

TRENDS AND CONTRADICTIONS IN CHINA'S RENEWABLE ENERGY POLICY

BY ANDERS HOVE
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China is the world's leader in wind and solar power, although new capacity is being added more slowly than several years ago. Meanwhile, a wave of coal power plant approvals and fewer public mentions of urban air pollution and climate change have raised questions about the future of China's renewable power sector in the wake of Covid-19.¹

In this essay, I examine China's recent energy policy announcements and their implications for the 14th Five-Year Plan, which will set energy policy for the period from 2021–2025. I argue that the future of renewable energy deployment in China will be shaped by an ongoing contradiction within the power sector between long-term market-oriented reforms on the one hand and short-term administrative planning on the other. This contradiction is well represented in two draft laws issued in April and June 2020: the draft Energy Law and the draft Guiding Opinion on Establishing a Clean Energy Consumption Long-Term Mechanism. The former states that the country should prioritize development of renewable energy by opening the market to more players, while the latter puts grid companies, provincial officials, and incumbent generation companies in charge of all aspects of planning and target-setting.

The ways in which this contradiction will be resolved are unclear. China's central government remains focused on promoting markets in the longer term, in part based on market models that have worked in Europe and the US, so international lessons and experiences could play a role. China's power reform could benefit from a greater focus on including consumers and other market players, and greater emphasis of long-term over short-term planning. Such a shift would help ameliorate the current trend of over-investment in unneeded and uneconomic coal capacity at the expense of renewables.

Background

China leads the world in terms of total installed wind and solar capacity, as well as in annual installations of wind and solar. These two sources combined provided around 9 percent of China's total electricity generated in 2019, a proportion that has grown by about 1% each year.² China continues to add wind and solar power capacity, but below their peak rates: for example, wind installations in 2019 were 26 gigawatts (GW), versus a peak installation of 33 GW in 2015, and photovoltaic (PV) installations in 2019 were 30 GW, down from a peak of 53 GW in 2017.³ A June 2020 guidance on energy security jointly issued by the National Development and Reform Commission (NDRC) and the National Energy Administration (NEA) mentions a 2020 target of

240 GW each for wind and solar PV, implying additions of 30 GW of wind and 36 GW of solar in 2020—in other words, stable or moderate growth for these sources.⁴

The peak and decline of wind and solar installations relates mainly to less generous subsidy policies.⁵ In the early period of wind and solar development in China, the country experienced boom and bust cycles — with booms due to declines in wind and solar capital costs that outpaced adjustments to administratively set feed-in tariffs and busts following downward revisions in feed-in tariffs. Unexpected installation booms that led to deficits in the fund used to pay for subsidized feed-in tariffs also raised issues for both developers and policy makers.⁶ Such funds are derived from surcharges on retail electricity sales, and the government stopped increasing these surcharges after 2016.⁷

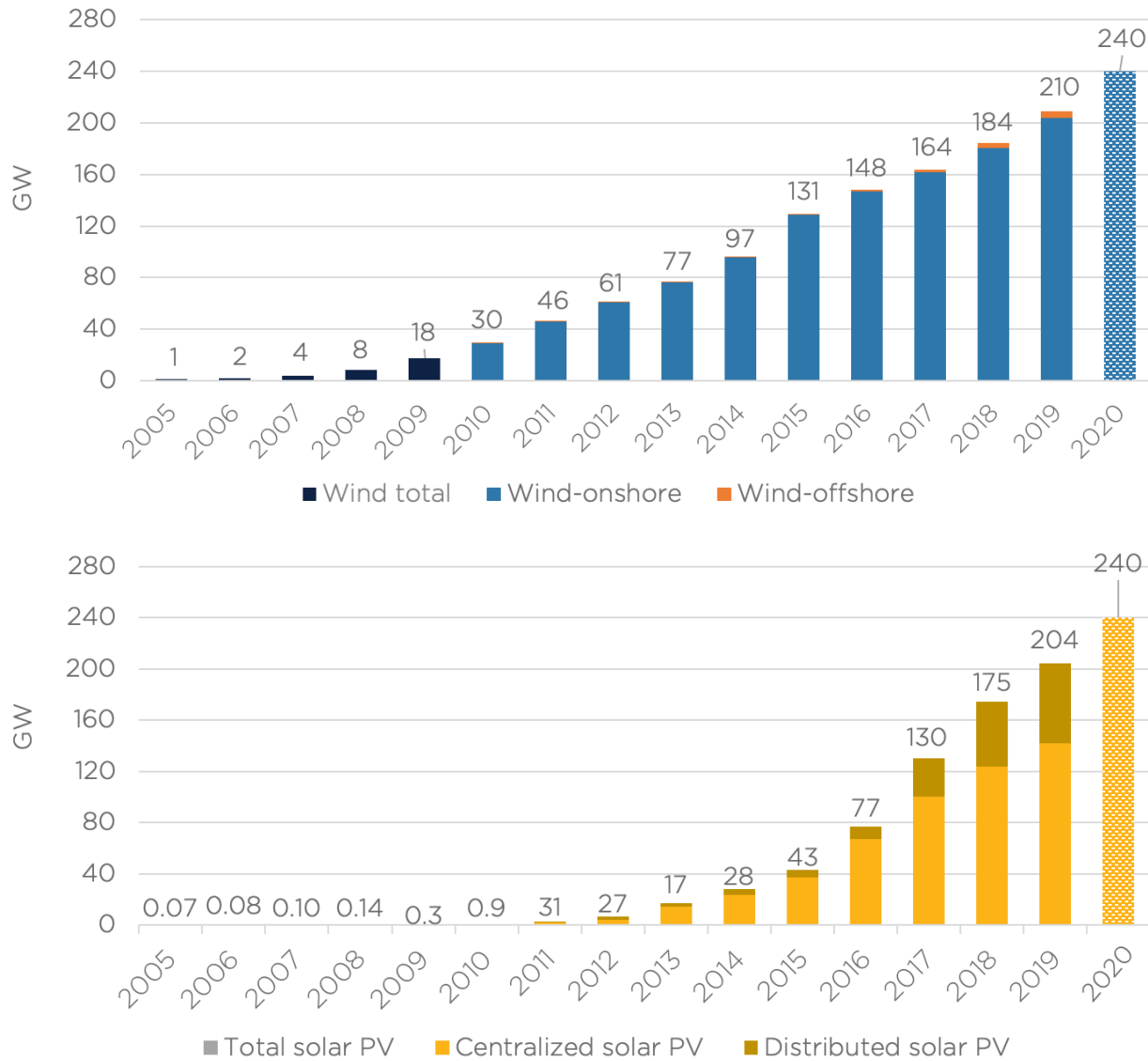
Policy makers increasingly require wind and solar to compete with coal on an unsubsidized basis. In 2018, the NDRC, which has overall responsibility for regulating electricity prices, signaled that wind and solar feed-in tariffs would be phased out completely by around 2020.⁸ In mid-2018, a sudden announcement that no further quotas would be available for solar feed-in tariffs led to a sharp drop in solar installations;⁹ that market has only partially recovered. For 2020, project approvals for any facilities that benefit from feed-in tariffs must be strictly controlled and limited to the anticipated increase in surcharge funds, which rise in proportion to electricity demand growth.¹⁰ Since January 2019, a new category of wind and solar projects, known as grid parity projects, have been granted fixed 20-year contracts provided the price is at or below the local coal tariff and provided planners consider that the provincial grid has sufficient ability to absorb the new renewable capacity.¹¹

Shift in Focus to Output and Consumption Rather Than Capacity Additions

Analysts often focus on GW of new additions as the main indicator of the transition to renewable energy, and Chinese energy planners had traditionally relied on administratively set capacity targets to guide the country's energy sector, including renewable energy. During the period of the 12th Five-Year Plan (2011–2015), the target for total 2015 solar installations was adjusted upwards five times from 2011 to 2013, from 5 GW initially to 35 GW. Because feed-in tariffs were adjusted infrequently and may not have kept pace with declining costs, installations handily exceeded even these targets,¹² creating a sense of euphoria in the industry. For the 13th Five-Year Plan, however, capacity targets were set at modest levels and not revised upward. By mid-2017, solar had already surpassed the 110 GW target for 2020, and wind exceeded its target of 210 GW in 2019.



Figure 1: China wind (top) and PV (bottom) capacity from 2005–2019, and target for 2020



Source: Various sources¹³

The 13th Five-Year Plan for the first time established energy generation targets for wind and solar, underlining the importance placed on integrating renewable energy rather than just building new plants: The target for wind was set at 420 TWh, and the solar target at 150 TWh.¹⁴ Wind is on track to meet this target in 2020, whereas solar surpassed its electricity production target in 2018.

Instead of spurring ever more renewable capacity, policy makers have come to focus more



on resolving persistent problems that impede the efficient integration of renewable energy. One metric of the renewable integration problem is known as the *curtailment rate*, defined as the percentage of electricity from wind or solar that could have been produced but which the grid would not accept. Overbuilding of wind and solar in remote regions with inadequate transmission was one issue, but many analysts considered physical barriers less important than those related to China's institutional and regulatory systems.¹⁵ Grid companies did not have to compensate renewable energy producers for curtailed energy and were responsible for upholding fixed annual operating hours contracts with coal generators.¹⁶ Many coal plants also serve as combined heat and power plants, providing local district heating in winter, another cause of inflexibility.¹⁷

Policy makers recognized that the goal of removing subsidies for wind and solar would be difficult if curtailment were left unresolved, given that curtailment reduces revenue and hurts overall project economics. The solution has been a combination of market-oriented reforms and administrative measures.

Four measures have played a role in resolving the country's renewable integration challenges:

1. **Guaranteed consumption of renewable energy:** China's Renewable Energy Law initially guaranteed full purchase of renewable energy, but in practice dispatch did not prioritize renewable sources. In 2016, China reiterated the requirement for full purchase of renewable energy and issued minimum dispatch quotas for provincial grid companies. Subsequently, in 2018, these requirements were reemphasized and strengthened. Guaranteed purchase amounts are set based on provincial capacity factors, which in turn depend on local wind and solar resources.¹⁸
2. **Binding targets for reducing curtailment:** In 2018, national energy authorities established a rule stating that provinces should basically resolve curtailment by 2020. Provinces were compelled to develop plans to reduce curtailment to below 5 percent by that year.¹⁹
3. **Compensation of curtailment:** The initial Renewable Energy Law and subsequent feed-in tariff for wind and solar were unclear as to whether wind and solar would receive compensation for all energy they could produce or only for the energy accepted by the local grid.²⁰ In practice, curtailed electricity production was not compensated, marking a difference between China's energy system and that of Germany, whose feed-in tariff China largely imitated.²¹ In 2016, China issued Rule 625, mandating compensation for curtailed energy,²² and in late 2019 the NDRC reiterated that such compensation was mandatory.²³ Clarifying that grid companies would bear the cost of curtailment introduced real, systematic economic incentives to reduce curtailment.
4. **Generation rights trading:** In the past, coal plants were generally dispatched under fixed monthly and annual operating hours contracts. Gradually, these have been replaced by monthly and annual bilateral power purchase contracts, but the principle of maintaining dispatch plans on a monthly and annual basis, thereby providing coal plant owners with certainty on revenue, has remained. Allowing these plants to receive compensation from other plants in exchange for generation hours has incentivized



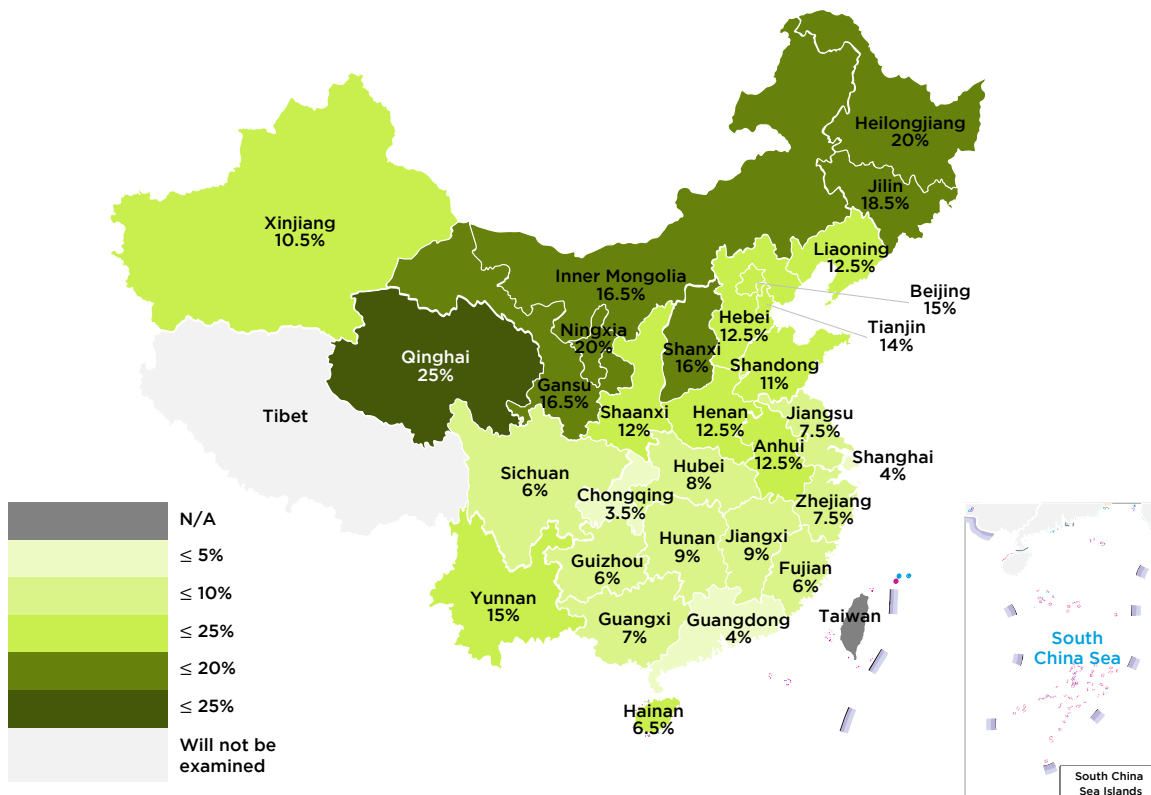
generators to accept dispatch on a more economic basis. Trading of generation rights between provinces has allowed marketing of renewable energy that would otherwise be curtailed.²⁴

As a result of these measures, wind curtailment has fallen from a peak of 17 percent in 2016 to 4 percent in 2019, while solar curtailment has fallen from 11 percent in 2015 to 2 percent in 2019.²⁵ Wind production has doubled since 2015 and solar production has grown by a factor of five in the same period.²⁶

Policy makers also introduced a variety of measures that could contribute to greater uptake of renewable energy by consumers. These include a 2018 release of the Clean Energy Consumption Action Plan; voluntary green certificates for purchase by companies or individuals in 2017; and a renewable obligation for provinces, grid companies, and large energy consumers.

- The NDRC published the Clean Energy Consumption Action Plan in December 2018, stating a goal of “basically resolving clean energy integration problems by 2020” and setting targets to reduce wind and solar curtailment below 5 percent in all provinces by that date. It outlines the responsibility of grid companies to improve grid infrastructure and fully act as a resource allocation platform. The plan also calls for “prioritization of models for clean energy green consumption,” specifying that “renewable consumption obligations should be extended to electricity consumers; grid companies and electricity retail companies should introduce green electricity packages; and end-users should be encouraged to take up clean energy.”²⁷
- On July 1, 2017, the NEA launched a voluntary green certificate market, mainly to reduce the government’s subsidy payment obligation by persuading corporates or individuals to purchase the certificates, which transferred the subsidy obligation for existing projects rather than creating a market for projects that would provide additional renewable energy beyond that already existing. For this reason, the green certificate market never took off.²⁸
- The renewable obligation (RO) went through three drafts in 2018 before adoption. China’s RO specifies consumption targets for just three years (including the current year), rather than setting targets for the provinces or market to aim for over the long-term. Indeed, the provincial obligation for 2020 was adjusted in June of this year to more closely reflect output. This means that the obligation resembles an administrative planning quota and does little to promote market-based investments in clean energy over the long-term.²⁹

Figure 2: 2020 minimum provincial non-hydro renewable obligation, percentage of generation



Source: National Energy Administration, June 2020

China's 2020 Renewable Energy Policies

2020 is the last year of the 13th Five-Year Plan and the key time for developing the 14th Five-Year Plan. Several policies that appear to lay out the basic framework for the 14th Five-Year Plan have now been released. They include a draft Energy Law, a draft policy on clean energy consumption, a target for 2020 renewable energy capacity, and updated policies and guidance on provincial coal plant approvals.

Energy Law

In April 2020, China's National Energy Administration published a new draft Energy Law.³⁰ The measure goes beyond prior energy law by clearly stating that renewable energy has priority for development in China's energy system. The measure explicitly calls for development of a low-carbon energy system, for non-fossil energy to gradually replace fossil fuel energy sources, and for finding substitutes for natural gas and oil. The measure mentions various renewable energy sources more than any individual fossil fuel. The draft mentions promoting



clean coal — which in China refers to newer, more efficient coal plants with low emissions of particulate matter, NO_x, and SO₂, including supercritical and ultra-supercritical coal plants — but also emphasizes efficiency, ecological protection, and environmental taxes. The priority attached to low-carbon energy, the requirement that energy planners consider environmental costs and damage, the emphasis on reducing emission of greenhouse gases and other pollutants, and the call for prices to include the cost of emissions and environmental damage are all encouraging signs that could indicate greater attention to these factors in energy sector policy in the future.

The draft Energy Law contains several important measures, but also contains contradictions. For example, while the measure reiterates that the market shall play a decisive role in allocating energy resources, it contains relatively few concrete clauses related to markets. The word “market” is mentioned 44 times, whereas the word “planning” is mentioned 74 times. Substantively, 21 of the 117 articles focus on planning, 17 articles on regulation or supervision, and only six articles discuss the market. No major market-related initiatives or targets are included in the draft.

The draft Energy Law codifies existing policies into law rather than instituting new policies. For example, the law mentions existing provincial renewable obligations, green certificates, and guaranteed consumption of renewable energy, but does not modify these policies or establish a long-term plan for how they might be coordinated or integrated.

One promising article explicitly encourages public participation in energy planning, stating that planners should seek the opinions of institutions, experts, and the public. The draft also indicates room for participation of more players in a competitive energy system—in contrast to the present system in which provincial authorities and major state-owned energy giants dominate planning and market guidance: “A well-regulated energy market system open to diverse players promotes orderly competition and achieves the optimal allocation of energy resources over a wider area.”

Clean Energy Consumption Draft

In May 2019, China’s National Energy Administration issued a draft Guiding Opinion on Establishing a Sound, Long-term Clean Energy Consumption.³¹ The Clean Energy Consumption draft includes sections on planning, markets, flexibility, technology innovation, and monitoring, and states China’s overall strategy to put clean energy *consumption* at the core—rather than new capacity.

The policy starts primarily with content on administrative planning, which includes “scientific targets” for renewable consumption and “strengthened analysis of renewable consumption capacity.” The latter emphasizes that renewable energy developers should strictly consider local grid capacity to absorb renewable energy. The draft promotes a list of innovative fields and technologies, including energy storage, multi-energy complementarity, and uptake of renewable electricity through port electrification, electric vehicle charging, hydrogen production, as well as heating and cooling.

Like the Energy Law draft, the Clean Energy Consumption draft vaguely mentions the need to



coordinate renewable obligations and green certificates. It suggests accelerating the adoption of spot and ancillary service markets to incentivize renewable energy producers, grid operators, power companies, and provinces to contribute to an efficient and cost-effective energy market and support the integration of renewable resources.

However, it fails to mention the need for coordinating renewable energy markets and green certificates markets with carbon markets. Furthermore, the draft does not include the word carbon and does not repeat the language from the draft Energy Law stating that China will prioritize development of renewable energy. Rather, it recommends “using the provincial power grid’s clean energy utilization target as a constraint,” and strictly limiting renewable project approvals to prevent overbuilding. Although the draft’s title refers to a long-term mechanism for supporting clean energy consumption, the only timeframe it gives for analysis of clean energy consumption is the three-year planning process for provinces and grid companies to determine provincial capacity for absorbing clean energy. Given that earlier short-term planning has produced over-investment in coal capacity that has a high likelihood of economic stranding, this omission could exacerbate this over-investment problem.

Although the draft is related to consumption, planning remains in the hands of large, state-owned producers including mainly grid companies, provincial energy planners, and large generators. This appears to contradict earlier calls for modernized systems of governance in the energy sector and the draft Energy Law’s call for opening the energy sector to public participation and new market players, as well as the document’s own preamble, which reiterates President Xi’s call for a revolution in energy consumption and production. In the US, consumers have played an important role in commercializing utility-scale solar and wind through the signing of power purchase agreements. Similarly, consumer groups have played a central role in advancing policies that reduced unneeded investment in long-lived fossil fuel infrastructure in favor of more economical and cleaner alternatives, including efficiency, demand response, and clean energy. The relative openness and transparency of power sector planning and regulation in the US has facilitated participation of the public and consumers in guiding and leading the energy transition.

Another interesting aspect of the Clean Energy Consumption draft is how it allocates responsibility for integrating renewable energy. Whereas the 2018 Clean Energy Consumption Action Plan placed responsibility for renewable integration squarely on the grid companies, the new draft prioritizes “grid-friendly” clean energy and mentions hybrid renewable plants that incorporate storage as a strategy for increasing renewable consumption. The draft does not explicitly provide new methods for promoting renewables paired with energy storage, nor does it rule them out. Notably, several provinces have begun requiring new wind plants to come equipped with storage for 20 percent of installed capacity, without offering additional compensation.³² It is unclear whether such requirements represent the most economical path to integrating more renewables into the grid. In a 2019 study by the International Energy Agency of China’s energy system, analysts recommended prioritizing flexibility, demand response, and trading electricity between provinces over requiring grid-scale energy storage.³³



Guidance and Targets for 2020 Renewables

The renewable targets set for 2020 appear to signal a return to growth for renewable energy, while falling short of the rapid growth of years prior. As noted above, in June 2020, the NEA set year-end capacity targets of 240 GW each for wind and solar.³⁴ At the end of 2019, China had 210 GW of wind installed and 204 GW of solar,³⁵ so this implies growth of 30 GW for wind and 36 GW of solar, which is roughly in line with total annual wind and solar installations in the past three years. The Ministry of Finance has also cut the amount allocated for PV subsidies from RMB 3 billion in 2019 to RMB 2.63 billion in 2020, while wind will receive subsidies of RMB 2.94 billion, down 30 percent from RMB 4.24 billion allocated in 2019.³⁶

Meanwhile, both central government planners and grid companies have released calculations on their ability to absorb renewable energy, which serves as a cap on new additions. The NEA has calculated China could absorb 85 GW of new additions in 2020.³⁷ State Grid, which serves most of China where most wind and solar capacity is located, estimated its territory can absorb 68 GW of new wind and solar.³⁸ Both these figures would be higher than the year-end capacity targets noted above, but shouldn't be taken as targets.

Wind and solar installations so far in 2020 were affected by the Covid-19 disruption, but the data suggest stable installation rates rather than a sudden collapse or dramatic increase. A total of 17.8 GW of wind and solar projects were completed in the first six months of 2020 (6.3 GW of wind and 11.4 GW of solar). This is a decline of 13 percent from the combined 20.5 GW added in the first half of 2018, which consisted of 9.1 GW of wind and 11.5 GW of solar.³⁹ Wind installations in particular have been affected by supply chain disruptions but are expected to rise toward the end of the year as the deadline for feed-in tariff subsidies approaches.⁴⁰ In June, the China Photovoltaic Industry Association forecast that China would add around 45 GW of solar in 2020,⁴¹ higher than in 2019 but in line with installations in 2018. In 2020, China's regulators have also approved 33.1 GW of subsidy-free solar projects and 11.4 GW of wind for connection in 2020.⁴² Overall, these figures indicate that wind and solar are likely to see stable or modestly higher capacity installations this year.

Policies on Coal

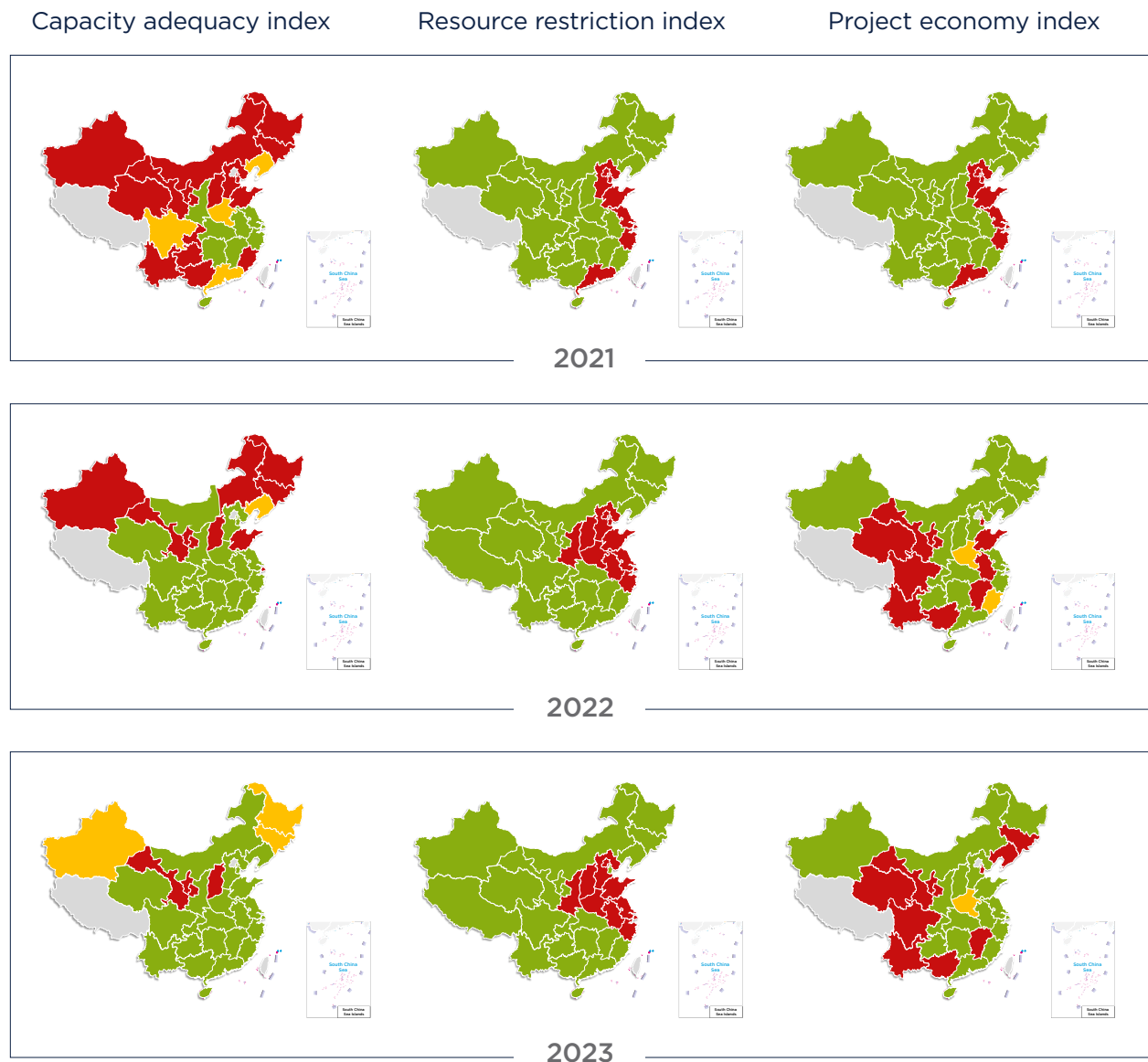
Given China's reliance on coal for the majority of electricity production and the continued build-out of new coal capacity in China, policies on renewable energy are inextricably linked to policies on coal. Prior to the Covid-19 pandemic, which resulted in a temporary drop in coal generation, China was moving to accelerate the construction of new coal capacity. In past years, provinces had sought to accelerate coal plant construction as an economic development strategy, despite low utilization of existing coal plants and long-running warnings of overcapacity and poor financial performance. This resulted in a tug-of-war between provincial announcements and measures issued by central authorities, which sought to rationalize coal capacity, improve integration of renewable energy, and boost electricity trade among provinces.

Though provinces have retained authority over new coal plant approvals, starting in 2016, China's NEA began a new traffic light system that effectively halted new coal plant construction in provinces deemed to have insufficient environmental capacity, resource capacity, or electricity demand to absorb new coal plants. The NEA's first traffic light



announcement labeled all but three provinces as either red or orange on one of these three categories.⁴³ Each year since then, the number of provinces granted a green light for new coal capacity has increased, and the latest NEA traffic light system, issued in February of 2020, included just five provinces labeled red or orange for the binding capacity adequacy metric (shown at left on the maps below).⁴⁴

Figure 3: NEA traffic light alert system for new coal plant approvals, 2021–2023



Source: National Energy Administration, 2018–2020



The result has been a surge in new coal plant construction and approvals at the provincial level. As of June 2020, there are reportedly 46 GW of new coal plants under construction, and an additional 42 GW of new coal plant approvals. The new coal plant approvals appear linked to lowered ambition on clean energy. For example, in May, Hunan province issued an announcement that provincial grid authorities would not permit any new utility-scale solar PV plants in the next four years due to insufficient grid capacity,⁴⁵ but just two days later, Hunan announced approval of a new 2 GW coal plant.⁴⁶ At least two other provinces have announced they have no ability to absorb new renewables in 2020, including Henan and Shanxi.⁴⁷

Perhaps in response to the new coal plant approvals, in June the NDRC issued a policy reiterating that provinces with 2023 red or orange traffic lights should not build new coal and overall coal capacity should remain within a 1,100 GW cap set for 2020. While the policy states that provinces should “in principle” prioritize renewable energy, demand side management, and imports over new coal, if these sources are insufficient to meet peak load then new coal plants can be permitted. (This principle had also been stated in the text of the coal traffic light policy issued in prior years.) Since no new mandatory limits are described, the policy largely reiterates current policy and leaves provinces in the driver’s seat regarding their preferred balance between new coal versus alternatives.⁴⁸

In the past two years, China has placed a high priority on reducing electricity prices and improving energy security.⁴⁹ Although policy makers in China may see coal as cheap and secure, many analysts view coal as economically risky and likely to be supplanted by cheaper renewables, which use inherently secure domestic wind and solar power and which are largely manufactured within China. The Energy Research Institute of the NDRC and its China National Renewable Energy Centre forecast that prioritizing renewable energy and halting coal additions would save RMB 7.2 trillion through 2050.⁵⁰ A 2019 study published in *Nature* forecasts that China could generate over 60 percent of its electricity from renewables by 2030 at 11 percent lower cost than a business-as-usual scenario in which coal capacity continues to grow.⁵¹ A 2019 *Nature Energy* article estimates that solar energy is already cheaper than retail electricity prices in most of China’s 344 prefecture and above cities and lower than desulfurized coal feed-in tariffs in 22 percent of those cities.⁵²

These estimates also track with international trends. A recent International Renewable Energy Agency (IRENA) analysis of renewable project data worldwide shows that the majority of wind projects are cheaper than the lowest cost fossil fuel alternative, and power purchase agreements for solar for construction in 2021 are on average 42 percent cheaper than the lowest cost fossil fuel alternative.⁵³ IRENA expects cost declines in renewable energy to continue through the 2020s, with energy storage costs alone declining as much as 65 percent. This implies that even in parts of China where wind, solar, or hybrid renewable energy plants are not yet at parity with coal tariffs, delaying further coal investments and procuring cheaper renewable energy later would save money.



Implications for the 14th Five-Year Plan

China's 14th Five-Year Plan for renewable energy will not only incorporate elements of the detailed policies described above but also take place in the context of major long-term guidance on energy policy. These directives include broad guidance for the overall energy sector, such as the power market reforms begun in 2015, the vision for a revolution in energy consumption and production, the principle of markets playing a decisive role in allocation of energy and environmental resources, and President Xi's overall vision for a Beautiful China, which incorporates low-carbon development and construction of an ecological civilization.

More concretely, the plan will incorporate past targets for non-fossil energy to provide 20 percent of primary energy production by 2030 and for China's total carbon emissions to peak by around 2030. Importantly, none of the policy announcements so far in 2020 imply any increased ambition on either of these targets. Rather, China appears to be focused on keeping the annual installations of renewable energy broadly stable, while leaving room for new fossil energy development led by provincial authorities.

Prior to the Covid-19 crisis, 2020 was shaping up to be a watershed year for climate negotiations, and China's role appeared particularly central given that this year's COP would coincide with development of China's 14th Five-Year Plan. Covid-19 has had several impacts on energy sector developments. First, reduced energy demand temporarily hit production of electricity from coal and seems likely to reduce returns on capital-intensive energy projects across the energy space. However, Covid-19 has also strengthened calls to boost China's energy security and local economic stability, and coal figures in both of these. In China, domestic coal has often been mentioned in the context of energy security, whereas variable renewable energy often isn't. While China's central government hasn't announced a specific economic stimulus plan in the wake of Covid-19, it has opened up local lending, some of which will support coal power projects.

Given that renewable energy can now compete with fossil fuels in most of the world, even without considering carbon prices or environmental externalities, and given that China has already led the world for several years in the manufacture and installation of wind and solar, many climate analysts had hoped that China's 14th Five-Year Plan would signal new ambition on renewable energy. Instead, the measures announced so far this year imply a trend of consolidation and conservatism, aimed at balancing the demands of provinces for new coal capacity with sustaining markets for clean energy and holding on to the gains made in integrating the renewable capacity already on the grid.

There is no doubt that China will continue to promote clean energy of all types, and the policies so far in 2020 have emphasized that China will continue to innovate in areas such as energy storage, hydrogen, floating solar, demand response, and electric vehicle charging. The continuing fall in costs for wind, solar, and energy storage are likely to make these resources all but inevitable winners in the long run. But for now, although China's energy policies continue to include language favoring renewables and market reforms in principle, the specific details focus more on short-term administrative planning targets and stable markets for both renewable energy and coal. The green light for new coal plant construction, constraints on



renewable development in the Clean Energy Consumption guiding opinion, and provincial-level caps on renewable energy indicate a conservative approach in the near-term. From these signals, it appears unlikely that the 14th Five-Year Plan will shake up the status quo of China's energy markets.

Notes

1. For an overview of renewable capacity by country, see Table 2, "Renewables 2020 Global Status Report," Ren21, March 2020, https://www.ren21.net/gsr-2020/tables/table_02/table_02/. See also Lauri Myllyvirta, "China's CO₂ emissions surged past pre-coronavirus levels in May," Carbon Brief, June 29, 2020, <https://www.carbonbrief.org/analysis-chinas-co2-emissions-surged-past-pre-coronavirus-levels-in-may>; Muyu Xu and David Stamway, "China's post-pandemic economic stimulus puts 2020 climate pledges at risk," Reuters, May 20, 2020; see also Twitter comments by Li Shuo, China climate analyst at Greenpeace East Asia, "Accurate analysis. As long as local authorities are in charge of project approval and infected with coal fever, it does not matter what Beijing says. 1100GW should NOT be seen as "cap", but green light for further growth. There is only more room for coal, not optimism," https://twitter.com/LiShuo_GP/status/1273791019331379202.
2. "中电联发布2019-2020年度全国电力供需形势分析预测报告," China Electricity Council, January 21, 2020, <http://www.cec.org.cn/guihuayutongji/gongxufenxi/dianligongxufenxi/2020-01-21/197090.html>.
3. 2019 wind capacity figures: "2019年风电并网运行情况," National Energy Administration, February 28, 2020, http://www.nea.gov.cn/2020-02/28/c_138827910.htm. 2019 solar capacity figures: "2018年可再生能源并网运行情况介绍," National Energy Administration, January 28, 2019, http://www.nea.gov.cn/2019-01/28/c_137780519.htm. 2015 wind capacity figures: "2015年全国风电产业继续保持强劲增长势头," National Energy Administration, February 2, 2016, http://www.gov.cn/xinwen/2016-02/02/content_5038302.htm. 2017 solar capacity figures: "2017年光伏发电新增装机5306万千瓦 居可再生能源之首," National Energy Administration, January 24, 2018, at http://fjb.nea.gov.cn/news_view.aspx?id=28662.
4. For 2020 cumulative installation targets, see: "关于做好2020年能源安全保障工作的指导意见, 发改运行〔2020〕900号," National Development and Reform Commission and National Energy Administration, 12 June 2020, https://www.ndrc.gov.cn/xxgk/zcfb/tz/202006/t20200618_1231501.html. 2019 wind capacity figures: "2019年风电并网运行情况," National Energy Administration, February 28, 2020, at http://www.nea.gov.cn/2020-02/28/c_138827910.htm. 2019 solar capacity figures: "2018年可再生能源并网运行情况介绍," National Energy Administration, January 28, 2019, at http://www.nea.gov.cn/2019-01/28/c_137780519.htm.
5. China's peak installations of solar PV was in 2017; cuts in feed-in tariffs and FIT quotas for solar feed-in tariffs led to a drop in solar installations in both 2018 and 2019. See "China still most attractive renewables market despite subsidy cuts – EY," Reuters, September 12, 2019, <https://www.euronews.com/2019/05/15/china-still-most-attractive-renewables->



[market-despite-subsidy-cuts-ey](#); “光伏行业：2019惨淡经营，2020路在何方,” Caixin, November 26, 2019, at <http://m.opinion.caixin.com/m/2019-11-26/101487343.html>. Solar feed-in tariff subsidies for both utility-scale and distributed projects had fallen since 2016. “Breaking: China looking to dramatically cut solar PV FIT,” *PV Magazine*, November 29, 2016, https://www.pv-magazine.com/2016/09/29/breaking-china-looking-to-dramatically-cut-solar-pv-fit_100026296/. Wind installations peaked at 30.5 GW in 2015 before declining due to tariff cuts. See “China’s wind power industry faces slowdown as tariff cuts loom,” *South China Morning Post*, October 20, 2016, <https://www.scmp.com/business/companies/article/2038694/chinas-wind-power-industry-faces-slowdown-tariff-cuts-loom>. Total wind and solar installations peaked in 2018 and declined in 2019; falling solar installations were only partially offset by rising wind installations.

6. For a good overview of the history of feed-in tariff subsidies and their gradual phase-out, see Yuki Yu, “China’s Renewable Power Price and Subsidy: “New” Design in 2020?,” *Energy Iceberg*, January 29, 2020, <https://energyiceberg.com/china-renewable-power-price/>.
7. “How to Harvest From China’s Renewable Asset Sales: Subsidy-Not-Receiveable the Biggest Threat,” *Energy Iceberg*, accessed August 9, 2020, <https://energyiceberg.com/china-renewable-subsidy-deficit/>.
8. Starting in 2015, China has begun a transition towards wholesale power markets. To date, most market transactions fall into a category known as mid- to-long-term contracts, which refers to bilateral contracts between large electricity consumers and generation companies. The contracts are for periods of one month, one year, or sometimes more than one year. Several provinces have begun spot power market pilots, but these are mostly performing simulated trading. The Guangdong provincial spot market pilot is the most advanced in terms of implementation, but trades account for a small proportion of total electricity consumption. See Yuyan Cao, Ruosida Lin, Daniel Wetzel, “Tracking China’s Provincial Spot Market Designs,” *Rocky Mountain Institute*, December 2019, <https://rmi.org/insight/tracking-chinas-provincial-spot-market-designs/>.
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About the Author

Anders Hove, CFA, is a Non-Resident Fellow at CGEP and an energy research analyst located in Beijing, China. He is currently Project Director for the GIZ-implemented Sino-German Energy Transition project. He has over two decades of public and private sector experience related to energy policy and markets, including nine years on Wall Street and over 10 years in China. He holds a bachelor's and master's degree in political science from MIT.



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