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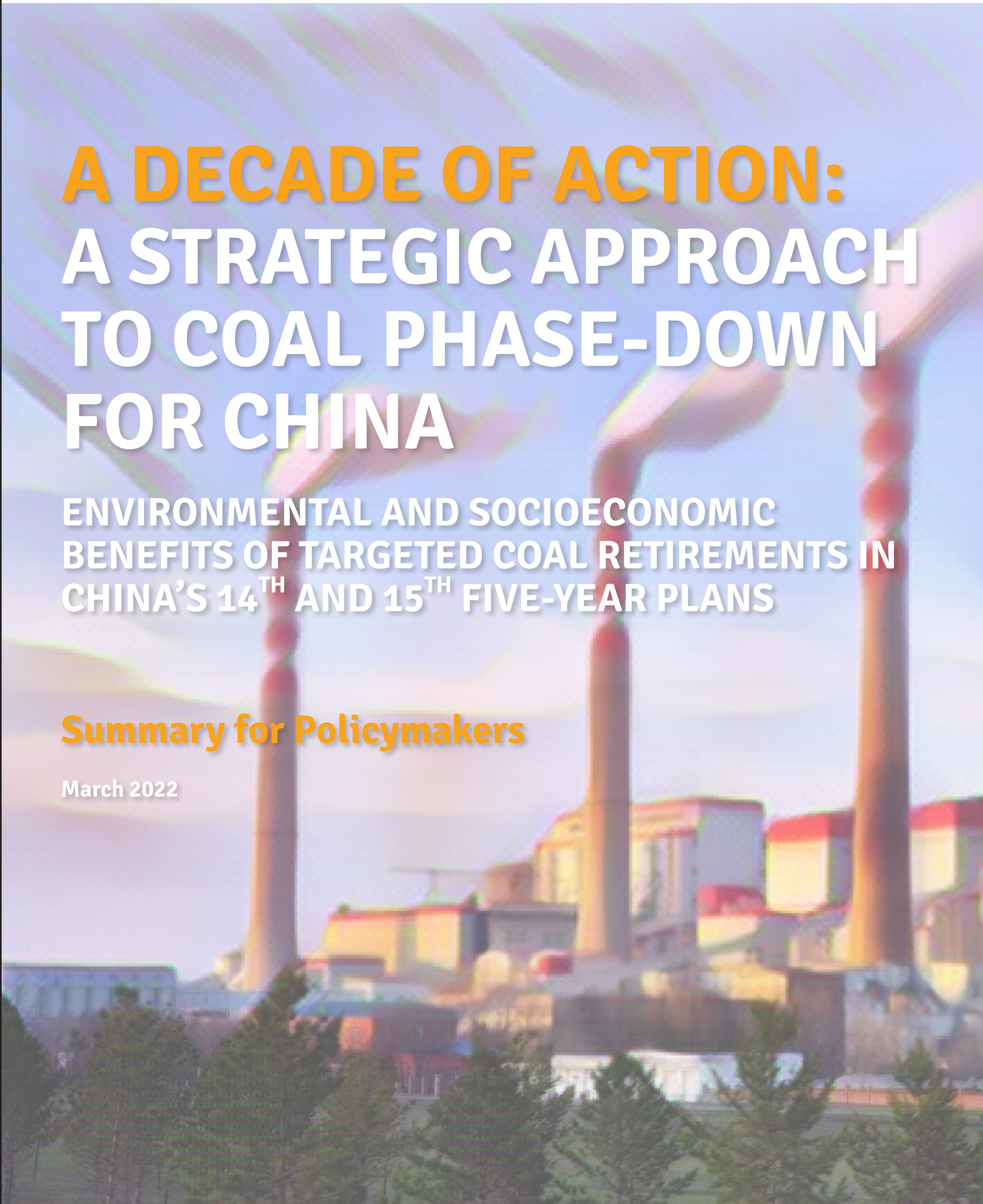

A DECADE OF ACTION: A STRATEGIC APPROACH TO COAL PHASE-DOWN FOR CHINA

ENVIRONMENTAL AND SOCIOECONOMIC BENEFITS OF TARGETED COAL RETIREMENTS IN CHINA'S 14TH AND 15TH FIVE-YEAR PLANS

Summary for Policymakers

March 2022

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THE CENTER FOR GLOBAL SUSTAINABILITY (CGS) at the University of Maryland utilizes a collaborative, interdisciplinary approach to deliver research, education, and engagement for policy impact. Launched in 2016, it features a core team of twelve leading scholar-practitioners and over 25 staff, students, and affiliates with an annual budget of roughly $3 million. Through analysis for ambition and collaborative action, CGS is helping drive the global engine of ambition critical to meet goals related to climate, development, and sustainability. We do this by integrating field-leading research, applied assessment, and policy analysis; and implementing it through partnerships and engagement at all scales.

About the California-China Climate Institute:

THE CALIFORNIA-CHINA CLIMATE INSTITUTE (CCCI) was launched in September 2019 and is a University of California-wide initiative housed jointly at UC Berkeley's School of Law (through its Center for Law, Energy, and the Environment) and the Rausser College of Natural Resources. It is chaired by Jerry Brown, former Governor of the State of California, and vice-chaired by the former Chair of the California Air Resources Board Mary Nichols. The Institute also works closely with other University of California campuses, departments, and leaders. Through joint research, training, and dialogue in and between California and China, this Institute aims to inform policymakers, foster cooperation and partnership, and drive climate solutions at all levels.

About the Renewable and Appropriate Energy Laboratory:

THE RENEWABLE AND APPROPRIATE ENERGY LABORATORY (RAEL- HTTP://RAEL.BERKELEY.EDU) is an interdisciplinary energy and systems science and policy research center based in the Energy and Resources Group (ERG - http://erg.berkeley.edu) and in the College of Engineering. The director, Daniel M Kammen is the James and Katherine Lau Distinguished Professor of Sustainability at the University of California, Berkeley, and Chair of ERG.

SUMMARY FOR POLICYMAKERS

A successful transition away from coal to clean energy is the central pillar of China's strategy to achieve carbon neutrality before 2060—and will be critical to keep a global 1.5° Celsius (C) pathway within reach. Yet recent trends are raising uncertainties for the critical period of 2020-2030 and even diverging from what is needed to achieve China's own internal goals embedded in the five-year plans. A feasible and practical strategy to address this can be driven by the existing five year planning processes and policy priorities, to carefully structure an orderly phase-down of coal coupled with feasible levels of accelerating renewable energy, energy efficiency, transmission, and load balancing.

Recent high-level policy statements from China have highlighted its willingness and interest to initiate a transition in its own economy in support of these global and national goals. Framing its overall trajectory are its latest Nationally Determined Contribution (NDC) and Long-Term Strategy (LTS), which signal China's intent to achieve carbon emissions peaking before 2030 and carbon neutrality before 2060. The more detailed action plans in the "1+N" policy framework provide a process for elaborating strategies to implement these goals. In these plans, for example, China has committed to "strictly control" new coal power projects and coal consumption over the 14th Five-Year Plan (2021-2025) (FYP) period, start to phase it down during the 15th FYP (2026-2030), and stop building coal power projects overseas. Notably, new commitments in the U.S.-China Joint Glasgow Declaration (2021) have also opened the opportunity to accelerate the work of reducing coal consumption.

Yet, despite these broad outlines and signals toward an overall gradual peaking and reduction of coal consumption, increasing policy emphasis on energy stability and security—and associated plans to build new coal power generation capacity and support continued coal production—has created high uncertainty in how China's coal power sector may evolve within this critical decade, and how China will deliver the commitment of a near-term coal phasedown. As a result, China's coal fleet and coal consumption have been growing and appear on track to continue to do so: newly-added capacity in China accounted for about three quarters of total global new builds in 2020 and there were over 200 gigawatts (GW) of new projects under development in China as of July 2021.

Coal transition pathways in support of these goals require a decrease in China's coal power generation by 25-30% between 2020 and 2030. However, current trends are not in line with this target. **Through a comprehensive review of existing policies on coal plant closure, retrofitting, and new builds, we estimate that total coal power capacity may grow by about 158 GW through 2030, with 202 GW of new builds and 44 GW of retirements, and reach 1,237 GW during the 15th FYP. If new early-stage coal power plant builds are canceled, China's coal fleet may still grow to 1,139 GW by the end of the 15th FYP.**

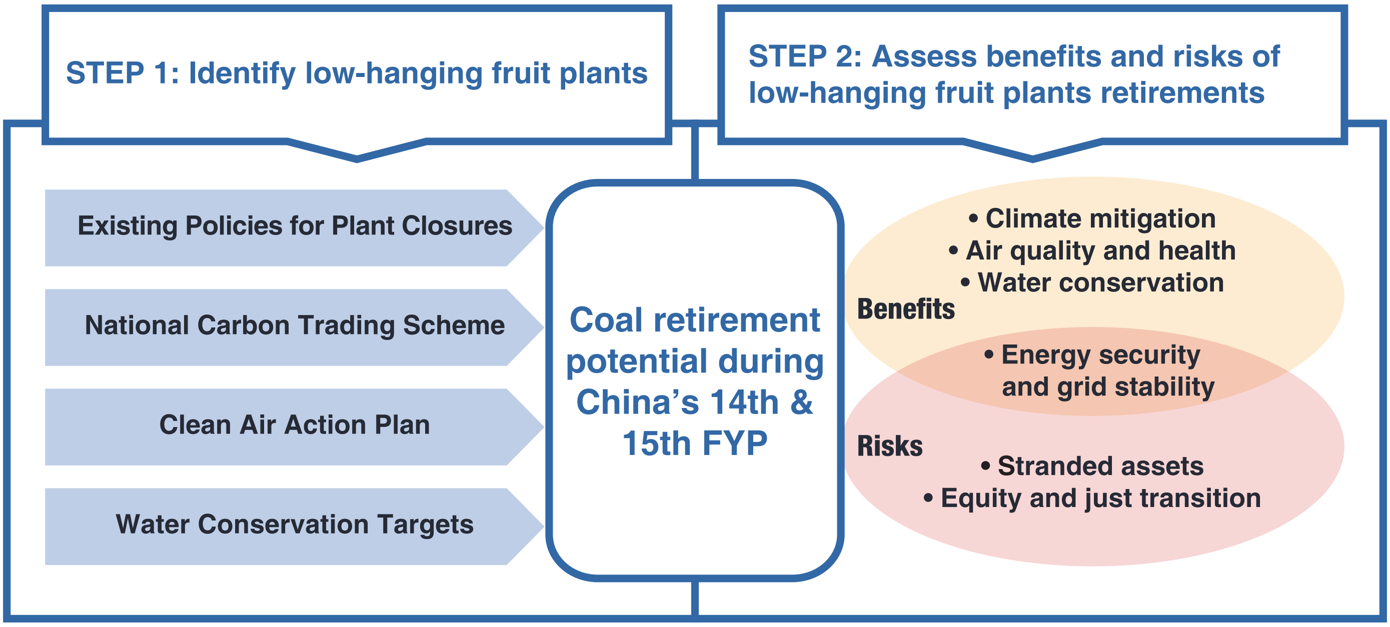
To scale down the coal fleets to be consistent with carbon neutrality and climate goals, it is therefore important to explore the full potential for near-term retirement and assess the broad environmental and socioeconomic outcomes of these retirements. A critical element of a rapid and orderly coal transition strategy is to target a small set of poorly performing, old, small, redundant, or otherwise undesirable plants (what we define as the "low-hanging fruit plants") for rapid retirement in the near term. This strategy not only effectively supports the attainment of other policy goals, but also substantially increases the feasibility and flexibility of the transition plan for the majority of existing coal plants. We ask: ***(1) how much obsolete coal power capacity can be orderly retired through existing policy measures during China's 14th and 15th FYP? and (2) more importantly, what environmental, economic, and social benefits and risks will be brought by the near-term coal retirements through 2030?***

To answer these two questions, we first develop a comprehensive, feasible plan to phase down coal-fired power capacity in China during the 14th and 15th FYP by retiring a small set of low-hanging fruit plants, and then demonstrate the effectiveness and broad social value of this plan by quantifying the large benefits and small risks of the rapid retirements of low-hanging fruit plants through 2030. Combined with rapid renewable deployment, efficiency improvements, and cross-region balancing, the well-structured and targeted near-term coal phasedown can help China achieve a rapid and orderly transformation of the power system in support of the national carbon neutrality goal and the global 1.5˚C goal while maintaining high-quality economic growth with improved human well-being.

Specifically, this near-term coal retirement plan takes into consideration China's existing policies, intersecting policy priorities, and near- and long-term climate commitments. The full retirement potential is explored with additional policy measures— including the National Carbon Emissions Trading Scheme, the Clean Air Action Plan, and the water conservation targets—and other regional priorities and equity concerns (SPM Figure 1). **We find that a total of 203 GW coal power capacity (19.4% of existing capacity) can be targeted for retirements during China's 14th and 15th FYP period (SPM Figure 2 & 3).** Combining the retirements with cancellation of new projects at early development stages, China's total coal power capacity would decrease to 981 GW by 2030. These retirements would bring large reductions in carbon and air pollutant emissions, improvement in average efficiency, large water conservation benefits, low risk in stranded assets, moderate and manageable job losses, and a small impact on the regional grid (SPM Table 1).

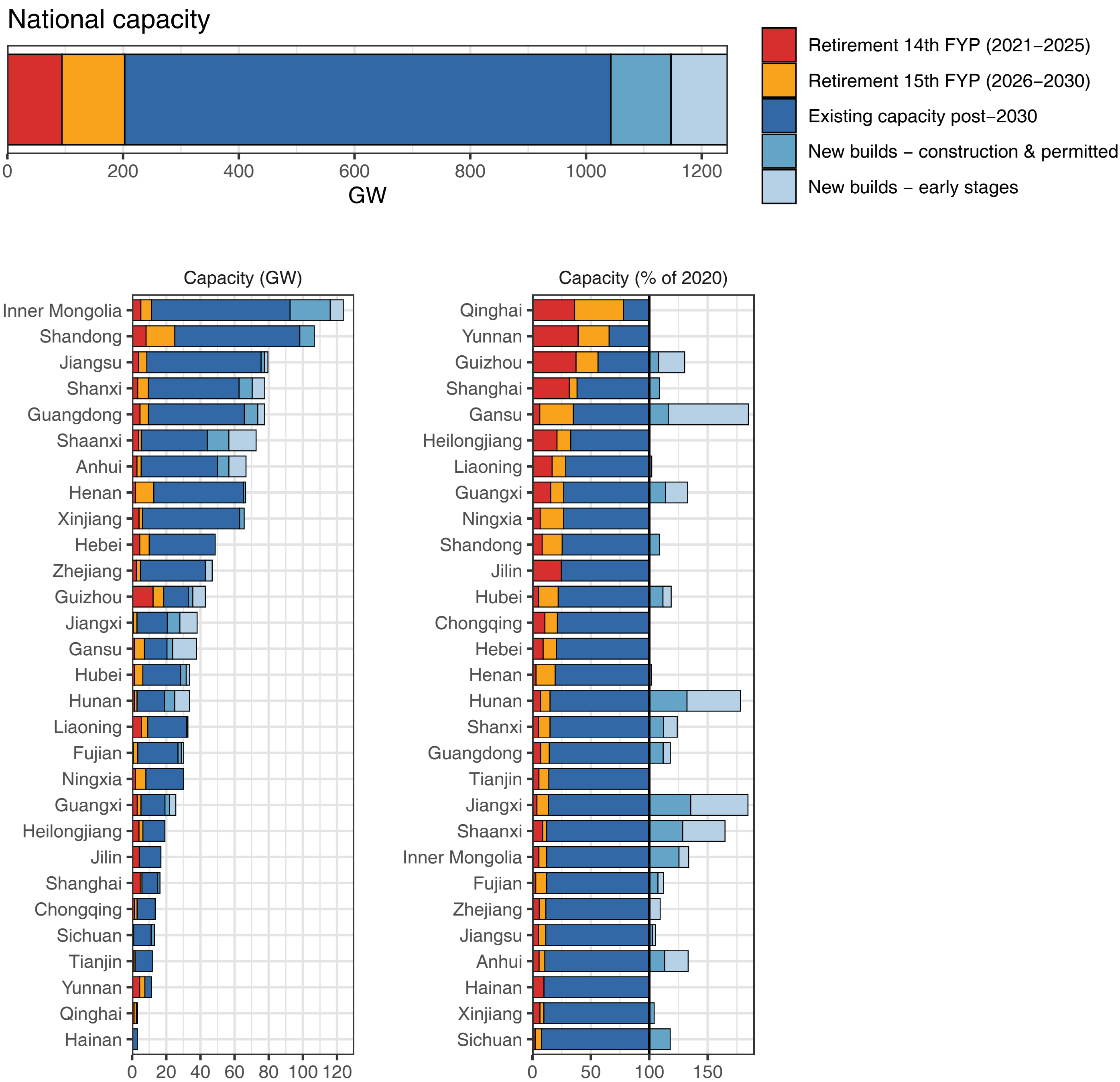
SPM FIGURE 1. Analytical framework of this report.

Identify low-hanging fruit plants for targeted retirements based on 14th & 15th FYP policies, and assess the environmental and socioeconomic benefits and risks of these retirements



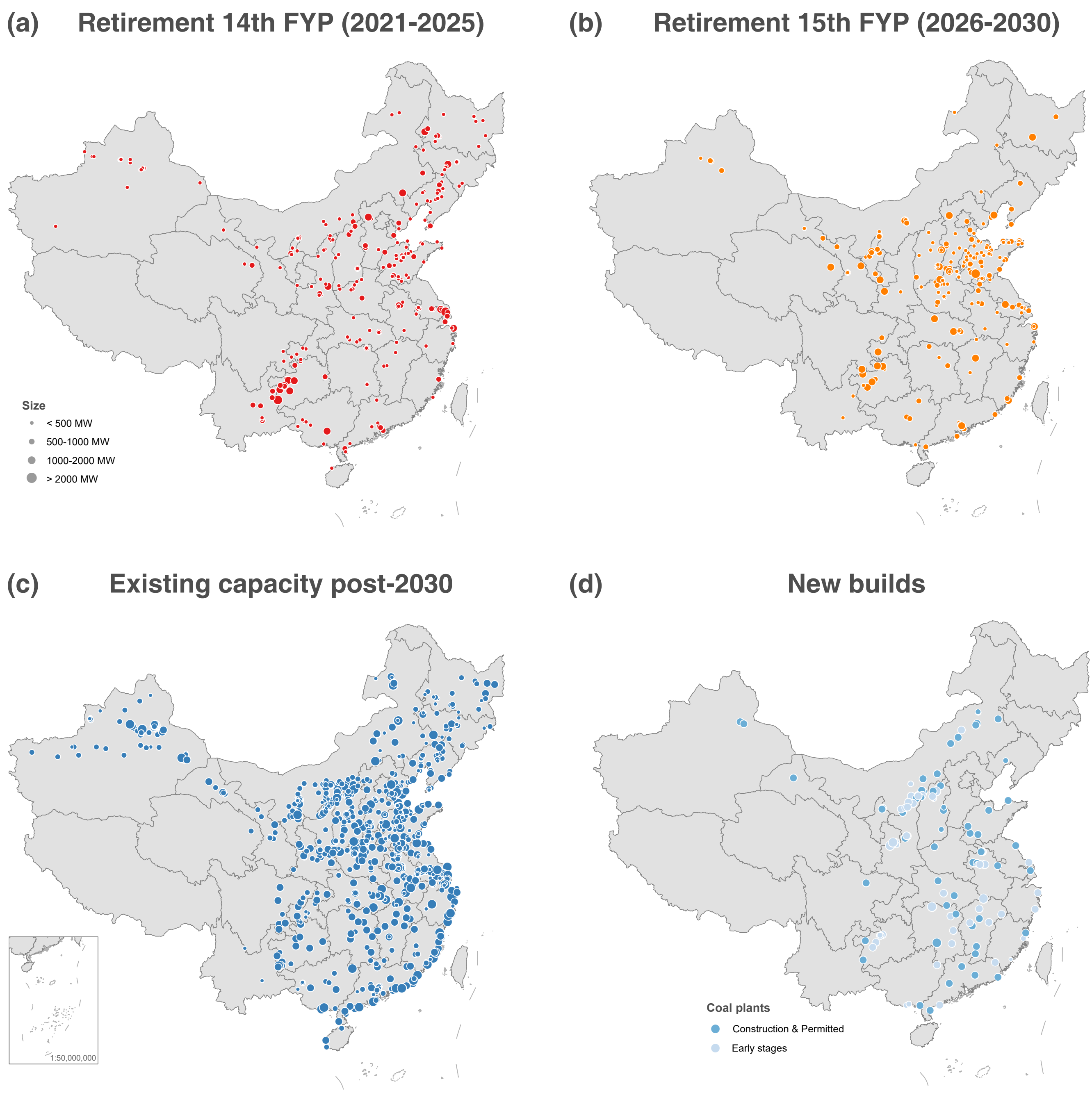
SPM FIGURE 2. National and provincial coal-fired plant retirements, existing capacity, and new builds during the 14th and 15th FYP.

The top bar shows national coal power capacity by different categories; the bottom left bars show coal power capacity by category and by province; the bottom right bars show the percentage of coal power capacity relative to 2020 by category and by province.



SPM FIGURE 3. Location of existing and proposed coal-fired power plants in China.

Locations of the low-hanging fruit plants for near-term retirements (a) during the 14th FYP (2021-2025) and (b) during the 15th FYP (2026-2030), (c) locations of the existing coal power plants remaining post-2030, and (d) locations of potential new builds of projects under construction and permitted, or at early development stages. Retirements are relatively evenly spread out over time and space, and the remaining coal plants are evenly distributed geographically.



There are significant benefits and manageable risks to implementing a practical strategy of phasing down low-hanging fruit plants. As shown in Table 1 below, the environmental, social and economic benefits of coal phasedown are substantial. It reduces coal power carbon emissions by 20.6% from 2020, or cumulatively about 1.2% of the remaining global carbon budget for achieving 1.5˚C (400 $GtCO_2$), a significant reduction with major benefits to the climate. It will lead to cleaner air with 36.6% reductions in SO_2, 29.3% reductions in NO_x and 41.2% reductions in $PM_{2.5}$, compared to 2020 levels, which are the primary causes of air pollution and a serious public health challenge. The plan presented in this report saves 2.3 billion cubic meters (m^3) of water annually, or 23% savings from 2020, an important factor given China's water stress and increasing droughts due to climate change. Closing down small, old, inefficient plants leads to 3.3% improvements in average coal power efficiency, outperforming the stated target.

Our analysis demonstrates that through a strategic and integrated planning process, the risks of phasing down coal become manageable and are clearly outweighed by the benefits. Our analysis considers these risks over time and space to address variations and imbalances across the country and geographic disparities. The shut down of these coal plants leads to the loss of only 5.7% of assets, which is comparatively small. It will lead to job losses of 33% of existing power plant workers, primarily medium- and highly-skilled workers who have transferable skills for working in the growing renewable energy sector. With our suggested retirement schedule, coal generation capacity could be replaced through a combination of new non-fossil generation, energy storage, and investment planning. Furthermore, as coal plants gradually shift from base load to peaking generation to help support an increasing share of renewables on the grid, it may not make economic or environmental sense to retrofit the low-hanging fruit plants for improved flexibility to serve this role.

As local and national governments begin to consider coal phase-down, there are tangible benefits to retiring low hanging fruit plants. These benefits are best realized through a strategic planning approach that considers both existing climate and socio-economic policy priorities and renewable energy needs. China's approach to planning provides a policy mechanism to develop these types of plans and integrate multiple policy goals.

A targeted strategy, which takes a long-term, national and subnational perspective as is presented in this report, provides a mechanism to spread coal retirements relatively evenly across the country and over time. This can proactively reduce shocks and risks for local communities, provinces, and regions to ensure that no area is overburdened. At the same time, it supports the necessary additional investments for building sustainable green economies and supporting workers and their families. It also provides time for the appropriate regulatory, fiscal and technical planning, and implementation for a sustainable energy transition.

This report provides a model for a feasible and practical strategy to phase-down coal to be coupled with accelerating renewable energy, energy efficiency and transmission, and load balancing. The report results offer a way forward and provide ample reasons for this work to start within the next five years. In order for a coal phase-down strategy to become reality, additional planning on the parts of the national and subnational governments will be required.

SPM TABLE 1. Total benefits and risks of the coal retirement during the 14th and 15th FYP*

Benefits		
Carbon emissions reduction in 2030 (% of 2020)		925 $MtCO_2$ (20.6%)
Efficiency improvement from 2020 to 2030		3.3%
Air pollutant emissions reduction in 2030 (% of 2020)	SO_2	143.8 kt (36.6%)
	NO_x	160.5 kt (29.3%)
	$PM_{2.5}$	25.1 kt (41.2%)
Savings of water withdrawal in 2030 (% of 2020)		2.3 billion m^3 (23%)

Risks	
Total stranded assets between 2020 and 2030 (% of 2020 coal plants assets value)	US$25 billion (5.7%)
Total job losses between 2020 and 2030 (% of 2020 coal plants jobs)	293,800 workers (33%)
Reduced power generation from low hanging fruit plants (% of 2020 total electricity)	830 TWh** (11%)

* $MtCO_2$: million metric tons of carbon dioxide; kt: metric kiloton; TWh: terawatt-hour; m^3 : cubic meters. SO_2: sulfur dioxide; NO_x: nitrous oxide; $PM_{2.5}$: fine particulate matter 2.5 microns in width.

** Note: Newly-installed solar and wind generation from 2021 to 2030 is estimated to be 2150 TWh.

Chinese national and subnational governments could begin implementation with the following steps:

1. Drawing on the report results, conduct a plant-level review to identify an early retirement schedule and strategy.
2. Combine this strategy with an analysis of renewable energy, grid, storage and transmission investment and fiscal planning to fund these investments and to replace any lost tax revenues.
3. Building on the estimates provided here, evaluate the job losses and their composition at the county level, and provide dedicated fiscal and capacity-building support for actions such as job training for impacted workers.

Through a strategic approach, the analysis presented here contributes to meeting China's long term policy objectives of reaching carbon neutrality, becoming an ecological civilization, and supporting China's social and economic development. In the short-term, it advances multiple intersecting regional policy goals for water management and air quality with rippling benefits for adaptation to climate risks and public health. Through phasing-down coal, China can meet its goals, be a model to demonstrate a pathway for countries and regions facing similar challenges in their transition, and support global climate efforts.