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# A High Ambition Coal Phaseout in China:

## Feasible Strategies through a Comprehensive Plant-by-Plant Assessment

### Summary for Policymakers



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# A High Ambition Coal Phaseout in China:

## Feasible Strategies through a Comprehensive Plant-by-Plant Assessment

### Summary for Policymakers

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by

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When managing today's energy, environment, and climate issues, China faces two critical energy challenges—and if approached creatively, the solutions to these challenges will benefit billions of people both within China and the world. The first challenge is to ensure that decades of progress in improving peoples' lives will continue with rapid and vigorous actions to restore better air quality within China. The second challenge is to utilize China's important role in combating global climate change to ensure that climate and energy actions around the world will allow us to succeed in reaching the ambitious and essential goals embedded in the Paris Agreement.

Perhaps the single most important near-term strategy across the world to address climate change is a rapid shift away from unabated coal-fired power in the global energy system and a corresponding shift toward non-emitting sources like renewables. As the world's largest coal user by a wide margin, China has a critical role in a successful global transition toward our shared sustainable future. The world today cannot reach its shared climate goals without a broad and rapid global phaseout of coal—which includes a rapid phaseout in China.

At the same time, a successful energy transition in China would also contribute fundamentally and significantly to China's own development priorities. A transformed economy in China is possible already today—and an economy that is no longer dependent on coal is cleaner, healthier, more sustainable, and most importantly, has a larger technological, educational and economic potential.

And progress in China is accelerating. Through successful implementation of the 12<sup>th</sup> and 13<sup>th</sup> five-year plan, China has already reversed growing coal consumption, cancelled and suspended a large number of new coal power projects, and made significant progress towards reducing local air pollution from existing coal power plants, by implementing ultra-low emission policy targets. While these steps demonstrate the effectiveness of current policies and the economic and public health benefits that come from continued phaseout, the current pace of China's coal transition remains insufficient to meet global climate and sustainability goals.

**Today it is clear that, for a 1.5°C or 2°C compatible pathway, the pace of coal retirements in China will have to increase to see a rapid phaseout of most conventional coal-fired power plants once they reach a 20- or 30-year lifetime. This report details how such a pathway can be achieved in a systematic way that allows an appropriately paced retirement strategy for individual plants that simultaneously maintains power stability and economic and social security.**

**A feasible strategy based on detailed, systematic assessment of priorities**

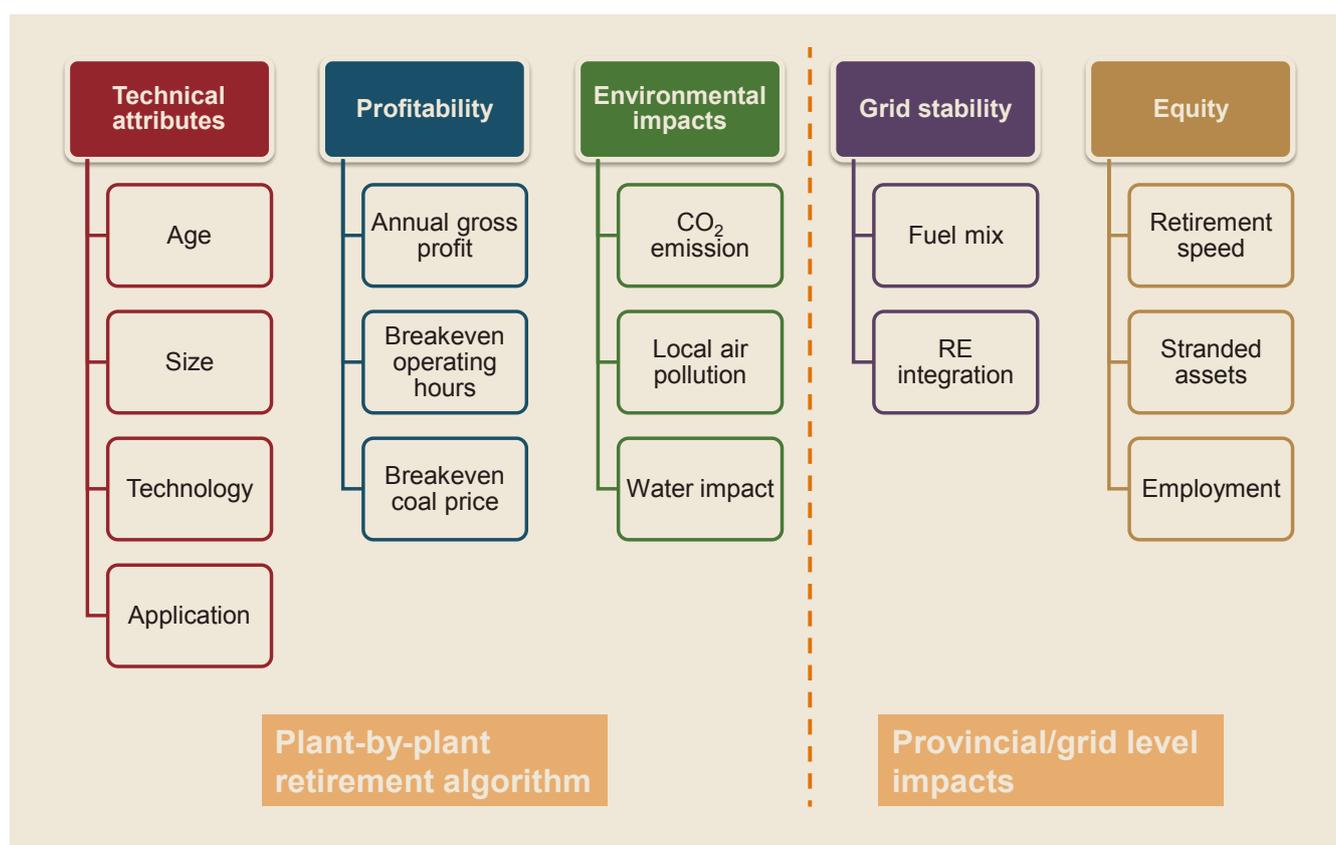
China's emerging leadership role as one of the world's largest economies extends to its leadership on climate change. China is serious about climate action. President Xi recently reaffirmed China's commitment to meeting the targets pledged in its Nationally Determined Contribution (NDC). China is now facing a critical moment and opportunity to introduce more stringent near-term goals in line with new science, enhance its climate ambition post-2030, and develop an actionable mid-century strategy for climate change mitigation and its energy system transition. The key component of this is how China can achieve deep decarbonization and carbon neutrality in power generation by phasing out coal by 2050 or earlier to support the Paris goals. Achieving that goal within the next 30 years will be an unprecedented challenge, raising questions of whether such a high-ambition pathway is truly feasible.

This report answers that question with an emphatic "yes." This report details how such a pathway can be achieved feasibly, balancing multiple important needs. In doing this, it demonstrates a pathway that allows for an appropriately paced retirement strategy for individual plants and simultaneously maintains power stability and economic security. It uses a comprehensive and systematic approach to guide a sustainable coal phase-out in China and lays out a roadmap for policymakers and stakeholders.

To do this, we first establish a five-dimensional framework for prioritizing the retirement of individual Chinese coal-fired power plants, based on technical attributes, profitability, environmental impacts, grid

stability, and equity (Figure 1). We then apply this evaluation framework to more than 1,000 operating coal plants, 3,000 units in China, we then identify the identifying a small fraction of plants that can easily retire first—the “low-hanging fruit” plants (Figure 2). Next, using the Global Change Assessment Model (GCAM-China) and the Integrated Policy Assessment Model of China (IPAC), we identify long-term emission scenarios consistent with the global 1.5°C and 2°C goals for China

and corresponding coal power generation pathways. We then explore alternative coal retirement pathways based on different phaseout priorities and policy designs (Figure 3). Finally, we evaluate the potential impacts with respect to grid stability, stranded assets, and other equity issues to identify the main challenges and potential policy solutions. This allows us to build out a proposed phase-out strategy that addresses the balance of demands at national, regional, and local levels.



**FIGURE 1.** Multiple metrics are used to quantify each of the five dimensions.

Technical attributes, profitability, and environmental impacts are used to develop the plant-by-plant retirement algorithm; while grid stability and equity, are complex issues and are evaluated at the more aggregate levels to explore potential impacts. Each dimension is assessed through a number of metrics.

### Key Findings

This report demonstrates how a rapid coal phaseout is now possible for China. Our key findings show:

- China can achieve a 2°C compatible coal power phase-out by 2050-2055 with little economic impact. A more ambitious 1.5°C phase-out by 2040-2045 is also feasible with a carefully designed retirement plan and a financial compensation mechanism.
- Any new construction of conventional coal plants is not in line with China's long-term deep decarbonization pathways. A total of 121 GW of coal plants are currently under construction and 74 GW planned, in addition to the 160 GW suspended. Building these new coal plants would largely increase the risk of stranded assets and shorten the lifetimes of all coal units.
- We identified 18% of existing power plants, or a total of 112 GW of capacity, as low-hanging fruit that need a rapid retirement in the near-term. These plants often have operated for more than 10 years, have a smaller size less than 600 MW, and use the less efficient subcritical combustion technologies. Self-use plants have a larger share identified as low-hanging fruit than power only and CHP plants. Across provinces, more than 60% of these plants, a total of 68 GW, are located in Shandong, Inner Mongolia, Henan, Hebei, Jiangsu and Shanxi. Moreover, Hebei, Heilongjiang, Shanghai, and Shandong have a larger percentage, more than 20% of capacity, identified as low-hanging fruit.
- The roadmap for retirement compatible with a well-below-2°C goal is based on an immediate halt to new construction of conventional coal plants, near-term retirement of low-hanging fruit, and then a gradual retirement of remaining plants based on their retirement rank score but with a minimum operational lifetime of 30 years. Applying this guaranteed lifetime will lower the average operating hours from today's 4,350 hours to 3,750, 2,500, and below 1,000 hours in 2030, 2040 and 2050, respectively, if not retrofitting for CCS.
- The roadmap for retirement compatible with a 1.5°C goal reduces the guaranteed lifetime to 20 years. Operating hours on average will decline to 2,640, 1,680 and zero hours in 2030, 2040, and 2045, respectively. Plants that want to operate at longer hours or continue operating beyond the phase-out schedule will need to be equipped with CCS, which, however, may not be viable for about 86 GW of early retired coal plants in Guangdong, Fujian, Guangxi, and Hainan provinces due to lack of onshore storage capacity.
- Compared to alternative policy design, the retirement roadmaps described above with the guaranteed lifetime of coal plants lower total stranded assets to about 241 billion yuan (~\$34 billion) under 1.5°C and 65 billion yuan (~\$9.3 billion) under well-below-2°C. However, the trade-off for the avoided stranded assets is that the coal plants will earn less profits during the operation period due to reduced utilization, by 451 billion yuan (~\$64 billion) under 1.5°C and 357 billion yuan (~\$51 billion) under well-below-2°C. Across provinces, stranded assets are highest in Shandong, Xinjiang, Inner Mongolia, Shanxi, and Henan.

### Principles of A Successful Strategy

These results speak clearly that rapid coal phaseout in China is possible, at a critical juncture where the world is looking to China for leadership in the global economy, on the clean energy transition, and on climate change. A successful and feasible strategy based on these the insights from this report can be implemented based on three principles:

1. **No New Coal.** Successful implementation of the 2°C- and 1.5°C-compatible coal phaseout pathways proposed in this report depends on an immediate halt to new construction of conventional coal plants in China. Deciding not to build planned or under-construction plants will avoid stranding valuable investments and will give existing plants more flexibility to phase out at an appropriate pace.
2. **Eliminate the Laggards.** We identify a small set of existing units that are eligible for faster shut-

down based on multiple technical, economic and environmental criteria—for example, they are old, small, inefficient and dirty.

3. **Guaranteed Lifetime.** Remaining existing units can be offered a guaranteed lifetime with gradually and responsibly reduced hours. The proposed pathways are designed for a gradual retirement that gives time to install new generation and modernize the electricity grid to take on a greater share of wind and solar. A phaseout is based on multiple assessment criteria such as energy stability of the grid, minimizing provincial economic disparity, and providing immediate health benefits to citizens.

### Complementary Policies

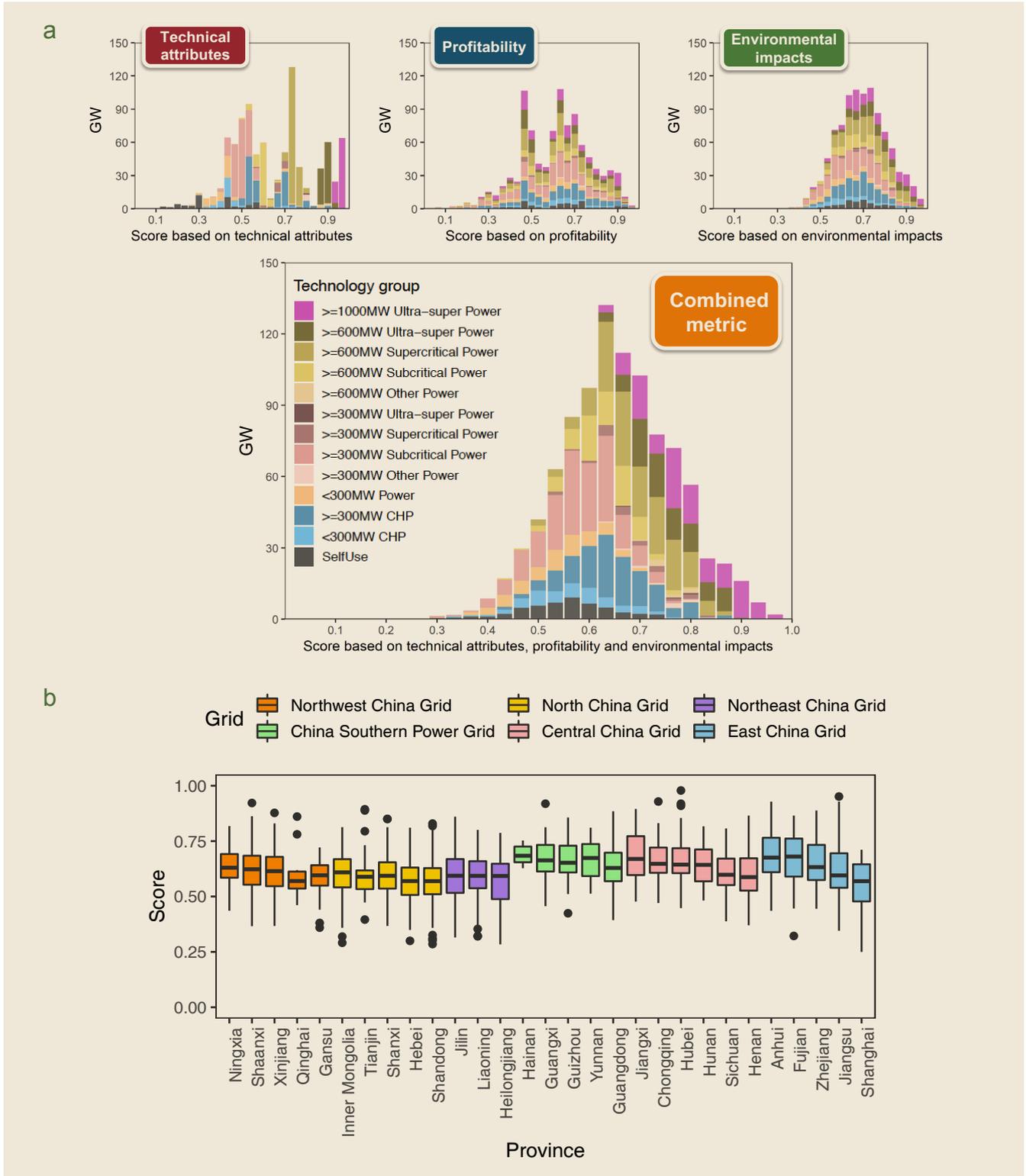
Achieving this impressive and feasible goal will require strong partnerships and new policy from the government. Entering the 14<sup>th</sup> five-year plan period (2021-2025), implementation of this phase out will require near-term conversations and decisions on implementation of a set of complementary policies.

**Transition financial support.** Providing financial support and other compensation mechanisms may facilitate reduced electricity generation. With the guaranteed lifetime, most of the existing Chinese coal plants can operate over the designed lifetime of 30 years for a 2°C pathway, and get initial investments paid back by running for 20 years for a 1.5°C pathway. Under such a strategy, the main drivers of potential economic impacts to plants are operating at reduced hours and/or not further extending the operation period. When coal plants running at reduced hours to support large-scale renewable energy in the system, a limited-duration subsidy or load-adjusting price may in certain circumstances be appropriate, as has been seen in other countries. Any such financial compensation mechanism should be limited to currently existing plants to discourage new construction.

**Continued Market Reform.** Ongoing power sector reforms and switching to market-based dispatch mechanisms is a key component of this transition. Market-based dispatch will support accelerated renewable generation by allowing the most cost-competitive resources to be prioritized. Meanwhile, it would remove the hidden protections that have shielded the coal plants from unfavorable market conditions and policy signals that would otherwise have shut them down.

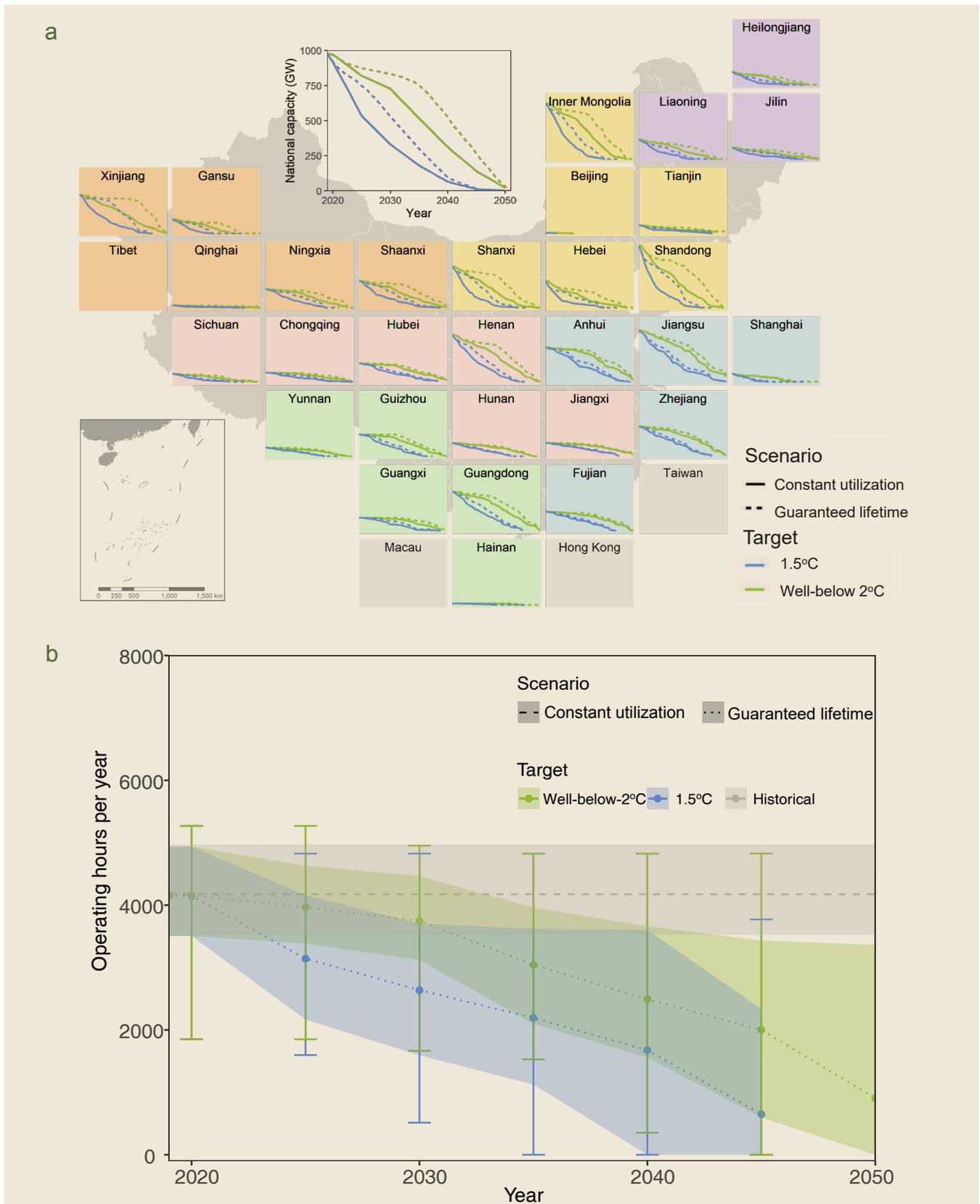
**Grid Planning and Modernization.** China has a mismatch of renewable resources in the north and west that are distant from the high energy demand regions in eastern coastal provinces. Long-distance and ultra-high voltage (UHV) transmission technologies are potentially part of the solution, but after a decade of fast development, UHV lines have not performed as expected. Moreover, accommodating a large amount of intermittent electricity from wind and solar would require substantial grid management and forward planning. In the long run, modernizing grid transmission and distribution, developing next-generation storage and other flexibility technologies, and deploying demand-side management technologies are promising but will require additional investments and R&D resources from both the public and private sectors.

China's long-term development strategy is highly consistent with the global agenda and the long-term climate goals. Although it is not yet clear what China's long-term climate mitigation strategy might look like exactly, the political environment has changed significantly in the past few years. It shows that China has chosen to move towards these pathways. In this light, China has great potential to eventually achieve these goals through a structured and rapid coal retirement plan.



**FIGURE 2. Combined retirement rank score of existing coal plants.**

(a) The combined score is based on the equal-weighted average of dimensional scores of technical attributes, profitability, and environmental impacts. The combined score, from zero to one, ranks all operating plants from first to last for retirement. Overall, plants to retire first are older, smaller, less efficient, self-use plants located in highly air polluted and water scarce regions. (b) The ten provinces with the lowest combined scores are Shanghai, Shandong, Heilongjiang, Hebei, Gansu, Liaoning, Shanxi, Jilin, Qinghai, and Henan.



**FIGURE 3. National and provincial phaseout pathways and gradually reduced operating hours under a guaranteed lifetime scenario.**

(a) Compared to the constant utilization scenario, national retirement pathways are delayed by about 5 years; regional impact varies largely across provinces. (b) Due to the delayed retirement of coal plants, remaining capacity must operate at gradually reduced hours.



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