

Hove, Anders; Xie, Gary Sipeng

Working Paper

Green certificates with Chinese characteristics: Will green certificates help China's clean energy transition?

OIES Paper: CE, No. 9

Provided in Cooperation with:

The Oxford Institute for Energy Studies, Oxford

Suggested Citation: Hove, Anders; Xie, Gary Sipeng (2023) : Green certificates with Chinese characteristics: Will green certificates help China's clean energy transition?, OIES Paper: CE, No. 9, ISBN 978-1-78467-213-3, The Oxford Institute for Energy Studies, Oxford

This Version is available at:

<https://hdl.handle.net/10419/280126>

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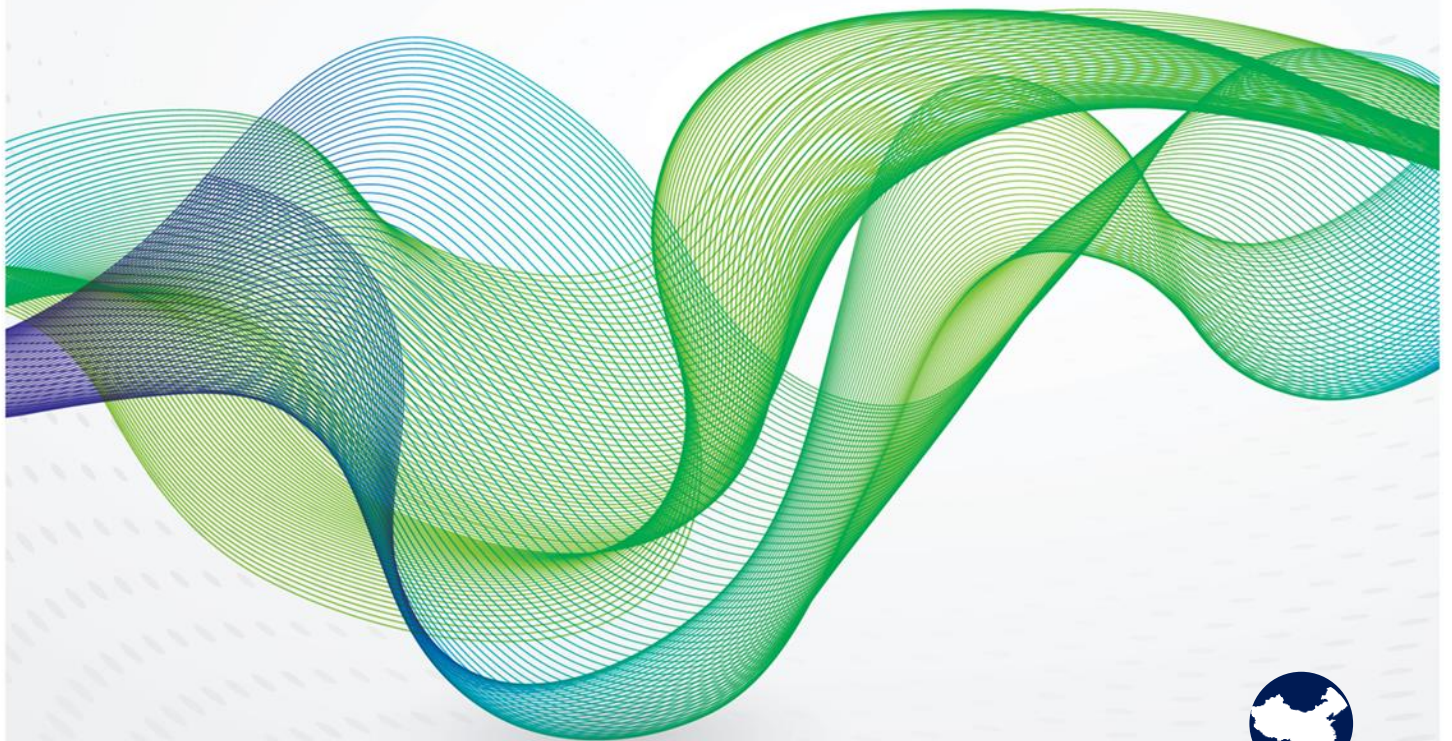
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July 2023

Green certificates with Chinese characteristics: Will green certificates help China's clean energy transition?



CHINA

OIES PAPER: CE9

Anders Hove, Senior Research Fellow, OIES &
Gary Sipeng Xie, Policy Advisor and British Columbia Advisor to
Canada's Minister of Natural Resources



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ISBN 978-1-78467-213-3



Acknowledgements

The authors gratefully acknowledge the helpful advice and comments provided by Philip Andrews-Speed of OIES, Sharon Feng of Azure International, Michal Meidan of OIES, Yan Qin of Refinitiv, Ye Ruiqi of Greenpeace East Asia, Zhang Sufang of North China Electric Power University and Xu Zheng of BP. Any errors are the responsibility of the authors.

This paper was first published on 1 August 2023. It was updated and re-posted on 8 August 2023 to reflect a new policy release on 3 August 2023.



Executive summary

Green power trading is a potential market-oriented approach to promoting a clean energy transition in China and shifting away from the subsidy- and planning-based approach used so far. In practice, however, China's leading instrument for this policy, the green certificate, has faced serious obstacles to acceptance. While new policies and existing trends will help resolve some of these obstacles, more must be overcome before China's green certificates can play a significant role in accelerating the country's adoption of clean, renewable energy.

China is a leader in renewable energy, including wind, solar, and hydro. Wind and solar, known in China as 'new energy', have been supported by subsidized feed-in tariffs, minimum purchase amounts, quotas, and auctions under the grid parity programme, as well as additional programmes for distributed solar. Most wind and solar capacity is owned by state-owned power companies, and the majority of its output is sold to the grid without any direct participation by the private sector, though this is changing gradually.

For years, China has also had various policies to promote the private purchase of renewable electricity, most notably the green certificate programme. A China green certificate represents the financial purchase of 1,000 kWh of wind or solar electricity; the certificates are issued by a regulatory entity to qualified wind and solar generators, which can then sell the certificates to private or state-owned purchasers, which buy certificates on a voluntary basis. The initial phase of this programme produced few results, but an uptick in market interest since 2021 and recent policy documents suggest green power purchasing is likely to play a larger role in China's power system. Just as China's internal electricity market and system have tended to diverge from international examples, China's green certificate system is unique, and the compatibility of China's green certificates with international practices is unclear. Originally designed to help phase out government subsidies for wind and solar, green certificates are undergoing a transition towards supporting unsubsidized wind and solar. However, China's green certificate market faces significant near-term obstacles around transparency, regulation, and its role—whether in meeting the low-carbon goal of private companies or in contributing to the provincial targets and quotas on energy consumption and renewable integration.



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Introduction

For almost a decade, China has sought to introduce more market elements into its electricity sector, both to improve the sector's economic efficiency by providing more market price signals for investment and operation and to encourage participation of new players, on both the generation side and the consumption side. For renewable energy, where China has sought to reduce dependence on government subsidies, market instruments such as green certificates offer the potential to involve public and private companies in the country's clean energy deployment while lessening its subsidy burden.

In 2017, when China launched its green certificate programme, the country was already the world's leading installer of renewable energy in terms of wind, solar, and hydro. The initial green certificate policy had several stated goals, but the leading purpose was to raise revenues for renewables from the private sector—particularly from private companies such as multinational consumer brands—and reduce the need for subsidies and other policy support. In the years since, subsidies have been withdrawn for new projects and limited for older projects, but green certificates have still struggled to take off. More recently, trading volumes have risen, and in mid-2023 a major new reform introduced that could expand the role of green certificates.

The purpose of this paper is to take stock of China's green certificate programme and answer the following important questions: (1) To what extent have green certificates helped accelerate the deployment of renewables, and will this change in the near term? (2) Why are green certificate purchase volumes increasing, and what effect will this have? (3) How attractive are China's green certificates to private companies—particularly international companies—and are China's green certificates recognized internationally?

The paper is structured in four sections. The first section gives background information on China's renewable energy policies, especially as they relate to government subsidies, given that green certificates began as a strategy for phasing out and replacing such subsidies. The second section provides an explanation of the history and present situation of China's green certificate policies and market. The third section discusses problems and challenges faced by the green certificate market. The fourth section evaluates the extent to which China's green certificates are likely to be recognized by international companies active in purchasing renewable energy and related instruments.

The evolution of renewable energy policy in China and the gradual introduction of market-oriented elements into wholesale electricity trading point to a brighter future for green certificate trading. The reasons are:

- While the government still seeks to use green certificates as a tool to raise revenue for renewable energy—by encouraging businesses and individuals to purchase certificates, with payment offsetting government subsidy obligations—recent government policies to top up the subsidy fund mean there is less urgency to use such revenues to substitute for the feed-in tariff deficit owed by the government. This lessens the market's perception that green certificates lack additionality, which was a major obstacle in the early years of the programme.
- The trend towards a resolution of the renewable subsidy deficit makes addressing this deficit a less salient policy goal for green certificates, but if green certificates become successful, this could lead to further moves to shift older wind and solar off of feed-in tariffs. Policymakers therefore have an incentive to increase the attractiveness of green certificates in the hope of further reducing the government subsidy burden, even after the feed-in tariff deficit is resolved.
- An increasing supply of wind and solar output with unsubsidized electricity production is available for marketing with green certificates, and these lower-cost green certificates issued by unsubsidized wind and solar projects are more economically attractive for purchase by the private sector relative to green certificates from subsidized projects in the past.

However, despite these positive developments, there remain many obstacles to the development of a vibrant and active green certificate market that would contribute to China's low-carbon policy goals. The future evolution of China's green certificate market is highly uncertain, as is the extent to which green certificates will be recognized internationally. Outside of China, there is an increasing shift from policies that simply add more renewable capacity to ensuring renewables are consumed where and when they are needed. This has led to a push in Europe and North America towards time-matched renewable markets, which could mean China's green certificates will be out of step with changes in other regions.



Background on China's renewable energy policies: Prior policy support and subsidies for wind and solar

The background of China's green certificate market, which properly began in 2017 as an additional support policy for wind and solar energy, is linked to the history of renewable energy subsidies in China that date back two decades, and particularly to the deficit in subsidy payments related to the design of the country's feed-in tariff for wind and solar electricity generation.

China began promoting wind and solar technologies as early as the 1990s, and the country's domestic wind market reached gigawatt scale in the mid-2000s, in part due to the Clean Development Mechanism under the Kyoto Protocol, which resulted in financial transfers for Chinese wind projects from Western countries seeking to comply with carbon emission targets.¹ The real inflexion point for wind and solar capacity in China took place around 2010–11. In 2009, after several years of promoting wind power via subsidized capacity auctions, China introduced a subsidized feed-in tariff for wind energy, granting a fixed payment tariff for 20 years to new projects approved under the scheme.² Subsidies for wind capacity auctions and subsequent feed-in tariffs were funded through the collection of a surcharge on electricity sales to most customers. A generous feed-in tariff was also introduced to cover solar photovoltaic (PV) in 2011.³ The introduction of these subsidized feed-in tariffs coincided with the take-off of the two technologies in China: wind power capacity rose from 12 GW in 2008 to 63 GW in 2011, and solar PV capacity rose from under 1 GW in 2010 to 3 GW in 2011 and to 16 GW in 2013.

The Chinese feed-in tariff was modelled on the feed-in tariff in the German renewable energy law⁴ and suffered from some similar drawbacks. In particular, China's feed-in tariff was adjusted on an annual basis, and typically such adjustments lagged the industry's progress in reducing costs. This resulted in a boom–bust pattern of wind installations—and, starting in 2011, solar PV installations—that ultimately led wind and solar capacity to grow far beyond government-set targets. Under China's Renewable Energy Law, grid companies were obligated to purchase all the electricity output of wind and solar generators, and all output qualified for subsidized feed-in tariff levels. However, grid companies had little incentive to dispatch wind and solar power over coal power, leading to high rates of curtailed wind and solar output: curtailment reached over 17 per cent at its peak for wind power in 2016, and 12 per cent for solar PV in 2015.⁵

Further, government feed-in tariff subsidy obligations dramatically exceeded renewable energy surcharge revenues, leading to an ongoing problem of renewable surcharge deficits,⁶ even though the central government steadily raised the surcharge, from RMB 0.001/kWh in 2006 to RMB 0.019/kWh in 2016 (Figure 1). At RMB 0.019/kWh, the surcharge represented a 3.2 per cent premium on the average retail electricity price of RMB 0.611/kWh.⁷ After 2016 the government signalled that no further surcharge

¹ Zhen-Yu Zhao et al., 'The impact of the CDM (clean development mechanism) on the cost price of wind power electricity: A China study,' *Energy*, 69, 18 April 2014, at <http://dx.doi.org/10.1016/j.energy.2013.10.050>.

² '国家发展改革委关于完善风力发电上网电价政策的通知,发改价格(2009)1906号 [NDRC notice on improving the feed-in tariff policy for wind power generation, NDRC Pricing (2009) No. 1906],' National Development and Reform Commission, 20 July 2009, at www.ndrc.gov.cn/xxgk/zcfb/tz/200907/t20090727_965206.html.

³ '关于完善太阳能光伏发电上网电价政策的通知,发改价格[2011]1594号 [Notice on improving the feed-in tariff policy for solar PV power generation, NDRC Pricing (2011) No. 1594],' National Development and Reform Commission, 24 July 2011, at www.nea.gov.cn/2011-08/01/c_131097437.htm.

⁴ Li Junfeng et al., 'A study on the pricing policy of wind power,' China Renewable Energy Industry Association, Greenpeace International, Global Wind Energy Council, 2012, at <https://gwec.net/wp-content/uploads/2012/06/Report-wind-power-price-policy-china.pdf>; 'The German feed-in tariff,' Future Policy, accessed 31 May 2023 at www.futurepolicy.org/climate-stability/renewable-energies/the-german-feed-in-tariff.

⁵ '2019 Q1&2 wind power installations and production by province,' China Energy Portal, 26 July 2019, at <https://chinaenergyportal.org/en/2019-q2-wind-power-installations-and-production-by-province/>; '2015-2020 年中国弃风弃光率,' Goku Research, 12 January 2020, at www.wukongzhiku.com/chart/21742.html.

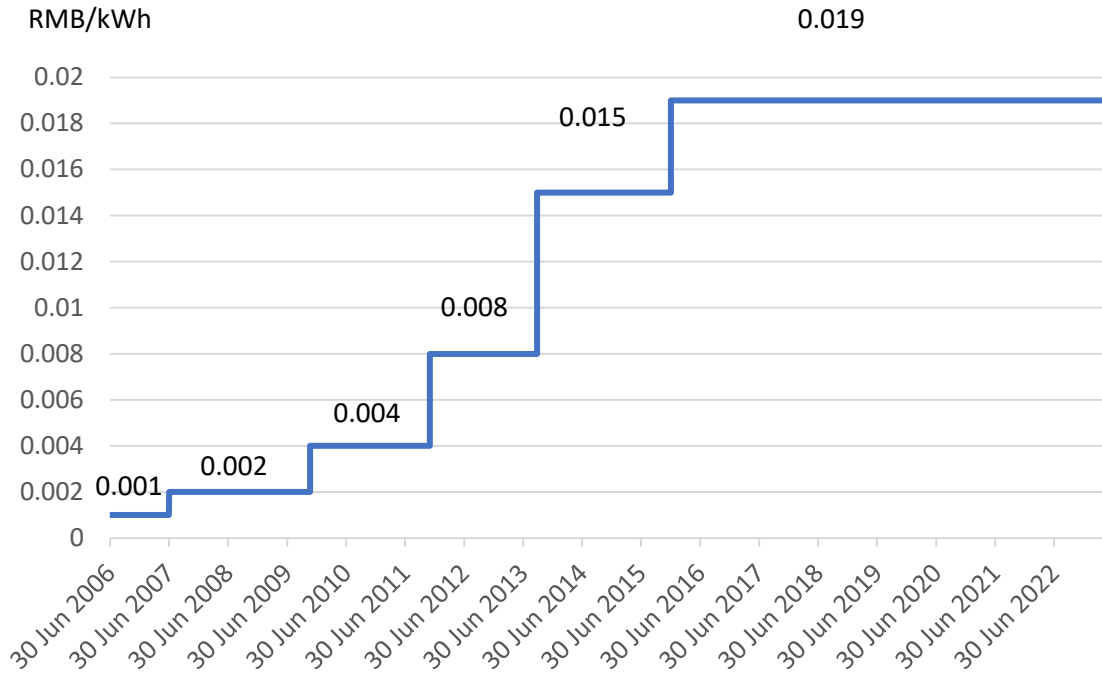
⁶ Yuki Yu, 'How to harvest from China's renewable asset sales: Subsidy-not-receivable the biggest threat,' *Energy Iceberg*, 2 December 2019.

⁷ Retail price of ¥0.611/kWh based on '我国电价的国际比较分析 [China electricity price international comparison analysis],' State-owned Assets Supervision and Administration Commission of the State Council, 23 March 2020, at www.sasac.gov.cn/n16582853/n16582883/c17715327/content.html.



increases were likely.⁸ As a result, the surcharge deficit continued to grow, reaching a cumulative RMB 400 billion by 2021, with follow-on impacts on renewable energy equipment providers and financing costs for renewable energy projects.⁹

Figure 1: China renewable energy surcharge levels over time, 2006–2023, RMB/kWh



Source: OIES, based on data from the China National Energy Administration.

⁸ 'IIGF 观点 | 我国绿证交易现状分析及未来展望,' Envirunion, 8 March 2022, at www.envirunion.com/newsinfo-33592.html;

Chang Su, '某新能源企业由于可再生能源补贴被拖欠濒临倒闭, 困局将如何破解? [Renewable energy companies are on the verge of bankruptcy due to arrears of renewable energy subsidies. How will the dilemma be resolved?],' Solar OfWeek, 13 August 2018, at <https://solar.ofweek.com/2018-08/ART-260006-8440-30256761.html>.

⁹ Wang Zhixuan, '王志轩: 我国绿色电力市场化政策评述及改革建议 [Wang Zhixuan: China's green power market policy and reform suggestions],' China Electricity Council, 18 January 2023, at www.cec.org.cn/upload/1/pdf/1611189701502.pdf.



Timeline of key policy developments related to green power and green certificates in China

2006: Introduction of renewable energy surcharge¹⁰
2009: Beginning of subsidized feed-in tariff for wind power¹¹
2011: Beginning of subsidized feed-in tariff for solar PV¹²
2015: Document #9 on Deepening Reform in the Power Sector¹³
2016: Requirement for full purchase of renewable energy,¹⁴ followed by additional policy on minimum purchase of certain hours¹⁵
2017: Launch of Green Electricity Certificates¹⁶
2019: National Development and Reform Commission announces most subsidized feed-in tariffs for onshore wind will be phased out by year-end 2020¹⁷
2019: Approval of first grid parity (unsubsidized) wind and solar PV projects¹⁸
2019: Provincial renewable energy obligation (quota)¹⁹
2021, June: National Development and Reform Commission announces the end of the feed-in tariff for distributed and central solar PV by the end of 2021²⁰
2021, September: Cross-provincial green power transactions announced²¹
2022: Implementation Plan for New Energy Consumption states that renewable energy would not count towards 'dual control' targets for energy consumption and energy intensity²²
2023:²³

¹⁰ '可再生能源发电价格和费用分摊管理试行办法 [Renewable energy electricity price and cost distribution pilot policy],' National Development and Reform Commission, 20 January 2006, at www.gov.cn/ztl/2006-01/20/content_165910.htm.

¹¹ '国家发展改革委关于完善风力发电上网电价政策的通知,发改价格(2009)1906号 [NDRC notice on improving the feed-in tariff policy for wind power generation, NDRC Pricing (2009) No. 1906],' National Development and Reform Commission, 20 July 2009, at www.ndrc.gov.cn/xxgk/zcfb/tz/200907/t20090727_965206.html.

¹² '关于完善太阳能光伏发电上网电价政策的通知,发改价格[2011]1594号 [Notice on improving the feed-in tariff policy for solar PV power generation, NDRC Pricing (2011) No. 1594],' National Development and Reform Commission, 24 July 2011, at http://www.nea.gov.cn/2011-08/01/c_131097437.htm.

¹³ '关于进一步深化电力体制改革的若干意见 [Opinions regarding deepening reform of the electric power sector],' China State Council, March 2015, at www.gov.cn/xinwen/2015-03/09/content_2831228.htm.

¹⁴ '关于做好风电、光伏发电全额保障性收购管理工作的通知 [Wind and PV guaranteed full purchase management policy notice],' National Development and Reform Commission and National Energy Administration, 31 May 2016, at www.ndrc.gov.cn/xxgk/zcfb/tz/201605/t20160531_963079_ext.html.

¹⁵ '风电、光伏保障性收购年利用小时数核定公布 [Wind, PV guaranteed purchase hours published],' Xinhua Net, 1 June 2016, at www.cspplaza.com/article-7249-1.html.

¹⁶ '三部门关于试行可再生能源绿色电力证书核发及自愿认购交易制度的通知 [Notice on three ministries issuing pilot renewable energy green electricity certificates issuance and purchase institutions],' National Development and Reform Commission, Ministry of Finance, National Energy Administration, 3 February 2017, at www.gov.cn/xinwen/2017-02/03/content_5164836.htm.

¹⁷ '国家发展改革委关于完善风电上网电价政策的通知 [Notice on improving wind feed-in tariff policy],' National Development and Reform Commission, 24 May 2019, at www.ndrc.gov.cn/xxgk/zcfb/tz/201905/t20190524_962453.html.

¹⁸ '两部门关于公布2019年第一批风电、光伏发电平价上网项目的通知 [Notice on two ministries approval of 2019 batch of wind and PV grid parity projects],' National Development and Reform Commission and National Energy Administration, 23 May 2019, at www.gov.cn/xinwen/2019-05/23/content_5393967.htm.

¹⁹ '关于建立健全可再生能源电力消纳保障机制的通知 发改能源[2019]807号 [Notice on the establishment and improvement of a safeguard mechanism for renewable electricity consumption], National Development and Reform Commission and National Energy Administration, 10 May 2019, at http://zfxxgk.nea.gov.cn/auto87/201905/t20190515_3662.htm.

²⁰ '关于2021年新能源上网电价政策有关事项的通知 [Notice on the 2021 new energy feed-in tariff policy and related programs],' National Development and Reform Commission, 11 June 2021, at www.ndrc.gov.cn/xxgk/zcfb/tz/202106/t20210611_1283088.html.

²¹ '我国绿色电力交易试点正式启动——绿电消费有了'中国方案' [China green electricity trading pilot kicks off, green power has a "Chinese solution"],' People's Government of China, 9 September 2021, at www.gov.cn/xinwen/2021-09/09/content_5636363.htm.

²² '促进绿色消费实施方案 [Implementation plan for promoting green consumption],' National Development and Reform Commission, 21 January 2021, at www.ndrc.gov.cn/xwdt/tzgg/202201/t20220121_1312525.html.

²³ '关于做好可再生能源绿色电力证书全覆盖工作促进可再生能源电力消费的通知 [Notice on Completing Work to Enable Green Certificates to Fully Cover Renewable Energy and Promote Renewable Energy Consumption],' China National Development and Reform Commission, 3 August 2023, at <https://zfxxgk.ndrc.gov.cn/web/iteminfo.jsp?id=20256>



To prevent an increase in surcharge deficits, the central government placed various limits on the wind and solar capacity different provinces could add to the grid under the feed-in tariff.²⁴ Feed-in tariff levels for new projects were steadily reduced, and—ultimately—subsidized feed-in tariffs for onshore wind and solar PV were phased out, starting in 2020. Onshore wind and centralized solar PV plants continue to be supported by various policies, particularly the 2019 grid parity programme, which provided new wind and solar PV projects with 20-year negotiated power purchase agreements, provided they could offer prices at or below prevailing grid tariffs.²⁵ Such projects do not receive the subsidized feed-in tariff, but the problem of the feed-in tariff deficit remains, given that older projects continue to generate electricity that qualifies for feed-in tariff payments.²⁶

Further, recognizing that some provinces had not fulfilled the mandatory purchase hours requirements—a requirement adopted by NEA to prevent arbitrary curtailment of wind and solar in favour of other generation sources—the central government reduced the obligation of provinces to pay subsidized feed-in tariffs for older projects, specifying that provinces would only be expected to pay feed-in tariff subsidies for a limited number of ‘minimum operating hours’.²⁷ These minimums were defined in June 2016, when the minimum purchase was set as 1,800–2,000 hours per year for wind energy and 1,300–1,500 hours per year for solar.²⁸ For years, some provinces flouted even the reduced minimum operating hours requirements and prevented renewable sources from selling power beyond obligatory minimums.²⁹ In 2020, the Ministry of Finance clarified that feed-in tariffs would be paid in most provinces according to a calculation of ‘reasonable lifetime operating hours’, based on the four wind resource classes and three solar resource classes established for wind and solar feed-in tariffs.³⁰ The reasonable operating hours listed in the policy work out to a capacity factor between 21 per cent and 27 per cent for wind, and between 12 per cent and 17 per cent for solar. These policies on ‘guaranteed’, ‘minimum’, and ‘reasonable’ operating hours encouraged provinces to set up additional markets for selling ‘excess’ renewable energy production beyond these amounts, including via interprovincial trading.

The numbers set for minimum purchase, and later for reasonable operating hours, effectively created a greater incentive for wind energy to sell into power markets by limiting feed-in tariff payments. Nationally, in 2021 wind produced for 2,246 hours, or a capacity factor of 25 per cent, with some provinces above a 29 per cent capacity factor. For solar, the national average was 1,161 hours, a 13 per cent capacity factor, with some provinces above 1,500 hours (18 per cent capacity factor).³¹ In other words, the average wind power plant produced 10 per cent more electricity than the *minimum* purchase requirement, and the average solar plant produced about the same amount of electricity as the minimum purchase requirement. Fewer provinces, however, exceeded the *reasonable* operating hours standard, and year-to-year changes in output likely mean provinces that exceed this standard in one year will not

²⁴ See, for example, the limits placed on various provinces in 2018 in ‘国家能源局关于发布 2018 年度风电投资监测预警结果的通知,’ National Energy Administration, 5 March 2018, at <http://fgcx.bjcourt.gov.cn:4601/law?fn=chl543s485.txt>.

²⁵ ‘国家发展改革委国家能源局关于积极推进风电光伏发电无补贴平价上网有关工作的通知, 发改能源[2019] 19 号 [NDRC and NEA notice on promoting wind and PV grid integration without subsidies],’ National Development and Reform Commission and National Energy Administration, 7 January 2019, at www.ndrc.gov.cn/xxgk/zcfb/tz/201901/t20190109_962365.html.

²⁶ Wang Zhixuan, ‘王志轩：我国绿色电力市场化政策评述及改革建议 [Wang Zhixuan: China’s green power market policy and reform suggestions],’ China Electricity Council, 18 January 2023, at www.cec.org.cn/upload/1/pdf/1611189701502.pdf.

²⁷ ‘关于做好风电、光伏发电全额保障性收购管理工作的通知: 最低保障收购年利用小时数核定表 [Notice on wind and PV full purchase requirement: Minimum obligation on purchase hours table],’ National Development and Reform Commission, 1 June 2016, at www.gov.cn/xinwen/2016-06/01/content_5078698.htm.

²⁸ ‘风电、光伏保障性收购年利用小时数核定公布 [Wind, PV guaranteed purchase hours published],’ Xinhua Net, 1 June 2016, at www.cspplaza.com/article-7249-1.html.

²⁹ ‘刘汉元代表：落实可再生能源保障性收购和优先上网政策 [Liu Hanyuan: Fully implement renewable guaranteed purchase and priority dispatch policies],’ Solar OfWeek, 5 March 2021, at <https://solar.ofweek.com/2021-03/ART-260006-8440-30488119.html>.

³⁰ ‘财政部：按合理利用小时数核定可再生能源发电项目补贴资金额度 [Ministry of Finance: Subsidy payments to renewables will be based on a project’s reasonable operating hours calculation],’ Xinlang Caijing, 21 October 2020, at <https://baijiahao.baidu.com/s?id=1681122887191774130>.

³¹ ‘国家能源局举行新闻发布会 发布 2021 年可再生能源并网运行情况等并答问 [NEA holds press conference to issue 2021 renewable integration statistics and respond to questions],’ National Energy Administration, 29 January 2022, at www.gov.cn/xinwen/2022-01/29/content_5671076.htm.



exceed it in all years. According to an unweighted average of operating hours statistics for wind and solar PV by province and resource grade, in 2020 and 2021 wind and solar operating hours across all resource grades exceeded the respective wind and solar reasonable operating hours quotas by 6 per cent,³² though of course many individual projects would greatly exceed this average. In the wind sector, operating hours have tended to increase over time,³³ potentially owing to larger turbines and improved efficiency. Without green certificates or green power trading, the policy of limiting feed-in tariff payments for 'excess' output would tend to discourage investment or dispatch aimed to increase efficiency or output beyond planned levels, penalizing the most efficient projects.

The situation that resulted from this complex support arrangement—subsidized feed-in tariffs, deficits in subsidy payments, and operating hours quotas for grid company purchase of renewables—created an impetus to find alternative sources of revenue to support renewable energy and encourage its uptake. Enter the Chinese green certificate—technically known as the Green Electricity Certificate, or GEC.

China's green certificate policies and market: History and present situation

Early history of the market

A voluntary green certificate market was established in 2017, exclusively for wind and solar electricity. Given the possibility that consumers such as private companies and individuals might be willing to voluntarily pay a premium to purchase renewable energy, the government established the green certificate as a proof of financial purchase of 1,000 kWh of wind or solar energy. Generators that sold green certificates would forgo the right to receive feed-in tariff subsidy payments for any purchase volumes covered by green certificates. Hence, the scheme's design primarily related to replacing feed-in tariff subsidies. Secondary trading was not permitted, and purchase volumes were almost non-existent due to the high prices needed to justify generators forgoing subsidy payments.³⁴ In late 2022, a new green power market policy clarified that green credits would serve as an accounting system for implementing quotas for energy consumption, under the 'dual control' system established in 2016 that sets annual provincial limits for total energy consumption and energy intensity of GDP. Provinces could cover their excessive consumption with green certificates.³⁵

From their introduction, the government viewed green certificates as a way to reduce the government's financial burden to subsidize renewable energy and thereby help reduce the feed-in tariff subsidy deficit. In announcing the trial of China's green energy market in 2017, the National Energy Administration (NEA) emphasized that a green energy market would 'be conducive to promoting the efficient use of clean energy and reducing the direct subsidy intensity of national financial funds, which has positive significance for building social consensus and promoting energy transformation'.³⁶

³² Unweighted average; author analysis. Operating hours statistics by province and resource grade taken from '关于 2021 年度全国可再生能源电力发展监测评价结果的通报 [2021 National Renewable Electricity Development Supervision and Evaluation Report],' National Energy Administration, 16 September 2022, at www.nea.gov.cn/2022-09/16/c_1310663387.htm.

³³ '全国各省 2014-2020 年风电利用小时数 [National provincial wind operating hours, 2014-2020],' Caijing, 26 November 2021, at <https://wind.in-en.com/html/wind-2412128.shtml>.

³⁴ '关于试行可再生能源绿色电力证书核发及自愿认购交易制度的通知, 发改能源[2017]132 号 [Notice regarding trial implementation of renewable energy Green Electricity Certificates and voluntary procurement and trading institutions, NDRC Energy (2017) No. 132],' China National Development and Reform Commission, Ministry of Finance and National Energy Administration, 6 February 2017, at www.nea.gov.cn/2017-02/06/c_136035626.htm. For critiques, see Ye Ze, '我国可再生能源绿色证书自愿认购交易规则评价与建议 [National Renewable Energy Green Certificate Voluntary Purchase and Trading Rules: An Assessment and Suggestions],' China Power, 30 June 2017, at www.chinapower.com.cn/guandian/20170630/82827.html and www.sohu.com/a/153973342_418320; Anders Hove and Daniel Wetzel, 'China is planning provincial quotas for clean energy,' China Dialogue, 23 April 2018, at www.chinadialogue.net/blog/10574-China-is-planning-provincial-quotas-for-clean-energy/-en; Shengnian Xu, 'Current situation of green electricity certificates,' Global Environmental Institute China, 29 April 2018, at www.geichina.org/en/gei-insight-current-situation-of-green-electricity-certificates.

³⁵ '国家发改委: 新增可再生能源消费不纳入能源消费总量控制 [NDRC: Incremental renewable consumption won't count towards energy consumption controls],' Xinhua Net, 17 November 2022, at www.chinanews.com/gn/2022/11-17/9896248.shtml.

³⁶ '国家发展改革委 财政部 国家能源局关于 试行可再生能源绿色电力证书核发及自愿认购交易制度的通知,' National Development and Reform Commission, 18 January 2017, at www.ndrc.gov.cn/xxgk/zcfb/tz/201702/t20170203_962895.html.



According to the 2017 policy, a green certificate would be issued for each megawatt-hour generated by wind and solar PV that is registered in China and receives the feed-in tariff subsidy. Hydro, nuclear, biomass, and other electricity sources did not qualify for green certificates, as the policy was intended mainly to promote wind and solar. A purchaser of a green certificate would receive an electronic PDF of the certificate, indicating the entity (power plant), the type of energy produced (wind or solar), the year of production, a unique number for the certificate, and the name of the purchaser (Chinese business or Chinese individual; international sales or sales to foreigners were not possible). The purchaser would not receive any physical electricity supplies as a result of the purchase: in the industry parlance, a certificate represented the purchase only of the green electricity ‘attributes’—in other words, the right to claim purchase of wind or solar electricity. No other attribute claims, such as regarding carbon or other emissions, were made for the certificates. To ensure maximum revenue for renewable generators, no secondary trading was allowed. This design proved unattractive to most potential buyers.

According to the initial policy document issued by the National Development and Reform Commission (NDRC) and the NEA, green certificates became available for purchase during a pilot period starting on 1 July 2017 as a voluntary market.³⁷ The document indicated that the voluntary market would be transitioned into a compulsory market starting in 2018. However, the compulsory market has not materialized.

While the green certificate policy included several objectives, such as promoting renewable energy development and encouraging private sector uptake of clean energy, the main purpose from the beginning was resolving the deficit in funds available to pay subsidized feed-in tariffs. Even in recent years, as the green certificate market has developed in new directions, resolving this deficit continues to be cited as one of the major purposes of the policy. For example, as late as November 2022, Huaxia Energy wrote, ‘As the green certificate trading market matures, the pressure on government renewable energy subsidies can be reduced’.³⁸

In 2019, the NDRC and the NEA expanded the number of projects eligible to issue green certificates, including grid parity onshore wind power and centralized solar PV projects.³⁹ In 2020, the Ministry of Finance set a time limit for renewable subsidies to facilitate transition to the green certificate market: 20 years from the date of grid connection for wind power and solar PV power generation projects, and 15 years after the date of grid connection for biomass power generation projects. Regardless of whether such a project has reached the full life-cycle subsidy, it would no longer enjoy the central government’s financial subsidy funds; instead, such projects would be instructed to issue green certificates.⁴⁰

For several years, China has also set provincial quotas for clean energy purchased—known as a ‘renewable energy purchase obligation’—specifying percentage values for overall renewable energy as well as for non-hydro renewables. The policy specified that provinces and covered entities (provincial grid companies as well as major energy consumers) could meet their quotas through various means, including (1) normal grid company purchase of guaranteed full operating hours from renewable plants, (2) direct power purchase or bilateral trading of excess renewable energy from wind and solar plants that produce beyond the guaranteed minimum purchase amounts, and (3) purchase of green certificates. However, the policy did not lead directly to an uptick in green certificate purchases, given that covered entities could more easily meet the quotas by direct purchase of renewables, such as through a power purchase agreement.⁴¹

Though the renewable energy obligation is often compared to the renewable portfolio standard policy in the United States, in practice it differs in several ways. Unlike the renewable portfolio standard, renewable obligation targets are set on an annual basis for the present year, or at most a year ahead,

³⁷ ‘国家发展改革委、财政部、国家能源局关于试行可再生能源绿色电力证书核发及自愿认购交易制度的通知,’ National Development and Reform Commission and National Energy Administration, 3 February 2017, at www.waizi.org.cn/law/16690.html.

³⁸ ‘国内绿证发展趋势与发电企业应对策略,’ Huaxia Energy, 30 November 2022, at <https://hxny.com/nd-81443-0-17.html>.

³⁹ ‘关于积极推进风电、光伏发电无补贴平价上网有关工作的通知,’ National Development and Reform Commission and National Energy Administration, 7 January 2019, at www.ndrc.gov.cn/xxqk/zcfb/tz/201901/t20190109_962365.html.

⁴⁰ ‘关于促进非水可再生能源发电健康发展的若干意见,’ Ministry of Finance, 20 January 2020, at www.gov.cn/zhengce/zhengceku/2020-02/03/content_5474144.htm.

⁴¹ Yuhuan Shen and Caroline Addy, ‘Renewable energy in China—here’s what you need to know,’ South Pole, 8 April 2022, at www.southpole.com/blog/renewable-energy-in-china-heres-what-you-need-to-know.



and so far are based largely on the amount of renewable energy expected to be added, rather than on a policy target designed to spur additional investment in renewable capacity.

Although for several years there was minimal purchase of green certificates—for reasons discussed below in the section on ‘Problems and Challenges’—policymakers continued to refer to green certificates and green power trading as important elements of ongoing power market reforms. In 2022, the NDRC stated that the establishment of a well-functioning green certificate market—with the goal of encouraging more private sector involvement in renewable energy—is part of the goals for China’s sustainable consumption and peak carbon emissions by 2030.⁴² The 14th Five-year Plan for a Modern Energy System, issued in March 2022 by the NDRC, also mentions the need to integrate electricity, carbon, and green power markets.⁴³

In 2022, the NDRC took a further measure to promote renewable energy by stating that provincial energy consumption quotas—under the system known as ‘dual control’, which sets targets for total energy consumption as well as energy intensity—would be adjusted such that incremental utilization of renewable energy (including hydro, biomass, wind, and solar) would not count against the annual quotas. The NDRC stated that green certificates issued to energy-consuming companies in each province would be used as the basis for the calculation, and provinces should upgrade their energy tracking systems to incorporate green certificates in the energy quota calculations. Secondary transfer of green certificates would be allowed ‘in principle’, though it is unclear if secondary *trading* would be permitted or, more conservatively, just a single sale from a generator to a consumer.⁴⁴ Since green certificates are presently available only for wind and solar energy, and the NDRC policy is stated only in general terms, it is unclear how this secondary transfer would be implemented in practice.⁴⁵

In August 2023, a new green certificate policy was announced by the NDRC together with NEA and the Ministry of Finance that significantly expanded and shifted the green certificate programme.⁴⁶ The new policy includes the following significant measures:

1. Green certificates can now include all types of renewable energy, including hydropower and biomass, not just wind and solar; however, existing hydropower projects will not receive green certificates, only new, “market-oriented” hydropower after 1 January 2023 will qualify. The NDRC also expects that non-electricity renewable consumption will eventually be included at a later date. Distributed wind and solar generators can also receive green certificates.
2. For the purposes of the Dual Control policy, green certificates can be used to show compliance.
3. Trading is allowed, but “in order to prevent speculation” only a single trade will be allowed “at this stage,” – meaning just the sale from a generator to a buyer, with bilaterally-negotiated prices that are published on trading platforms.⁴⁷
4. “In principle,” domestic renewable energy producers can only use green certificates, and may not issue I-RECs. International recognition and purchasing of green certificates should be

⁴² ‘促进绿色消费实施方案,’ National Development and Reform Commission, 21 January 2022, at www.ndrc.gov.cn/xwdt/tzgg/202201/P020220121303052384813.pdf.

⁴³ ‘十四五现代能源体系规划 [14th Five-Year Plan for a Modern Energy System],’ National Development and Reform Commission, March 2022, at www.ndrc.gov.cn/xxgk/zcfb/ghwb/202203/P020220322582066837126.pdf.

⁴⁴ ‘关于进一步做好新增可再生能源消费不纳入能源消费总量控制有关工作的通知 [Notice on ensuring incremental renewable energy is not included in total energy control],’ National Development and Reform Commission, 16 November 2022, at www.ndrc.gov.cn/xxgk/jd/jd/202211/t20221116_1341436.html. Regarding secondary trading, the document states that green certificates ‘原则上可以转让 [in principle can be transferred],’ which could refer to a single sale from generators to users, or to secondary trading.

⁴⁵ Wang Zhixuan, ‘王志轩：我国绿色电力市场化政策评述及改革建议 [Wang Zhixuan: China’s green power market policy and reform suggestions],’ China Electricity Council, 18 January 2023, at www.cec.org.cn/upload/1/pdf/1611189701502.pdf.

⁴⁶ ‘关于做好可再生能源绿色电力证书全覆盖工作促进可再生能源电力消费的通知 [Notice on Completing Work to Enable Green Certificates to Fully Cover Renewable Energy and Promote Renewable Energy Consumption],’ China National Development and Reform Commission, 3 August 2023, at <https://zfxxgk.ndrc.gov.cn/web/iteminfo.jsp?id=20256>

⁴⁷ ‘国家发展改革委、国家能源局有关负责同志就《关于做好可再生能源绿色电力证书全覆盖工作 促进可再生能源电力消费的通知》答记者问,’ National Development and Reform Commission, 3 August 2023, at https://www.ndrc.gov.cn/xxgk/jd/jd/202308/t20230803_1359098_ext.html



encouraged and China should participate in setting international standards for mutual recognition.

5. Green certificates should be integrated with carbon trading, though the method for such integration is still to be studied. It is unclear whether green certificates would eventually be considered as carbon offsets or CCERs for the purpose of the China carbon ETS.

The new policy represents a significant evolution of the green certificate programme, both by expanding the qualifying generation and by clarifying that green certificates will be used for the Dual Control policy, and effectively banning the issuance of I-RECs by domestic renewable generators. If fully implemented, the policy on Dual Control could substantially increase the demand for green certificates. While banning the issuances of I-RECs may seem harsh, this would effectively deter double-counting of Chinese renewables under both green certificates and I-RECs, and should therefore improve the international recognition of Chinese green certificates.

Electric power market reforms and direct green power trading

Ongoing power market reforms in China that began in 2015 have had a significant impact on renewable energy policies and have recently begun to result in more direct trading of renewable energy, but they have thus far had little interaction with green certificate policies. Whereas wholesale power market trading initially focused on monthly and annual operating hour contracts from coal plants, renewable energy projects have been increasingly encouraged to participate in bilateral transactions. This opened up the possibility of direct power purchase agreements between renewable energy producers and consumers, albeit for a comparatively short period, such as a year (as opposed to a decade or longer in North America). Pilot spot markets initiated in certain provinces have also encouraged the (limited) participation of renewable energy generators, albeit usually as price-takers rather than bidders, usually for limited volumes, and often resulting in losses for new energy producers.⁴⁸ Provinces have also traded excess renewable energy interprovincially, albeit on a centralized basis with provincial grid companies acting as single buyers and sellers, based on fixed prices and volumes.⁴⁹

Bilateral trading of green energy has increased rapidly since 2020. In September 2021, the Beijing Power Exchange Centre and the Guangzhou Power Exchange Centre held a pilot trading session for direct bilateral trading of green energy between provinces, reporting transactions of 8 billion kWh, for terms of a year or multiple years. Over 250 market entities in 17 provinces participated in transactions.⁵⁰ While a continuous market has yet to develop, provincial and interprovincial bilateral trading of renewable electricity continues to grow. Zhejiang Province, for example, reported that its provincial green power market reached 2.7 billion kWh in 2022, six times greater than the prior year.⁵¹

Potential resolution of feed-in tariff subsidy deficit

As noted above, by 2021 the renewable energy surcharge deficit had reached RMB 400 billion (\$56 billion). While most renewable power plants are owned by state-owned firms—meaning the subsidy deficit is basically an IOU from one government branch to another—media reports have consistently shown that these deficits cause higher financing costs for renewable project developers and for

⁴⁸ For two recent summaries of conditions for renewables in provincial spot market pilots, see: ‘最高损失 30%，新能源参与现货交易现状与影响 [Highest losses of 30%, new energy participation in spot trading situation and impact],’ Storage World Net (Chunjiewang), 3 May 2023, at http://chunjiewang.net/domestic_detail/8104; Zhou Jiawei, ‘新能源参与现货市场之我见 [New energy participation in spot markets and my views],’ The Paper, 20 February 2023, at http://paper.people.com.cn/zgnyb/html/2023-02/20/content_25967414.htm.

⁴⁹ ‘跨省区电力市场交易相关问题及政策建议 [Cross-provincial power market problems and policy suggestions],’ China Electricity Council, abstract posted to In-en.com, 11 February 2022, at <https://m.in-en.com/finance/html/energy-2250539.shtml>.

⁵⁰ ‘我国绿色电力交易试点正式启动——绿电消费有了‘中国方案’ [China green electricity trading pilot kicks off, green power has a ‘Chinese solution],’ People’s Government of China, 9 September 2021, at www.gov.cn/xinwen/2021-09/09/content_5636363.htm.

⁵¹ ‘浙江 2022 年绿色电力交易增长 6 倍多 [Zhejiang 2022 green power market trading increases by 6 times],’ Xinhua, 10 February 2023, at www.gov.cn/xinwen/2023-02/10/content_5740994.htm.



equipment suppliers, particularly for private players.⁵² After years of letting renewable energy surcharge deficits accumulate, the advent of grid parity (unsubsidized) wind and solar, and forecasts that the deficit would continue to widen through 2028, seem to have pushed the government to finally seek resolution.

In 2021, the government issued various policies promoting options for supporting renewable energy firms, including securitization of feed-in tariff payment arrears.⁵³ During 2022, there were consistent reports that companies were receiving full payment of feed-in tariffs, including those arrears. The government had also substantially increased its fiscal budget for making catch-up payments.⁵⁴ In 2023, the Ministry of Finance, the NEA, and the NDRC also announced that projects with a high proportion of green certificate or bilateral green power trading sales would qualify for priority payment of subsidies,⁵⁵ suggesting that the subsidy deficit is not completely resolved. Overall, it appears that one of the major motivations for the introduction of the green certificate policy in 2017 may be now at least partly on the way to resolution, meaning green certificates can focus on unsubsidized projects rather than serving as a subsidy replacement.

Problems and challenges for China's green certificate market

Low transaction volumes

From the inception of the green certificate market in 2017, trading volumes—or, more accurately, purchase amounts, given that secondary trading was not permitted—were small. From 2017 to 2020, a total of 300 million green certificates were issued nationwide, but only 43,000 were purchased, roughly 0.1 per cent. By one calculation, in 2019 green certificates only accounted for 0.8 per cent of China's renewable electricity generation and 0.1 per cent of the country's electricity consumption.⁵⁶

Low transaction volumes related in part to the design of green certificates as a substitute for feed-in tariff subsidies that had already been granted. This meant that a wind or solar generator would forgo a contractual payment from the government in exchange for selling the green certificate. Wind and solar generators continued to view such subsidy payments as guaranteed, albeit subject to delays, and were reluctant to sell green certificates for feed-in tariff subsidized electricity for substantially less than the subsidies already promised. In addition, wind and solar feed-in tariffs were set at different levels, which has led to drastically different prices for wind and solar green certificates and for subsidized versus unsubsidized green certificates. In 2022, the average offer price for green certificates for subsidized wind power was RMB 208.6/MWh (\$29/MWh), and for subsidized solar PV it was 628.8/MWh (\$88/MWh). Given the wholesale electricity price was around RMB 474/MWh (\$66/MWh),⁵⁷ the average green certificate offer price (which does not include physical electricity, only the certificate itself) represented a premium of 44 per cent or 132 per cent for wind and solar PV, respectively. Only one transaction for subsidized green certificates was reported for the year.⁵⁸ Though private companies may have some willingness to purchase green energy at a premium, despite other concerns, this level of premium was prohibitive for anything but symbolic purchases in nominal amounts.

⁵² Xi Jinghua, '4000 亿缺口, 拖欠六年的可再生能源补贴有望补齐了 [After 6 years, RMB 400 billion renewable energy subsidy deficit has potential to be made whole], Jiemian News, 28 March 2022, at <https://m.jiemian.com/article/7262295.html>. Yuki Yu, 'How to harvest from China's renewable asset sales— or not,' Energy Iceberg, 25 November 2019, at <https://energyiceberg.com/china-renewable-asset-sales>.

⁵³ Xi Jinghua, '4000 亿缺口, 拖欠六年的可再生能源补贴有望补齐了 [After 6 years, RMB 400 billion renewable energy subsidy deficit has potential to be made whole], Jiemian News, 28 March 2022, at <https://m.jiemian.com/article/7262295.html>.

⁵⁴ '可再生能源发电补贴核查'进行时, 4000 亿缺口如何填补 [Renewable energy subsidy inspection underway, how to fill the cumulative deficit of RMB 400 billion], Number 1 Caijing, 3 November 2022, at <https://m.yicai.com/news/101583223.html>.

⁵⁵ '关于享受中央政府补贴的绿电项目参与绿电交易有关事项的通知 [Notice regarding apportionment of central government subsidies and green power trading participation], China Ministry of Finance, National Energy Administration, National Development and Reform Commission, 27 February 2023, at <https://m.in-en.com/article/html/energy-2322611.shtml>.

⁵⁶ '中国绿证市场进入快速发展期,' Allbright Law, 2023, at www.allbrightlaw.com/CN/10531/16cd580e114551a1.aspx.

⁵⁷ ¥474/MWh represents the average benchmark coal tariff plus a 20 per cent trading range cap implemented in 2021. See Yuying Qian, 'China raises cap on electricity price: What has changed and possible impact for business,' Integral Energy, March 2022, at www.integralnewenergy.com/?p=32919.

⁵⁸ Wang Zhixuan, '王志轩: 我国绿色电力市场化政策评述及改革建议 [Wang Zhixuan: China's green power market policy and reform suggestions], China Electricity Council, 18 January 2023, at www.cec.org.cn/upload/1/pdf/1611189701502.pdf.



Subsequently, as more wind and solar plants have come online with no feed-in tariff subsidy, the green certificate market has started to grow. According to NEA data, in 2021 over a half-million green certificates were purchased, and purchases rose by a factor of 15 to reach 10.3 million in 2022, accounting for roughly one-sixth of certificates issued (Table 1).⁵⁹ Both wind and solar green certificates are being purchased in significant volumes.

Table 1: Cumulative green certificates sold as a percentage of total green certificates issued

Date	Wind (%)	Solar (%)
Jul 2017	0.03	0.04
Nov 2018	0.14	0.01
Jun 2019	0.15	0.01
Oct 2020	0.16	0.00
Oct 2021	0.28	0.21
Aug 2022	3.15	15.50
Apr 2023	16.76	40.10

Source: OIES, based on Green Energy Platform data.

Though trading volume has increased, there remain unexplained differences in trading across provinces. Taking the wind power industry as an example, as of 11 October 2022, Jilin, which has the highest transaction volume, had traded a total of 941,792 wind power green certificates, while Ningxia, which has the lowest transaction volume, had traded six wind power green certificates.⁶⁰ While some disparity could be explained by the relative availability of subsidized versus unsubsidized certificates, that difference could not be large enough to explain this degree of variance. One possibility is that transactions are strongest in provinces with more foreign investment or major supply chains for major international consumer brands.

While the August 2023 green certificate policy mentions “trading,” it explicitly states that only a single trade is permitted from generator to buyer. An NDRC Q&A document issued at the same time as the policy states that this will prevent “speculation.”⁶¹ Disallowing trading also reduces the need for tracking systems and simplifies administration of the programme. However, the absence of trading reduces the attractiveness of green certificates for several reasons. Trading serves multiple purposes, including in attribute markets created by policy: Trading provides additional price transparency, allows hedging to manage risk, and gives businesses flexibility when their operations change or if parts of their business operations change hands. In such cases, trading gives an artificial asset like a green certificate additional value by insuring that the purchaser is not stuck with it in case their own situation changes.

Lack of additionality

Under the initial green certificate system, where all green certificates were issued by feed-in tariff subsidized wind and solar projects and where the purchase of a certificate replaced the government’s obligation to pay the subsidy, the purchase of the green certificate did not encourage or relate to construction of new or additional wind and solar capacity. In effect, the money was passed through to

⁵⁹ ‘国家能源局发布 2022 年可再生能源发展情况并介绍完善可再生能源绿色电力证书制度有关工作进展等情况,’ National Energy Administration, 14 February 2023, at www.gov.cn/xinwen/2023-02/14/content_5741481.htm.

⁶⁰ ‘国内绿证发展趋势与发电企业应对策略,’ Huaxia Energy, 30 November 2022, at <https://hxny.com/nd-81443-0-17.html>.

⁶¹ ‘国家发展改革委、国家能源局有关负责同志就《关于做好可再生能源绿色电力证书全覆盖工作 促进可再生能源电力消费的通知》答记者问,’ National Development and Reform Commission, 3 August 2023, at https://www.ndrc.gov.cn/xxgk/jd/jd/202308/t20230803_1359098_ext.html



the government, almost resembling a charitable donation. As one Chinese expert put it, if a company wants to make a charitable donation, ‘wouldn’t it be more meaningful to just give the money to a school?’⁶²

The evolution of green power trading and green certificate trading away from substituting for feed-in tariff subsidy payments does not resolve the issue of additionality. Two types of green power trade—excess operating hours beyond ‘full purchase’, and projects whose original feed-in tariff has expired—arguably do not constitute additional energy production, since these projects were originally built under the policy-supported feed-in tariff. Grid parity projects appear more likely to qualify as additional, since the main policy support they receive is in the form of preferential (but unsubsidized) 20-year power purchase agreements.

Of course, additionality is not an absolute requirement and has not necessarily been scrupulously abided by in the design of green power markets worldwide. The European guarantee of origin (GO) market, for example, has resulted in a large number of transactions from older hydropower projects in Scandinavia that predate the GO market, or the low-carbon energy transition itself, by decades or more. The US renewable energy certificate (REC) market, which includes both mandatory and voluntary REC markets, does not have any special requirements for excluding projects that receive subsidies, and doing so would be impractical given that all wind and solar in the United States has generally received the production tax credit or investment tax credit.

Green power market expert Wang Zhixuan has written that additionality will probably not be a feature of future green power markets in China either, since the purpose of such markets is related to the country’s policy goals, such as promoting domestic clean energy technology or encouraging greater uptake of renewables by various private and state-owned companies, even after the issue of the subsidy payment deficit is resolved.⁶³ For example, if green certificates come to play a larger role in fulfilling provincial renewable energy quotas or energy control quotas (under dual control), the market would not depend on additionality.

Double-counting

Because the green certificate market has evolved slowly, and not in tandem with other policy changes in power markets and carbon markets in China, there have been repeated concerns about double-counting of green certificates. In bilateral power transactions in which the purchaser of green energy has not explicitly acquired the green certificates for a power transaction, they might still claim credit for purchasing wind or solar power, while the power producer sells its green certificates separately. In its August 2023 green certificate policy, the government clarified that green certificates for power purchase agreements or mid-to-long-term power transactions would be delivered in batches to the purchasers, and since no secondary trading is allowed this implies no potential for double-counting will exist. Similarly, the August 2023 policy states that “in principle,” domestic renewable generators may only receive Chinese green certificates, and not I-RECs, potentially deterring double selling of green power on international markets. These reforms are certainly helpful, but it may still be difficult to fully monitor all claims of green power consumption, especially when such claims are made to consumers via advertising. Third-party verification is the usual method, but establishing a reliable third-party verification scheme for all corporate green power claims may take some time.

There have been persistent calls for green power markets and carbon markets to be further integrated. Currently, the carbon market covers only the coal power and coal heating sectors, whereas feed-in tariffs, green certificates, and the power market are considered separate. Covered entities can meet their carbon market obligations in part through China Certified Emission Reduction credits (CCERs), for up to 5 per cent of their annual obligation. The issuance of CCERs was suspended for years due to concerns about double-counting, and recently the government has issued a guidance document specifying that renewables for which the green certificates have been sold would not qualify for

⁶² Yao Jinnan and Jia Kehua, ‘绿色电力证书为啥少人问津？[Why do so few people care about green certificates?],’ Beijinging, 2021, at <https://news.bjx.com.cn/html/20210118/1130286.shtml>.

⁶³ Wang Zhixuan, ‘王志轩：我国绿色电力市场化政策评述及改革建议 [Wang Zhixuan: China’s green power market policy and reform suggestions],’ China Electricity Council, 18 January 2023, at www.cec.org.cn/upload/1/pdf/1611189701502.pdf.



CCERs.⁶⁴ Indeed, incorporating renewables into the CCER market would result in double-counting of environmental attributes. Later, in the August 2023 green certificate policy, the government reiterated its intention to link the carbon and green certificate markets, while clarifying that this remains subject to further study.

The link with the carbon market is important, both for the domestic carbon market and for potential compliance with international carbon requirements. Companies in sectors that would be exposed to the European Union (EU) Carbon Border Adjustment Mechanism (CBAM) would potentially benefit if they could offset carbon emissions (at least for EU compliance) by purchasing green certificates as proof of cleaner production. Even if green certificates are more expensive than prices in China's domestic carbon market, they are bound to be cheaper than carbon prices in Europe, which will determine the level of the CBAM. There have been calls to establish an official link between purchase of green certificates and CCERs.⁶⁵ For now, it appears unlikely that China green certificates would offset any CBAM exposure, especially if China's policy officially considers green certificates entirely separate from carbon markets.

Lack of transparency

China's present green power market, both for power purchase agreements and for green certificates, has inadequate transparency around rules and policies as well as, crucially, prices and trading. The coexistence of the power purchase agreement market, the green certificate market, and power markets, and their stepwise evolution along separate timelines, shows that the present green power market has developed in an ad hoc fashion.

In terms of regulation, there remain concerns that rules and requirements at the highest level are still unclear. Scholars at the Development Research Centre of the State Council have noted three problems in this regard. First, though the National Renewable Energy Information Management Centre issues green certificates, it has not clarified which unique environmental attributes the certificates represent (renewable production, or all environmental attributes) or whether the green certificate is the only certification of those attributes. A February 2023 NEA statement clarifies that green certificates are the sole certificate of green attributes,⁶⁶ a statement further reemphasized in the August 2023 policy, but this may not fully resolve the issue.⁶⁷ A long-term contract for distributed solar or offshore wind has environmental attributes, but these sources cannot obtain green certificates. Further, the meaning of green certificates depends in part on the perception and requirements of different buyers, which may be located outside of China or face scrutiny from media or environmental organizations that question the attributes of green certificates, making it difficult for a single government body to control the perceptions of the green certificate and its attributes. Second, though green certificates can be purchased through the power trading centre where the green power trading pilot is located or through the China Green Power Certificate Subscription Trading Platform, there is insufficient disclosure on these platforms of important attributes of each certificate. Lastly, China lacks an effective third-party certification system and a mutual recognition mechanism between green certificates and the standards of important international low-carbon organizations.⁶⁸

Pricing transparency is also lacking. While the National Renewable Energy Information Management Center is the official platform where companies can select a project from which to purchase green

⁶⁴ 'China's domestic voluntary carbon market reboot to shake up global offsets trade,' S&P Global, 8 May 2023, at www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/050823-chinas-domestic-voluntary-carbon-market-reboot-to-shake-up-global-offsets-trade; 'Corporate net zero pathways: Shandong clarifies rules to avoid the double-counting of environmental attributes,' Azure International, 22 August 2022, at www.azure-international.com/corporate-net-zero-pathways-shandong-clarifies-rules-to-avoid-the-double-counting-of-environmental-attributes.

⁶⁵ Han Xue and Gao Shiji '进一步完善绿电市场化机制的建议,' China Development Press, 4 July 2023, at <https://cdo.developpress.com/?p=14157>.

⁶⁶ '王大鹏：绿证的核发和交易对推动可再生能源高质量发展，提升绿色电力消费水平具有重要意义 [Wang Dapeng: Green certificate verification and trading and renewable energy high quality development; increasing green power consumption has important meaning],' National Energy Administration, 13 February 2023, at www.nea.gov.cn/2023-02/13/c_1310697051.htm.

⁶⁷ Han Xue and Gao Shiji '进一步完善绿电市场化机制的建议,' China Development Press, 4 July 2023, at <https://cdo.developpress.com/?p=14157>.

⁶⁸ '韩雪、高世楫 | 低碳转型背景下绿电市场化机制设计的思考,' Sohu News, 5 December 2022, at www.sohu.com/a/613798446_807373.



certificates, there is significant activity in markets outside of the formal platform.⁶⁹ Further, pricing information on the platform suggests the pricing remains static and conditions for trading somewhat opaque. As already mentioned, subsidized projects maintain high prices and low trading volume, reflecting unwillingness to sell green certificates at lower prices and forgo subsidy revenue. However, for unsubsidized projects, prices are almost all fixed at RMB 50 (\$7) per certificate, with only a few offering lower prices. This may reflect government guidance about the appropriate price level, or it may indicate that companies trade more certificates by direct, bilateral negotiation, not via the official platform. Effectively, there is no proper market for green certificates and, therefore, no consistent pricing information available to potential buyers.

The August 2023 green certificate policy clarifies that while multiple trading platforms will continue to exist, all green certificate transactions should be published in a timely fashion—including listed trades as well as bilaterally negotiated transactions. However, green certificates will be issued in batches to companies engaged in mid-to-long-term contracts with renewable generators, meaning that this market and its prices will continue to be separate from the green certificate market.

Interestingly, of the 99 projects that sold a green certificate on the platform in 2022, 24 projects sold only one certificate, often to themselves. Ten projects account for 63 per cent of trades, and 20 projects account for 87 per cent of the total green certificates sold. Some projects are clearly favoured in green certificate trading, even though the prices are uniformly at RMB 50 per certificate. Price competition is not a factor in this market, and many trades may represent tests or demonstrations that the platform works or that companies are participating at some de minimus level.

Further complicating the issue of price transparency is the direct purchase of green certificates from generators. Directly purchased certificates are often cheaper, sometimes from RMB 20-30.⁷⁰ Such deals are more likely when certificates are purchased in bulk, but negotiating these purchases comes with significant transaction costs for both sides, meaning renewable generators are often only willing to consider direct transactions when the purchase volume is high.⁷¹

Competition with International Renewable Energy Certificates

Many corporate buyers of renewable energy have aggressive targets for achieving net-zero emissions through the purchase of renewable certificates of one kind or another. BMW, BASF, Sumitomo, and Apple have all actively participated in China's green power markets. However, companies with global operations have other options, even if they have substantial operations in China.

International Renewable Energy Certificates, or I-RECs, have existed for years and are certified by a variety of third-party entities. I-RECs are widely available in China, and many Chinese companies prefer I-RECs over Chinese green certificates due to their global profile and established history.⁷² Chinese companies can also issue I-RECs for sale internationally, making the I-REC a direct competitor of the domestic green certificate. Further, I-RECs can be traded, which is an important attribute for most companies, since business operations change constantly and companies can hardly forecast their or their supply chains' exact electricity needs.

However, I-RECs pose certain problems in their own right. Up to June 2021, only state-owned Chinese enterprises in which the national or provincial government owned more than 50 per cent of a generation project were eligible for I-RECs, which are available for trading.⁷³ Since June 2021, I-REC regulations have been amended to allow private Chinese companies to be eligible for I-RECs as well.⁷⁴

⁶⁹ '绿证认购平台,' China Green Certificate Platform, accessed 31 May 2023, at www.greenenergy.org.cn.

⁷⁰ '国内绿证为啥少人问津,' China Energy News, 13 December 2021, at <https://news.bjx.com.cn/html/20211213/1193224.shtml>; '低碳目标刺激企业购买绿证, 但不是买了就行,' Green Economy, 9 July 2022, at <https://m.jiemian.com/article/7705107.html>.

⁷¹ '现在可以通过什么方式购买绿证?', Carbon Emissions Information Net, 29 March 2022, at www.rtans.com/Carbon_emissions/1648521950718.html.

⁷² '国内绿证为啥少人问津,' China Energy News, 13 December 2021, at <https://news.bjx.com.cn/html/20211213/1193224.shtml>.

⁷³ '阳光视点 | 国内企业如何开展国际绿证交易,' Sunshine Overview, 8 May 2020, at www.sunshinelawfirm.com/newsinfo.aspx?id=2171.

⁷⁴ '掘金国际绿证: 新能源企业如何通过 I-REC 提升公司收益?', Jiaoma Energy, 2 September 2022, at <https://mp.ofweek.com/ecep/a356714674327>.



Previously, I-RECs did not limit the domestic subsidies that projects could receive, meaning Chinese state-owned enterprises could receive and sell I-RECs for power produced by projects that received the subsidized feed-in tariff and could sell Chinese green certificates for the unsubsidized portion. As of January 2023, however, I-REC no longer issues certificates to companies receiving domestic subsidies.⁷⁵

Following the August 2023 green certificate policy, it appears that domestic generators will no longer be permitted to issue I-RECs, though there is nothing in the policy to prevent companies in China or multinationals with Chinese operations from using I-RECs to achieve climate or renewable energy goals.

Another internationally traded green energy certificate is the APX TIGR, which is issued by a United States-based registry. Currently, the I-REC is favoured over APX TIGR because of its lower price. APX TIGR is usually traded at around RMB 20–30 per certificate, while the I-REC is traded at around RMB 2–20. Part of the reason for its lower price is that I-REC issues certificates to hydro projects while APX TIGR does not, and hydro projects tend to have lower pricing.⁷⁶ Notably, both the I-REC and APX TIGR trade at prices far lower than Chinese green certificates, which typically start at around RMB 50 for unsubsidized wind and solar projects.

International recognition

To date, China's green certificates have not achieved widespread international recognition. Currently, green certificates are designed for China's domestic market and to meet domestic clean energy objectives. As already mentioned, the green certificate policy includes elements designed to help provinces comply with their renewable obligations, as well as to provide additional revenue to renewable energy producers. Many corporations with operations outside of China might be interested in voluntarily purchasing low-cost green certificates in China if these were available, to cover electricity consumption by their operations either in China or globally. Indeed, the top purchasers of green certificates in China to date are mainly international companies. For many such companies, international recognition matters for the credibility of environmental claims.

Various Chinese experts have offered different explanations for why Chinese green certificates have yet to be widely accepted. The simplest explanation is lack of time and experience. Although the green certificate market is over five years old, the low purchase volumes and the purpose of the original green certificate to be a substitute for the payment of feed-in tariff subsidies mean that only recently, with the advent of unsubsidized green certificates, has there been significant market interest in purchasing Chinese green certificates. Since purchase volumes have only increased in the last two years, there are naturally only a few players with experience in the market. For international companies, I-RECs are also easier to explain and document to corporate management and international investors or third-party ESG (environmental, social, and governance) verifiers.⁷⁷ Green power market expert Wang Zhixuan has also noted that the legal basis and functions of the Chinese green certificate remain vague and pricing lacks transparency and uniformity, which reduces the certificates' attractiveness compared with I-RECs for large international players.⁷⁸

We have examined the requirements of three major third-party entities: RE100, EcoVadis, and the Science-Based Targets Initiative (SBTi). For each, there is some ambiguity as to whether these organizations recognize Chinese green certificates.

⁷⁵ '国际权威绿证签发机构 I-REC 在中国完成全球首个非国有电站注册合作!', Sohu News, 3 August 2021, at www.sohu.com/a/481240473_703050.

⁷⁶ '绿色电力的'身份证'——绿色电力证书认购指南', WLY Energy, 22 August 2022, at <https://wly-energy.com/IndustryNews/15.html>.

⁷⁷ Yao Jinnan and Jia Kehua, '绿色电力证书为啥少人问津? [Why do so few people care about green certificates?]', Beijinging, 2021, at <https://news.bjx.com.cn/html/20210118/1130286.shtml>.

⁷⁸ Yao Jinnan and Jia Kehua, '绿色电力证书为啥少人问津? [Why do so few people care about green certificates?]', Beijinging, 2021, at <https://news.bjx.com.cn/html/20210118/1130286.shtml>.



- Chinese green certificates meet **RE100** criteria for redemption and double-counting.⁷⁹ However, RE100 states that to avoid double-counting and to enable credible claims, RE100 can only accept claims if the user of the GEC follows the requirement to redeem all other instruments (for example, greenhouse gas (GHG) offsets and any other energy attribute certificate (if issued for the same renewable energy generation)) in order to achieve attribute aggregation and claim renewable energy usage in a credible manner.⁸⁰ Some third-party brokers, such as Envision, claim that they are able to help customers satisfy RE100 requirements with their green certificate transactions.
- **EcoVadis** recognizes Chinese green certificates. According to Jason Yan, a senior sustainability analyst from EcoVadis, 'EcoVadis recognises the Chinese government launching the Green Electricity Certificate (GEC) system as a means for businesses and individuals to buy renewable energy voluntarily. GEC is currently valued and credited in EcoVadis rating as an evidence for the **"Purchase(s) and/or generation of renewable energy"** under the energy consumption and GHGs criteria.' However, EcoVadis evaluates corporate claims across 21 indicators of corporate social responsibility, and only two (energy and GHGs, and supplier environmental performance) are related to green certificate requirements.
- **SBTi** recognizes the use of energy attribute certificates that adhere to the Scope 2 emissions standards of the Greenhouse Gas Protocol.⁸¹ The Greenhouse Gas Protocol recognizes instruments according to its eight Scope 2 quality criteria.⁸² These criteria require that an instrument must (1) convey the direct GHG emission rate attribute associated with the unit of electricity produced; (2) represent an exclusive instrument for GHG emission rates for electricity; (3) be tracked, redeemed, retired, or cancelled on behalf of the reporting entity; (4) be issued and redeemed as close as possible to the period of energy consumption to which the instrument is applied; (5) be sourced from the same market in which the reporting entity's electricity-consuming operations are located and to which the instrument is applied; (6) be calculated based on delivered electricity, incorporating certificates sourced and retired on behalf of its customers; (7) ensure all contractual instruments conveying emissions claims be transferred to the reporting entity only; and (8) provide an adjusted, residual mix characterizing the GHG intensity of unclaimed or publicly shared electricity. It is unclear whether China's green certificates meet all these criteria, given that they do not explicitly relate to GHG emissions, but rather to wind and solar electricity production. The prevention of double-counting of environmental attributes would be critical to ensuring China green certificates meet the SBTi criteria.

Given that international practices on renewable energy certification are hardly uniform and are always undergoing change, there is not a uniform best practice or international standard to compare with China's green certificate or green power purchase agreement market. Also, there is no clear timeline for a definite international standard to be developed, just as the timeline for the future evolution of China's green certificate market remains unclear.

International recognition of China's green certificates is also a major goal of Chinese policymakers. To push more companies in China to use Chinese domestic green certificates rather than alternatives, the NEA in November 2022 clarified that green certificates are the sole proof of environmental attributes of renewable energy in China.⁸³ The August 2023 green certificate policy calls for mutual recognition to be improved, and the NDRC notes that RE100 recognizes green certificates and the influence of green certificates among international companies "continues to expand," while also banning Chinese generators from selling I-RECs and disallowing secondary trading in Chinese green certificates. Notably, the August 2023 policy commits China to increasing the international recognition of Chinese green certificates, both by promoting them directly to companies and the public, and by "strengthening the research and formulation of international standards for green certificate issuance, measurement, and transactions, and improve the international recognition and influence of green certificates."

⁷⁹ 'Green Electricity Certificate (GECs) of China Technical Assessment Report,' RE100, August 2020, at www.there100.org/sites/re100/files/2020-10/Chinese%20GEC%20Paper_RE100_2020%20FINAL.pdf.

⁸⁰ 'Green Electricity Certificate (GECs) of China Technical Assessment Report,' RE100, August 2020, at www.there100.org/sites/re100/files/2020-10/Chinese%20GEC%20Paper_RE100_2020%20FINAL.pdf.

⁸¹ 'SBTi FAQ,' Science Based Targets Initiative, at <https://sciencebasedtargets.org/faqs#what-are-the-emissions-scopes-which-scopes-do-targets-have-to-cover>.

⁸² 'GHG Protocol Scope 2 Guidance,' Greenhouse Gas Protocol, at <https://ghgprotocol.org/scope-2-guidance>.

⁸³ Miao Fan, '可再生能源绿色电力证书新解方,' Solar OfWeek, 21 November 2022, at <https://solar.ofweek.com/2022-11/ART-260006-8420-30579757.html>.



Evolution of green certificates outside of China and potential impact on China's market

Just as China's green certificates have a unique purpose and origin—relating to China's feed-in tariff subsidy deficit—so too do RECs in North America and GOs) and Renewable Obligation Certificates in Europe and the United Kingdom.

The market for green certificates emerged from Europe in the 1990s as a market-based energy policy that, at least in theory, would allow the market to provide additional incentives to develop and produce renewable energy and would determine the price of this support.⁸⁴ However, prices of GOs have remained extremely low and are dominated by certain issuing countries and generation types, particularly hydro. In 2020, 760 TWh were traded as GOs in the EU, which corresponds to 80 per cent of the EU's renewable electricity generation. Based on Association of Issuing Bodies data, in 2019 the share of technologies among GO issuances was 54 per cent hydro, 20 per cent wind, 8 per cent biomass, 8 per cent fossil, 5 per cent nuclear, 4 per cent solar, and 1 per cent geothermal.⁸⁵ The geographic mismatch between GO buyers and sellers, and the dominance of hydro, has likely limited the extent to which GOs have contributed to the development of additional renewables in Europe. Austria and the Netherlands have taken the step of encouraging domestic purchase of GOs to, in turn, encourage more investment in local renewable energy to match domestic consumption.⁸⁶ Moreover, GO prices in the Netherlands increased after large power consumers committed to sourcing their GOs from the Netherlands only, indicating that increased interest of power consumers in local procurement can increase the value of GOs.

In the United States, the renewable portfolio standard began in the late 1990s as a way for states to mandate gradual increases in renewable energy as a share of the power mix. Trading certificates for compliance, as well as for sale to voluntary purchasers, was standardized nationally by the US Environmental Protection Agency in the late 1990s.⁸⁷ Working with non-governmental organizations and eventually with private companies seeking to procure renewables, the agency established the Green Power Partnership and completed the first voluntary REC transaction in 2000. Since then, REC trading has gone national, along with widespread development of power purchase agreements for clean energy. Independent verification entities, either with individual states or with regional transmission organizations, track and regulate the issuance and cancellation of RECs and ensure that environmental attributes are not double-counted, including across power purchase agreements and unbundled RECs. While the United States has no national policy mandating a certain level of renewables, wind and solar have received tax credits for roughly two decades; such subsidies exist alongside voluntary and state-mandated REC trading.

As public pressure on climate change rises, so too has corporate interest in renewable energy—along with criticism from the public and non-governmental organizations of questionable practices and imperfect policies. Media reports sometimes question whether corporate commitments to 100 per cent clean energy are real, and companies are responding by demanding more from generators and regulators who offer RECs and GOs. In both the United States and Europe, there are moves to significantly reform and alter the way green electricity is traded: one such reform is related to increasing the geographic match between electricity consumption and green energy purchased; another involves time-matching, sometimes referred to as '24/7 time-matching'. Google is one prominent company already committed to spatial and temporal matching of electricity demand and green energy procurement.

Scholars have started to recognize the importance of shifting away from megawatt-hours towards promotion of renewable energy produced at the right time and in the right place. In a study of green power markets in California, analysts found that procurement of new renewable energy in the middle of the day, when solar is plentiful, can create demand for new power imports and fossil energy to meet

⁸⁴ Poul Erik Morthorst, 'The development of a green certificate market.' *Energy Policy* 28.15, 2000, 1085–1094.

⁸⁵ Yan Qin, 'European GO market: overview and latest trend,' presentation, Refinitiv, 21 June 2021.

⁸⁶ 'Industry calls for domestic guarantees-of-origin power policies', Independent Commodity Information Services, 18 February 2021, at www.icis.com/explore/resources/news/2021/02/18/10607745/industry-calls-for-domestic-guarantees-of-origin-power-policies.

⁸⁷ 'REC questions & answers,' Environmental Tracking Network North America, 2018, at <https://resource-solutions.org/wp-content/uploads/2018/01/ETNNA-REC-QandA.pdf>.



the evening ramp.⁸⁸ Ensuring companies procure clean power (including storage) using hourly accounting has a far higher benefit for reducing carbon emissions in solar-dominated regions than pure 100 per cent renewable energy targets.

Currently, 24/7 time-matched RECs are only available in one market in the Midwest, known as MISO (the Midcontinent Independent System Operator). The Midwest Renewable Energy Tracking System (M-RETS), a private consortium in MISO that manages REC trading in the region, introduced hourly tracking for all RECs registered with its system starting in 2019.⁸⁹ In a detailed study of hourly REC trading, M-RETS cited a number of advantages. Time-matched REC purchases provide an incentive for installation of storage or a more diverse array of renewable energy sources with a flatter energy generation profile—or one more matched to load. Load-matching provides valuable information to the market and to grid planners. Further, load-matching works in both directions, providing an incentive for the user to adjust load during hours when renewable energy is scarce.

In Europe in 2022, the European Network of Transmission System Operators—Electricity (ENTSO-E) published a proposal to implement a version of 24/7 time-matching along with geographic matching of GOs. ENTSO-E suggests either hourly or 15-minute time-matching, reflecting the evolution of European spot markets towards more granular trading intervals to more closely reflect the fluctuations in renewable electricity output.⁹⁰ A 2021 paper from Eurelectric—supported by several major renewable energy producers such as Centrica, Vattenfall, EDF, Endesa, and Iberdrola; green electricity consumers such as Amazon, Microsoft, and Ikea; and trading exchange EEX—also called for 24/7 time-matching for corporate renewable sourcing.⁹¹ Enel is one of the largest European energy providers already offering time-matching for renewables.⁹²

If time- and spatial-matching of green power becomes commonplace in Europe and North America, this could cause an additional disconnect with China's present green certificate system. While China's green certificate market is national, China lacks a national electricity spot market. China also suffers from major transmission bottlenecks at the provincial and regional levels, especially between western and eastern China and at periods of peak summer demand. Further, China has struggled to improve the flexibility of its power system and has deployed various subsidies and market instruments to try to boost the flexibility of both renewables and conventional power. This includes establishing a separate market for power plant ramping—classified in China as an ancillary service—as well as requiring energy storage at new renewable facilities or introducing capacity payments for flexibility upgrades at conventional thermal plants. If China's green certificate or green power market continues to grow and fulfils its objective of raising new revenues for renewable electricity production without differentiating between time or place of supply versus demand, this could worsen the problems of meeting peak demand, paradoxically leading to further calls to boost coal-fired power capacity.

Conclusions: Various barriers remain before green certificates can play a larger role

China has become the world's leading producer and consumer of renewable energy, including wind and solar, but its relatively recent green certificate programme has lagged behind the development of the country's clean energy sector and only recently seen an uptick in purchases. The increase in interest in green certificates is directly tied to the transition of policies away from promoting green certificates mainly as a path to replace government subsidies for existing projects supported under the feed-in tariff, and towards using green certificates to support unsubsidized projects and energy production outside the FIT.

⁸⁸ Jacques A. de Chalendar and Sally M. Benson, 'Why 100% renewable energy is not enough,' *Joule* 3, 19 June 2019, at <https://doi.org/10.1016/j.joule.2019.05.002>.

⁸⁹ Ben Gerber, 'A path to supporting data-driven renewable energy markets,' M-RETS (Midwest Renewable Energy Tracking System), March 2021, at www.mrets.org/wp-content/uploads/2021/02/A-Path-to-Supporting-Data-Driven-Renewable-Energy-Markets-March-2021.pdf.

⁹⁰ 'Views on a future-proof market design for guarantees of origin,' ENTSO-E, 20 July 2022, at www.entsoe.eu/2022/07/20/views-on-a-future-proof-market-design-for-guarantees-of-origin.

⁹¹ 'A timely match: Accelerating power system decarbonisation by moving towards 24/7 matching in corporate renewable electricity (RES-E) sourcing and market integration,' RE-Source and Eurelectric, October 2021, at <https://247res.eurelectric.org/wp-content/uploads/2021/10/FINAL-A-Timely-Match-compressed.cleaned.pdf>.

⁹² 'Granular tracking and matching of renewable electricity—timing is of the essence,' Enel, October 2022, at www.enelgreenpower.com/content/dam/enel-egp/documenti/offerte/granular-tracking.pdf.



Although green certificates have seen higher trading volumes and some important policy developments that presage their integration with other efforts to achieve carbon neutrality, there remain several major obstacles to a mature green certificate market in China:

- Green certificate purchase and trading volumes remain low overall due to various factors, such as those listed below.
- Transparency in relation to regulations, attributes, and pricing remains low.
- Compatibility with international practices is unclear, and Chinese green certificates exist alongside and compete with international certificates.
- Secondary trading is not permitted.
- China's green certificates do not provide an incentive for time or geographical matching of load with renewable supply, which could provide a perverse incentive in China's renewable energy market while potentially making the certificates less attractive for certain buyers interested in such matching.

Lastly, as renewables move from the periphery towards the centre of the power sector inside and outside China, there is the potential for new forms of time and geographically matched green certificates to contribute towards power sector flexibility, moving beyond their initial design as a purely supplemental revenue source for renewables. China's green certificate market is certain to continue to grow. Whether it can play a larger role in facilitating the transition towards China's clean energy future will depend on the resolution of some of the major barriers that still affect the programme and reduce its attractiveness to potential buyers and sellers.