China's carbon peaking and neutrality strategy. The Integrated energy and environmental Policy Assessment model for China (IPAC) team conducts energy and climate policy analysis, focusing on energy transitions, low-carbon technologies, and emissions. They contribute to projects like China's Climate and Ecological Environment Evolution report and IPCC and UNEP assessments. IPAC is also part of scientific networks like the Integrated Assessment Modelling Consortium (IAMC) and the China Energy Modelling Forum (CEMF).

PBL Netherlands Environmental Assessment Agency

PBL Netherlands Environmental Assessment Agency is the national institute for strategic policy analysis on environment, nature, and spatial planning. It plays a key role in global environmental assessments and develops climate and energy scenarios through the Integrated Model to Assess the Global Environment (IMAGE). PBL contributes to European research projects and international assessments like those by the IPCC, UNEP, and the Global Land Outlook. It is part of networks like the IAMC, GCP, and EMF, and provides climate policy advice to the European Commission and the Dutch government.