Raising the Bar:

Managing and Improving Clean and Renewable Energy Sourcing in Corporate Supply Chains

By the Clean Energy Sourcing Research Initiative

LABORATORY FOR ENERGY AND ORGANIZATIONS

清华大学能源环境经济研究所
INSTITUTE of ENERGY, ENVIRONMENT and ECONOMY
TSINGHUA UNIVERSITY

The main authors are Valerie Karplus, Xiliang Zhang, Da Zhang, Yi Song, and Xinhao Wang.

Acknowledgements

The authors would like to express special thanks to all the members of the Clean Energy Sourcing Research Initiative and Tsinghua Enterprise Carbon Neutrality Strategy Roundtable for their valuable experiences and views.

The authors are also grateful for the support from external experts (in alphabetical order by last name): Hui Chen (CSPG), Xiangyu Chen (SGCC Hebei), Yuchuan Hu (HBPX), Jiandong Liu (CREEI), Yifeng Liu (HBPX), Zhu Li (BPX), Jianghong Nie (HBPX), Guang Tian (SGCC Hebei), Yang Yang (SGCC Hebei), Xian Zhang (BPX).

About Laboratory for Energy And Organizations (LEO)

LEO, an initiative of the Wilton E. Scott Energy Institute for Innovation at Carnegie Mellon University, aims to understand how organizations can effectively respond to climate change by mitigating GHG emissions across their operations and local and global supply chains.

About Institute of Energy, Environment and Economy, Tsinghua University (3E)

3E is an interdisciplinary research institute founded in 1980. The institute aims to promote energy transformation, economic growth and social development, and to contribute to the mitigation of climate change in China and globally.

About the Clean Energy Sourcing Research Initiative (CESRI)

In 2021, LEO and 3E initiated the CESRI to conduct new research on approaches for incentivizing and validating high-integrity sources of greenhouse gas emissions reductions in global supply chains.

Disclaimer

The statements in this white paper are the personal views of the authors and do not represent any institution or department. The research results may lag behind the design and implementation of relevant policies, and the latest policy information and research results will be updated through relevant means.

CONTENTS

Executive summary

Corporations worldwide have pledged to achieve carbon neutrality by mid-century, responding to the urgent need to mitigate global climate change. Pledges to use clean and renewable energy (CRE), defined as zero-carbon electricity with no GHG emissions during power generation, to power their own and suppliers' operations form a centerpiece of many corporate net-zero goals. Collectively, delivering on these pledges could help to bend down the global GHG emissions trajectory, reducing the odds of a climate catastrophe.

Realizing this potential will not be easy. Only the most ambitious corporate pledges target reductions in GHG emissions associated with the production of inputs upstream, although these emissions account for an outsized share of most corporations' climate footprints. At the same time, most corporations have limited ability to influence supply chain GHG emissions, as suppliers may operate in distant locations and are subject to diverse—and often conflicting—climate policies.

The crux of the challenge is how to ensure that efforts to install, procure, or invest in CRE ultimately end up reducing GHG emissions. Existing methodologies, such as the additionality standard of the United Nation-run Clean Development Mechanism (CDM), compare actions to counterfactual scenarios. The construction of these counterfactual scenarios relies heavily on subjective judgement. Actions may be evaluated differently under various national standards. Policies and regulations may create situations in which a unit of CRE credit can be counted multiple times, overstating the impact. There is a need today for concepts and standards that can anticipate and adapt to expected changes in the policy landscape and CRE market in the coming decades.

To fill this gap, this white paper reviews existing concepts and standards that could be used to evaluate corporate and supplier actions to reduce GHG emissions. While the discussion focuses specifically on efforts to eliminate or offset GHG emissions by deploying CRE, many of the ideas developed here can be generalized to other low-carbon solutions. Our analysis focuses in depth on these topics in China, given its central role in global supply chains, the high carbon intensity of its electricity system, and its unique policy and institutional complexities.

In this research, two factors are important to incentivize corporate and supplier actions. The first is environmental integrity, representing how much CRE procurement actually reduces GHG emissions. In the absence of clear and consistent approaches to evaluate the environmental integrity of CRE claims, corporations and suppliers may hesitate to act. While the additionality standard is widely used, the concept of additionality is not always ideal in regard to CRE procurement context because (1) corporations adopt varying definitions and (2) the increasingly favorable economics of CRE have shifted focus to addressing non-economic barriers of CRE deployment. The second is recognition, which relates to stakeholders' perceptions of CRE procurement, which may depend on a combination of evolving expectations, definitions, and standards. The assurance that national governments and other stakeholders will recognize preexisting claims even as policies evolve is important for corporations and suppliers to act with confidence to procure CRE.

Price is also a central concern to would-be buyers of CRE. Historically, the cost of CRE has been higher than conventional power generation, leading many governments to subsidize generation from CRE sources, for instance, through feed-in tariff (FIT) or tax credits. As the cost of CRE, particularly wind and solar, has fallen, policymakers have reduced direct financial support. Deployment targets for generation or consumption such as renewable portfolio standards have replaced subsidies in some markets. While technology cost reductions should make CRE more affordable to end users, its attractiveness depends on electricity market structures that affect the relationship between cost and end-user price.

This white paper concludes that current standards are becoming less relevant as economic barriers to deployment fall, while new issues such as curtailment arise. In order to address challenges of environmental integrity and recognition, new regulatory concepts and harmonization efforts are needed to build a shared set of standards to evaluate corporate and supplier CRE claims. We recommend establish an official, secure and reliable information system that would signal goals, preferences, short and long-term CRE procurement intentions, and to promote the design of relevant standards and policies. For such a system to work, various departments need to work together, and standards should continue to work as regulations evolve in the future.

Abbreviations

CCER	China certified emissions reduction
CDM	Clean development mechanism
CRE	Clean and renewable energy
DPP	Direct power purchase
EAC	Energy attribute certificate
ETS	Emissions trading system
FIT	Feed-in-tariff
GEC	Green electricity certificate
GHG	Greenhouse gas
GPT	Green power trading
ISO	International Organization for Standardization
MEE	Ministry of Ecology and Environment
MIIT	Ministry of Industry and Information Technology
MOF	Ministry of Finance
MOHURD	Ministry of Housing and Urban-Rural Development
MWh	Megawatt-hour
NDRC	National Development and Reform Commission
NEA	National Energy Administration
NRIC	National Renewable energy Information management Center
RCC	Renewable consumption certificate
RPS	Renewable portfolio standard
SC	State Council
UNFCCC	United Nations Framework Convention on Climate Change
VPPA	Virtual power purchase agreement

Glossary

Term (English)	Term (Chinese)	Explanation
China certified emissions reduction	中国核证自愿减排量	Certified amount of emissions reduction that could be used to offset certain carbon emissions by entities included in the carbon market
Clean development mechanism	清洁发展机制	A mechanism that allows countries to use certified emission reduction credits for fulfilling Kyoto targets
Direct power purchase	电力直接交易	Direct contract signed between generation companies and electricity consumers based on voluntary participation and independent negotiation
Energy attribute certificate	能源属性证书	A certificate to certify the ownership rights to the environmental attributes of one unit of CRE
Emissions trading system	碳排放权交易市场	A government measure (also known as “cap and trade”) placed on corporations to meet the limit on carbon emissions with tradable allowance
Feed-in-tariff	上网电价	An incentive policy that guarantees specified electricity rates (typically above-market price) to renewable generators
Full self-consumption	自发自用	Electricity generated from on-site renewables is all used for self-consumption
Green electricity certificate	绿色电力证书	The official certificate issued to each MWh of non-hydro CRE, including onshore wind and solar power (excluding distributed generation)
Green power trading	绿色电力交易	Electricity consumers buy green power directly from generators or grid companies and receive renewable consumption certificates
Renewable consumption certificate	可再生能源电力消费凭证	Certificate issued to electricity consumers participating in the green power trading
Renewable portfolio standard	可再生能源消纳责任权重	An annual regulatory mandate which requires each province to use a predetermined percentage of renewable electricity
Self-consumption and surplus feed-in-grid	自发自用、余电上网	Apart from self-consumption, excess electricity generated from on-site renewables is sold to the grid
Subsidy-enabled green electricity certificate	补贴绿证	Associated CRE projects are eligible for FIT subsidies
Subsidy-free green electricity certificate	平价绿证	Associated CRE projects are ineligible for FIT subsidies
Virtual power purchase agreement	虚拟电力购买协议	A purely financial contract between the seller and the buyer who does not take title to the physical electricity

01

Addressing GHG emissions through investments in CRE

As the world confronts climate change with growing urgency, reducing GHG emissions has become a priority for corporations. GHG emissions related to the production of upstream inputs and downstream end uses (referred to as Scope 3 emissions) often dwarf direct emissions, accounting for up to 90% of a corporation's total GHG emissions (Carbon Trust, 2021). This white paper focuses on supply chain GHG emissions, the subset of Scope 3 emissions associated with upstream inputs. Among corporations, the most ambitious corporate climate pledges include plans to reduce supply chain emissions.

However, reducing supply chain GHG emissions poses substantial challenges. First, corporations must incentivize reductions in the GHG emissions of dozens or hundreds of suppliers around the world, each facing a distinct set of subnational and national climate policies. Second, corporate managers have a limited ability to influence their suppliers' decisions to decarbonize, while suppliers themselves may be unable to control the source of their electricity. Third, suppliers may also face domestic policy priorities and pressures, including climate and energy policies, which may overlap with each other or be in flux, making it unclear which actions will be recognized or rewarded. Fourth, the cost of purchasing electricity generated from CRE is usually higher than electricity produced from fossil fuels, and corporations may need to pay high environmental premiums. Fifth, verifying the fulfillment of CRE procurement goals can be costly, making it difficult to reward environmental leadership. Sixth, a corporation's suppliers may lack effective access to information on their GHG emissions and methods to control them.

As corporations increasingly announce voluntary actions to reduce GHG emissions, internal and external stakeholders are asking how to evaluate their efforts. One standard that has been widely used in international climate agreements is additionality, which first asks about the economic viability of a project and second calculates the GHG emissions reduction achieved by a project relative to a hypothetical no-project baseline. Related concepts, such as materiality and emissionality have also been proposed for demonstrating the environmental integrity of corporate and supplier actions to reduce GHG emissions (Please see Section 2.1).

Related to environmental integrity is the question of who recognizes a corporation's CRE claim, especially as markets for CRE evolve and policies change. Here the concepts, exclusivity, legitimacy, and legality of claims come into play (Please see Section 2.2). Will a corporation's stakeholders, including shareholders, governments, and customers, accept a CRE project or procurement approach under prevailing guidelines and expectations? Will acceptance continue into the future even as rules change? This recognition can play an important role in the GHG reduction strategies corporations and their suppliers pursue.

These questions are particularly salient in China, given the country's outsized role in global supply chains and the high share of fossil fuels in its electricity generation mix. As the world's largest carbon emitting nation, China now has policies in place to address climate change and facilitate the expansion of CRE. Policies include the emissions trading system (ETS) that acts as a tradable performance standard, renewable portfolio standards (RPS), and other policies to promote increased use of CRE. These policies interact with each other as well as with corporate and supplier pledges to improve their reliance on CRE. These interactions can complicate efforts to claim credit for GHG emissions reductions, as the role of the corporation or its supplier cannot be distinguished from the requirement of the policy and the obligations on other players, such as utilities.

This report asks what steps are needed to support corporate climate leaders in their efforts to increase reliance on CRE in their supply chains. First, we evaluate the role of standards for environmental integrity and recognition of claims and identify limitations associated with prevailing concepts. Second, we describe how these challenges manifest against the background of China's climate change and renewable energy policies. Third, we recommend steps to establish agreed standards and improve coordination between government policy and corporate action in ways that could accelerate reductions in GHG emissions.

02

The CRE pledges of corporate leaders are outpacing current policies

Voluntary corporate pledges to advance climate neutrality are increasing, which stimulates demand for CRE sourcing around the world. Despite a challenging business environment, global corporate sourcing of renewables set a record in 2020, increasing by 18% (BloombergNEF, 2021). Multinational corporations are a major driver of renewable energy demand growth, both in the country where they are headquartered and operated (IEA, 2018).

Corporations use CRE to address their GHG emissions footprint in one of several ways. Corporations can build distributed renewables on site for self-consumption or procure electricity directly from a CRE source. CRE can be collocated with a factory that provides a dedicated supply of electricity or purchased from a supplier off-site via a bilateral contract. Besides, corporations can buy unbundled energy attribute certifications (EACs), which correspond to the ownership rights to the environmental attributes of CRE.

While existing policies have created several mechanisms to support corporations and suppliers in procuring CRE, it is unclear whether these mechanisms will be capable of handling increases in CRE demand on a large scale. Some CRE standards and policies were designed at a time when CRE represented a modest share of the market and was more expensive than the conventional generation. As CRE market share increases in the future, expansion of intermittent resources imposes costs on the grid, leading to increasing curtailment, and challenges established for electricity sector institutions that were designed around dispatchable generation. Expansion may depend on improving current mechanisms that can support the growing CRE demand and promote effective consumption.

2.1 Demonstrating the environmental integrity of claims

There is currently no single set of widely agreed guidelines to evaluate the environmental integrity of actions corporations and suppliers take to implement climate neutrality pledges. Corporate annual reports vary in the terms used to describe their investments and to assess their progress, including additionality, materiality, and emissionality. Below, we describe the content and pros and cons of each term in demonstrating the environmental integrity of corporate CRE claims. Our analysis suggests that while additionality supports a more precise claim, it relies on subjective judgements that can be easily manipulated. Materiality lacks a direct connection to GHG reductions, and establishing emissionality requires the construction of a location-specific GHG emissions baseline, which carries formidable data requirements in practice. All three terms have limitations, either conceptual or practical. They were designed for the context of offset markets or voluntary action, which may not be completely suited to today's corporate CRE procurement market without improvement.

The classical additionality test may fall short

The term additionality was first applied to climate change mitigation actions in the 1997 Kyoto Protocol. According to the Protocol's Article 12, a certified project activity must pass an additionality test, which requires demonstrating that GHG emissions reductions would not have otherwise occurred in the baseline scenario (UNFCCC, 1997). This is to ensure that credits are not awarded for GHG reductions that would have happened anyway.

The evaluation of additionality in CDM methodologies consists of five steps as shown in Figure 1 (CDM Executive Board, 2012). The first step is optional (Step 0), and the evaluation procedure continues if the project is not first-of-its-kind. After identifying alternative courses of action (Step 1), additionality requires that the developer demonstrate that the project is not financially attractive (Step 2) or that a non-financial barrier is preventing project implementation (Step 3). If either is satisfied, and no similar activities are observed or the proposed project is essentially different from similar activities in the market (Step 4), a project is considered additional. China certified emissions reductions (CCERs) are designated by following a similar procedure that references CDM methodologies.

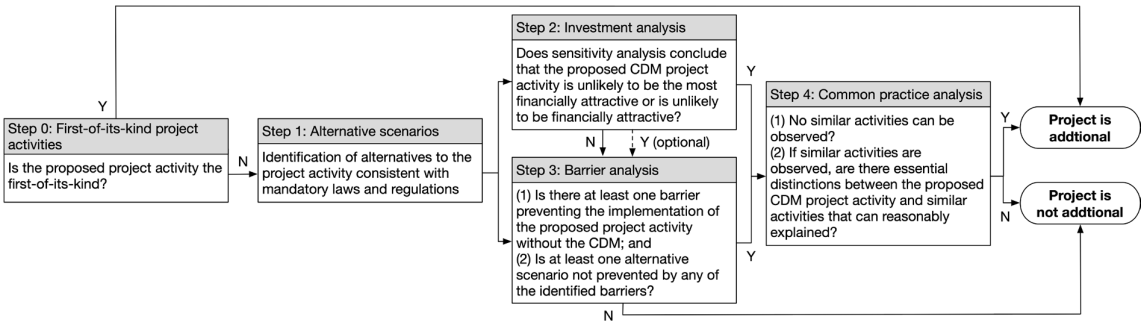

Figure 1. CDM tool for the demonstration of additionality (CDM Executive Board, 2012)

Traditionally, the additionality test has been applied to in a range of offset certifications (e.g., CDM, CCER) and corporate voluntary GHG emissions reductions schemes (e.g., the Gold Standard, the Voluntary Carbon Standard). The test has been criticized for calculating reductions relative to an unobserved baseline, which is highly subjective and vulnerable to manipulation (Cullenward and Victor, 2020; Gillenwater, 2012; Koo, 2017; Schneider, 2009). Small changes in estimated project costs can make the difference between a project being considered additional or not (Cullenward and Victor, 2020). If the additionality test is unreliable, it will affect the effective operation of the global carbon market. One study has found that the majority of energy-related project types under the CDM are unlikely to be additional (Cames et al., 2016).

Beyond the above challenges, the concept of additionality is not easily translated to today's CRE procurement context. First, there is no external oversight and unified procedure for evaluating additionality claims (CRS, 2016). Second, falling CRE costs have reduced the relevance of the investment analysis (Step 2), and even if a project were found to face non-financial barriers (Step 3), deploying renewable energy is increasingly become a common practice among utilities, precluding additionality. What the test does not take into account is the difficulty corporations may face in CRE investment or procurement to cover their operational energy use. Typically, buyers are price takers: they are asked to pay a premium for renewable energy and may have the limited latitude to influence

the pace of expansion and availability. Moreover, the procedure of proving additionality is complicated and costly, which may therefore disincentivize corporations from procuring CRE. Table 1 compares and contrasts the application of the additionality test in the CDM market and CRE procurement market.

	CDM market	CRE procurement market
Origin	CDM establishes a single set of rules for certifying emissions reductions such that they can be used for compliance purposes in a carbon market. If additionality is not achieved, actual GHG reductions of the carbon market will be lower.	Corporate CRE procurement occurs in the context of electricity markets and mandatory and voluntary CRE goals. If additionality is not achieved, corporate CRE claims and associated GHG reductions will be overstated.
Requirements	The additionality test is required for the proposed project to get certified GHG emissions offset credits under the CDM.	Demonstrating additionality is voluntary and corporations face varying degrees of internal and external pressure to do so. There is no single set of rules or a test for demonstrating additionality.
Practice	CDM project developers have incentives to manipulate tests including exploiting baseline uncertainty to demonstrate additionality.	Very few corporations claim the additionality of their CRE procurement. Those that do rarely publish the basis for their claims or address interactions with existing policies.

Table 1. The application of additionality in the CDM market and CRE procurement market

An important question concerns whether a corporation or supplier must increase CRE-based generation beyond that required or incentivized by domestic policies in order to be considered additional. The additionality test of the CDM would imply the answer is yes because one can argue that CRE would have been deployed to comply with the policy in the absence of the CDM project. However, in practice, it is very difficult to demonstrate that a CRE developer has exceeded its policy obligation. Most policies target deployment of a certain level of capacity or share of generation but establishing which corporation used the marginal kilowatt-hour that exceeded the policy requirement is not practical. In some jurisdictions, attributing credit for enabling CRE generation may be further complicated by policy overlaps that lead to double counting. This issue will become ever more salient as the stringency of climate policies increases, limiting the relative share of GHG emissions reduction opportunities from CRE procurement that fall beyond the scope of established policies. For all of these reasons, the traditional additionality test may not be well suited for evaluating the environmental integrity of corporate and supplier CRE claims.

Materiality as an alternative for signaling effort

In part to address some of the limitations of additionality, policymakers and corporations have sought alternative concepts to describe the impact of their CRE activities. Around 2018, the concept of materiality appeared in the industry press. Materiality is defined as an action that increases the amount of clean energy available, relative to a no-action situation. Importantly, the term “action” is broadly defined and deliberately flexible, but a corporation must participate in a CRE project in a way that enables a project’s success (Apple Inc., 2018). For example, a corporation could require that suppliers purchase CRE for their operations.

Materiality does not require that the corporation or its supplier be the indispensable force, which is the hallmark of additionality, but aims to identify their material impacts during the process (Sievert, 2021). Instead of an opaque and subjective calculation that generates a yes or no answer as in the case of additionality, establishing materiality requires disclosing the action involved, allowing investors and other stakeholders to evaluate it. Although this property of materiality is quite powerful, materiality is not directly linked to GHG emissions reductions, making it difficult to compare the environmental integrity of various claims.

Emissionality as an alternative standard focused on local environmental impact

More recently, as part of the search for suitable standards, the term emissionality has been proposed to describe the degree to which a new CRE project displaces fossil-fueled generation from the local grid and thus creates a greater or lesser amount of avoided marginal emissions (Richardson, 2019). Some think a project’s impact can be largely affected by where a renewable project gets built, especially the composition of the local grid’s energy mix and dispatch patterns (Bronski and McCormick, 2018). To increase emissionality, corporations are encouraged to build CRE projects in carbon-intensive grid regions to increase GHG reductions and reduce curtailment of electricity generated from wind and solar. Emissionality does not require demonstrating economic or non-economic barriers, as the additionality test does. Relative to materiality, it establishes a much stronger link to GHG emissions reductions.

One of the major challenges to relying on emissionality is the availability and quality of data. Estimating emissionality requires accurate data at sufficient resolution and granularity for the existing power grid for baseline construction. Ideally, these data would have high temporal and spatial resolution and account for uncertainty in operational patterns. Such data can be very challenging to obtain and analyze, especially in markets where continuous monitoring data for power plant GHG emissions are not publicly available.

Beyond data, emissionaility raises other problems. First, the choice of location made under the objective of maximizing carbon abatement is not always economically optimal (John, 2021). For example, building a CRE project near high-emitting generators may have high emissionality, but another location may result in a far lower cost to operate. Second, corporations and their suppliers have limited ability to influence the location of CRE projects, constrained by land, climate, and other conditions.

Towards a shared set of ambitious standards

For corporations and suppliers, the focus is to find standards that are at once environmentally sound, sufficiently flexible, and easily understood and recognized by internal and external stakeholders. The terms additionality, materiality, and emissionality, summarized in Table 2, can capture aspects of corporate effort but each has limitations.

Standards	Definition	Requirements	Implications
Additionality	An activity is defined as additional if the developer was the indispensable force, i.e., the project would not have been built otherwise	Credible baseline and barrier analysis; Evaluation metrics (e.g., avoided carbon emissions, increased CRE capacity, increased CRE generation)	Basic concepts need to be adapted to the corporate CRE procurement context; Traditional tests and assumptions required have limited applicability as climate policies are expanded and renewable energy costs fall
Materiality	Materiality refers to the impact a corporation has on the success of a CRE project	Standardized evaluation procedure; Disclosure of actions	Materiality is an easy-understanding and flexible concept, so its wide adoption is possible; Materiality can incorporate various indicators; It is challenging to reach a consensus among corporations
Emissionality	Emissionality shows the degree to which a new CRE project displaces fossil-fueled generation on the local grid	Time- and location-based evaluation metrics Clarification of system boundary	Emissionality is able to present local impacts by integrating spatial and temporal factors; Unavailability and low quality of data will negatively affect the claim supported by emissionality

Table 2. Summary of additionality, materiality, and emissionality

Standards differ in terms of target, cost, feasibility, and other factors. The standards of additionality and emissionality in particular will depend on the expansion of climate policies that incentivize CRE. The applicability of additionality depends on cost, non-financial barriers, and common practice; with falling costs and rapid expansion of the installed base, it is becoming difficult for corporations to justify that any CRE investments are additional. Materiality is a relatively flexible standard but lacks a direct link to GHG reductions. Of the three, emissionality may best approximate the GHG emissions reductions, provided that data on local emissions factors—e.g., at the grid region or provincial level—are available, accurate, and applied consistently. Beyond the three standards discussed here, many corporations are privately developing standards for emissions accounting or crediting, although adoption is highly uneven. Other public standards are being popularized by efforts such as the Science-Based Targets Initiative and the RE100 Initiative.

One option for addressing these challenges involves a process that iterates among corporate CRE procurement goals, CRE pricing and procurement options, and climate policy instruments. Such a process could build on existing policies and institutions, such as renewable energy crediting systems or systems for purchasing renewable power. As a starting point, corporate buyers would signal their demand for CRE. Pooled demand would form a basis for planning the buildout of CRE, which could be procured via bilateral contracts and renewable energy certificate markets from a combination of

existing and new suppliers. Buyers would commit to covering a certain percentage of their electricity use with CRE, which would grow over time. Aggregate demand for CRE could be compared against long-term trajectories for power sector decarbonization. Corporations would be evaluated on the basis of the share of their energy use they source from CRE and on the total magnitude of GHG emissions reduced, relative to the sector's historical levels.

2.2 The recognition of claims as an enabler of CRE development

Beyond standards for environmental integrity, corporate and suppliers will only undertake CRE procurement with confidence if claims are recognized by governments and external stakeholders. Here, the terms exclusivity, legality, and legitimacy describe various forms of recognition.

⦿ Exclusivity avoids double counting

Exclusivity refers to the uniqueness of a claim to the environmental attributes associated with CRE generation. CRE crediting systems, such as the RE100, require that corporations and suppliers demonstrate exclusivity (RE100, 2021). For example, a utility and its customer cannot both retire EACs for electricity that the former generates, and the latter consumes. Such double claiming would overstate GHG emissions reductions.

A similar logic applies when CRE purchases or the energy attribute credits associated with them are surrendered for crediting under multiple policies. In this case, double counting occurs, and GHG reductions are lower than intended. For unbundled EACs, supporting a robust and transparent system to issue and track certificates is crucial for enhancing exclusivity (IEA, 2018). Linking registries of EACs can further limit double counting.

⦿ Legality ensures governments accept CRE claims

Legality refers to actions compliant with laws, regulations, and standards. It is related to exclusivity because some CRE policies require the demonstration of exclusivity in order to be considered legally sound. In part as a result of the rapid development of CRE markets, the legality of various CRE procurement options may not be specified in policies, which can lead to controversy over whether actions meet standards or requirements. Laws, regulations, and standards may impose additional requirements on whether various EACs can count towards the crediting provisions or requirements of different systems. If establishing the legality of certain types of claims is a lengthy, opaque, or cumbersome process, or if legality is uncertain, it can discourage corporations from procuring CRE in the first place.

Establishing and affirming the legality of EACs over time requires clear criteria and dependable enforcement. While this may sound straightforward, it is complicated by the fact that policies are supervised by different government departments, which may adjust rules independently of one another. For example, EACs may be recognized in RPS-like mechanisms but their role in the carbon market remains unclear. This will undermine the legality of EACs. Building effective cross-department coordination can reduce the risk of unrecognized demonstration and the waste of resources.

Legitimacy ensures stakeholders recognize CRE claims

Legitimacy refers to how a CRE method is viewed by corporate internal and external stakeholders. Unlike legality, which is defined based on laws, regulations, and standards, legitimacy depends on perceptions relative to expectations, which are changing over time and may differ across audiences, including headquarters, investors, customers, and the public. Legitimacy has recently included an increasing emphasis on environmental factors, including climate-related metrics. Environmental integrity, legality, and legitimacy are also related to legitimacy. Legitimacy can affect the attention corporations pay to these standards, or to prosocial activities in general, as well as the role of these aspects in decision making. For example, if exclusivity and legality considerations are satisfied, CRE claims may be more likely to be considered legitimate. Corporations that aim to lead in environmental sustainability likewise have an interest in pushing for clear rules and high standards, which increase confidence that prosocial actions will be recognized and rewarded.

It is worth noting that legitimacy is often contested, and considerations of legitimacy can affect which types of investments are considered green or zero carbon. Hydropower is considered renewable by some initiatives such as the RE100, although it is recommended to comply with sustainability standards from the Green-e Renewable Energy Standard or Low Impact Hydropower Institute (RE100, 2021). However, some corporations do not accept it, for example, because of concerns about ecosystem or water resource impacts. Nuclear and biomass energy are also not uniformly accepted as green energy sources.

While the definition of legitimacy is broad and changes over time, related concerns can have a strong influence on corporate and supplier choices. Variation in sensitivity to legitimacy pressures across corporations or suppliers can further explain why CRE procurement strategies differ, even when decision-makers face the same legal requirements. Large multinational corporations, especially those with declared climate commitments, may face stronger pressure in this respect. Such variation can also prohibit the progress of CRE procurement practice for joint ventures when multiple investors hold different even contradictory views. Even within one supply chain, it can be difficult for corporations to control suppliers' definition of legitimacy, which might increase how challenging it is to require suppliers to develop or procure CRE for their operations.

Recognition affects incentives to invest in CRE across the supply chain

Table 3 summarizes the three concepts related to the recognition of CRE claims, i.e., exclusivity, legality, and legitimacy. While these concepts represent distinct considerations, they all influence stakeholders' acceptance of CRE procurement and as a result the pace of clean energy transition across the supply chain.

Standards	Explanation	Requirements	Implications
Exclusivity	Making an exclusive claim requires that no other entities can claim the same CRE generation or usage under any policy schemes	Clear rules; Credible tracking system; No risk of double counting	Exclusivity is a relatively objective concept with a clear definition; Insufficient policies and mechanisms may result in double counting and make it hard to claim exclusivity; Professional guidance and clear regulations are necessary
Legality	Corporate actions are compliant with laws, regulations, and standards in the place where they and their suppliers operate	Clear laws, standards, and regulations; Legally enforceable contracts	Legal actions tend to be recognized by governments; Laws and regulations are generally clearly described, but may not cover every aspect; Clear regulations form the basis for corporations to follow; A stable policy system is essential to provide long-term legality
Legitimacy	It refers to how a CRE method is viewed by corporate internal and external stakeholders	Statement of involved laws and regulations; Social impacts and public recognition	Legitimacy is viewed differently by various stakeholders; Related to environmental integrity, exclusivity, and legality; Influence CRE procurement strategies; Actions to achieve legitimacy will likewise vary, depending on perceived stakeholder pressure;

Table 3. Summary of exclusivity, legality, and legitimacy

03

The policy landscape behind China's CRE market

This section begins by describing the CRE procurement options available, which are affected by power sector structure and operations, then discusses relevant policy tools. The policy landscape defines the minimum standards of environmental integrity required for all market players and affects the standards of recognition. We examine how the standards discussed in the previous section play out in the context of CRE procurement in China. Finally, the impact of evolving policy landscape on the long-term development of CRE procurement is analyzed.

3.1 Corporations in China have multiple CRE procurement options

Corporations and their suppliers in China can fulfill CRE commitments in multiple ways, including installing CRE on site, purchasing physical renewables via direct power purchase (DPP) or green power trading (GPT), investing in renewable energy consumed elsewhere, or purchasing China's Green Electricity Certificate (GEC) or international certificates, such as International Renewable Energy Certificate (I-REC) and Tradable Instruments for Global Renewables (TIGR). We take I-REC as a representation of international EACs in this paper. Available options are summarized in Table 4.

Type	In-force time	Regulatory agency	Organization agency	Availability	Corporate examples	Major challenges	Interactions with RPS or ETS
On-site renewables	No specific time	NDRC, NEA	Generally constructed by corporations	Nationally available	GM, Schneider	Subject to the capacity of distribution substations and local rules; Unclear ownership of CRE attributes if not completely self-invested	RPS; ETS (potential)
GEC	2017	NDRC, MOF, NEA	NRIC	Nationally available	Luxshare, RMI	Now only available for onshore wind and solar projects; Lack of wide international recognition	RPS
I-REC	2014	I-REC Standard	Green Certificate Company	Nationally available	Bridgestone, ECOHZ	Not supported by Chinese policies; Cannot be used towards meeting RPS targets	Indirect interactions

DPP	No specific time	Vary by provincial or local government	Gird company, Power Exchange Center	Available in some provinces but subject to local rules	L'Oréal, LG Chem, P&G	No renewable consumption certificate (RCC) issued; Not consistently supported by local governments; Not available for all corporations	Indirect interactions
GPT	2021	NDRC, NEA	Gird company, Power Exchange Center	Available in most provinces but subject to bespoke policies	BASF, Covestro, Shell	Now only available for wind and solar projects; Limited transaction volume compared to high demand	RPS; ETS (potential)
Direct investment	No specific time	NDRC	Generally decided by corporations	Nationally available	Apple, Foxconn	Unclear ownership of CRE attributes between developers and investors; The enforcement of the contract is at risk without clear policy support	RPS

Table 4. Summary of CRE procurement options in China (CRS, 2019; RMI, 2018)

On-site renewables

Capacity for generating renewable energy is installed at a corporate or suppliers' site (e.g., building roofs or ancillary vacant sites) to supply virtually all or part of the load. Corporations can use the generated electricity for "full self-consumption" or "self-consumption and surplus feed-in-grid" subject to prevailing rules. The latter refers to the sale of excess CRE generation to the grid. On-site renewables need to be put-on-record by the Chinese National Development and Reform Commission (NDRC) before construction. As of September 2021, distributed solar power accounted for more than 30% of all solar power capacity (Shi, 2021).

Such projects can generate savings or revenue streams, for instance, FIT subsidies, free or discounted use of green power, or income from surplus power delivered to the grid (WRI, 2019). In China, the ability to take advantage of these streams varies by corporations, e.g., depending on the rules of the province or local grid operator, and over time. Overall, on-site renewables especially distributed solar power are installed by many corporations to source renewable electricity because of their practicability, as well as the promising environment and economic benefits.

Green electricity certificate (GEC)

As unbundled EACs, GECs only trade on the environmental attributes of CRE, or in other words the certificate is sold separately from the underlying electricity. In 2017, the GEC system is launched as a way to incentivize the deployment of renewable energy. The system, operated by the China National Renewable Energy Information Management Center (NRIC), enables corporations and individuals to purchase CRE voluntarily. GECs are issued to electricity producers of onshore wind and solar power (excluding distributed generation), for each MWh of non-hydro CRE generation (NDRC, MOF, and NEA,

2017). If GECs are sold off, project developers need to give up FIT subsidies for the specified amount of electricity generation. GECs began with subsidy-enabled GECs and have expanded to subsidy-free GECs in recent years as renewable energy projects have approached grid parity.

In 2021, the NDRC announced that new onshore wind and solar projects were no longer eligible for the FIT subsidy (NDRC, 2021a). Until May 2022, a total of 43 million GECs were issued, 8.3 million were listed, but only 1.9 million were sold; the price of subsidy-enabled GECs ranges from 128.6 to 745.4 ¥/MWh, while the average price of subsidy-free GECs is about 50 ¥/MWh with the range between 30 to 65 ¥/MWh (Green Electricity Subscription Platform, 2022).

⦿ International renewable energy certificate (I-REC)

Introduced in 2014, I-REC also certifies the environmental attributes of CRE and is operated by a non-governmental organization. I-RECs are issued to generation facilities in multiple countries including China. Compared to GECs, I-RECs cover a wider range of project types, including wind, solar, and hydropower that accounts for a large portion of the issued volumes. (I-REC Standard, 2021a). Through June 2022, the volume issued in China exceeded 100 million, of which hydropower accounted for 52% and wind power accounted for about 43% (I-REC Standard, 2021a).

According to the updated issuance criteria, if a generation facility receiving FIT is registered in the I-REC registry, it will no longer be eligible for I-RECs from 2023, otherwise, the new restrictions will take effect immediately in June 2022 (I-REC Standard, 2021b). In the past, FIT projects were not excluded from I-RECs. As a result, some of the I-RECs currently traded in the market are from CRE projects receiving FIT subsidies as well (China Energy News, 2021). When using unbundled EACs to meet climate goals, some buyers tend to purchase I-REC at a low cost, while others may opt for GEC because it is backed by the Chinese government.

⦿ Direct power purchase (DPP)

This option involves transactions between electricity buyers and generators to procure CRE directly, mainly through bilateral contracts, centralized bidding, or listed transactions. While historically there are limited examples of DPP in China, the new round of power sector reform that began in 2015 highlighted the role of DPP in providing additional flexibility and cost savings (State Council, 2015) [1] .

Subject to province-specific and seasonal restrictions, DPP of intermittent renewable power is permitted in some provinces (RMI, 2019). For example, Sichuan province is more supportive of renewable DPP during hydro-abundant seasons. Compared to fossil fuels, the scale of DPP traded on renewable electricity is much smaller, in part because CRE generators are less motivated to conduct DPP under the full guaranteed purchase mechanism. Corporations engaged in these transactions are typically large consumers, and smaller corporations may find it difficult to participate with bespoke requirements.

1. According to the policy document *Several Opinions on Further Deepening the Reform of the Power System* issued by the State Council in 2015.

Green power trading (GPT)

GPT trades on both the physical and environmental attributes of green power. It is a relatively new mechanism that creates a direct channel between generators and buyers. In September 2021, China carried out the first GPT pilot scheme based on the *Working Plan for a Green Power Trading Pilot* [2] approved by the NDRC and NEA (NDRC and NEA, 2021). More than 250 market entities from 17 provinces participated in this pilot and transacted over 7.9 TWh of green power; the prices increased by 0.03-0.05 yuan/kWh compared to local medium and long-term power trading (Weng, 2022). In addition to the national pilot scheme, Guangdong, Zhejiang, Jiangsu, Hubei, and other provinces have set up regional GPT and explored different mechanisms accordingly.

Corporations and their suppliers have welcomed the successful launch of the pilot scheme, with many expecting expanded and normalized GPT. In 2022, two national-level Power Exchange Centers successively released the documents of GPT rules (Beijing Power Exchange Center, 2022; Guangzhou Power Exchange Center et al., 2022) [3]. As stated in both documents, subsidy-free green power is prioritized in the GPT. Currently, GPT only allows for wind and solar power and is planned to include eligible hydropower and other types of renewables in the future. As for issuance, GECs will be issued to CRE generators by the NRIC based on the transaction information. This can help to reduce the possibility of double issuing certificates to the same CRE under the GEC and GPT systems.

Although GPT is similar to DPP given that generators sign contracts directly with consumers, GPT is a nationwide dedicated system for green power and is explicitly supervised by the NDRC and NEA. By contrast, DPP for CRE is often *ad hoc* arrangement that is not consistently supported by local governments. With the supporting issuance system, GPT provides a reliable way for corporate buyers to purchase green power and make credible claims about being powered with renewable electricity.

Direct investment

Corporations adopting this method provides capital funding for renewable energy projects in exchange for various benefits, such as buying electricity at a discount and making CRE usage claim. Different from other types of CRE procurement options, direct investment is less regulated by the Chinese government in addition to the construction of the project itself. Many invested projects get FIT subsidies as well, similar to on-site renewables (CRS, 2019).

The unclear ownership of the purchased green power and its environmental attributes make it challenging for investors to claim the CRE usage. To reduce this type of risk, some corporations have attempted to guarantee exclusive ownership through a contractual instrument, such as not allowing developers to sell GECs to others. However, the execution of the contract may not be strong enough, requiring additional efforts by investors to monitor and prevent such risk. Potential solutions include using GPT or GEC to clarify the ownership of environmental attributes of electricity purchased from invested renewable energy projects.

2. The working plan is submitted by State Grid and China Southern Power Grid (the full text is not publicly available).
3. Beijing Power Exchange Center organizes the GPT in the State Grid region, and Guangzhou Power Exchange Center organizes the GPT in the China Southern Power Gird region.

3.2 CRE procurement options are embedded in multiple policies

The Chinese government has issued a series of climate and environmental policies to accelerate the progress on decarbonization and reduce GHG emissions. Some of the policies set up mandatory targets and therefore influence corporate use of the above CRE procurement options. Table 5 provides a summary of these policy systems.

Policy	In-force time	Regulatory agency	Obligated entities	Major challenges	Interactions with CRE procurement options
RPS	2019	NDRC, NEA	Provincial governments	Relatively weak incentives for corporations	On-site renewables; GEC; GPT; Direct investment
Dual Control	2016 (the 13th Five-Year)	NDRC	Governments from a national level to county level and some corporations (based on local rules)	Potentially influence the investment and operation of corporations	Indirectly connected to CRE procurement options through RPS
ETS	2011 (regional ETS pilots); 2017 (the construction of national ETS); 2021 (the open of national ETS)	MEE	Corporations (power generation industry is included in the national ETS)	Other energy-intensive industries have not been included in the national ETS yet; Unclear emissions calculation of purchased green power in Scope 2 emissions	On-site renewables (potential); GPT (potential)

Table 5. Summary of policy systems related to CRE procurement (NDRC and NEA, 2019; MEE, 2021)

Renewable portfolio standard (RPS)

RPS is a regulation that establishes minimum and incentive targets for both total and non-hydro CRE consumption at the provincial level. The first compliance year of RPS is in 2020, and compliance obligations are defined annually. In each province, the energy authority leads the responsibility for formulating a working plan and the implementation of RPS. There are two types of entities obligated to substantiate a specified share of their electricity is sourced from renewable energy: (1) suppliers including grid companies, distribution companies, and electricity retailers; and (2) consumers who purchase electricity from the wholesale electricity market or possess generation facilities (NDRC and NEA, 2019). To fulfill RPS goals, regulations specify that corporations can purchase GECs or excess RPS quotas.

In 2020, all provinces achieved minimum targets of CRE consumption. In terms of non-hydro targets, Henan province transferred 1.20 TWh of excess quotas to Qinghai province, and Zhejiang province received 1.26 TWh of excess quotas from Ningxia province (Shi, 2021). Currently, we are aware of few examples of transferring RPS quotas among corporations. Some have suggested that implementation to date has been relatively weak for corporations, but stronger for government agencies. Although obligated entities can meet the target by purchasing GECs, the actual use of GECs in RPS is insignificant based on known information. The incentive effect of RPS on the demand for CRE procurement is not yet obvious. To claim that a corporation has procured CRE in excess of what

would have otherwise been delivered based on the regional grid average, there needs to be a CRE procurement mechanism that facilitates RPS. Several provincial governments are currently exploring how to set up green power consumption requirements at the corporate level for energy-consuming corporations and provide support for corporations procuring CRE (NDRC Jiangsu et al., 2022). It will be important to ensure that the relationship between such a system and an emissions trading system (ETS) is well defined.

⦿ Dual control system of total energy consumption and energy intensity (Dual Control)

The Dual Control system refers to coordinated targets to limit total energy use and energy intensity of economic activity at the national and regional levels. The idea of energy cap policy dated back to the 11th Five-Year (2006-2010), during which energy intensity needs to be decreased by 20% (Guo et al., 2019). After years of development, the Dual Control policy was first implemented in the 13th Five-Year (2016-2020) and exerted a strong influence on local governments. Although some have suggested that the Dual Control policy may be one of the reasons why few places conducted power rationing, the actual impact of Dual Control is not yet fully understood (The Lantau Group, 2021).

In 2021, the NDRC issued *The Plan to Refine Dual Control of Energy Intensity and Total Energy Consumption*, which enables more flexibility to encourage renewable electricity consumption (NDRC, 2021b). If a province achieves the incentive RPS target, the excess amount of CRE use above the minimum RPS target can be exempted from the cap on total energy consumption. Later, at the Central Economics Work Conference, it was announced that incremental renewable energy consumption will not be included when determining total energy consumption, and it would be necessary to shift the focus of Dual Control from energy consumption to carbon emissions (Xinhua, 2021). A Recent key document on renewable energy development also emphasized the exclusion of new renewable energy in the examination of total energy consumption (NDRC and NEA, 2022) [4].

⦿ Emissions trading system (ETS)

The ETS in China operates as a tradeable performance standard for GHG emissions by setting limits on carbon intensity, and corporations can buy and sell rights to emit. In 2011, China selected seven regions to pilot emissions trading, and the operation of each pilot follows a different set of rules. Based on the experience gained from the regional pilots, the national ETS officially opened in July 2021 in accordance with key policies released by the Ministry of Ecology and Environment (MEE) (MEE, 2021). The regional pilot systems are still operational, regulating the corporations and sectors not covered by the national ETS. For now, China's national ETS applies to 2,162 power generation companies, covering about 4.5 billion tons of carbon emissions, and will strive to cover seven other major energy-intensive sectors (Zhang, 2022). In the initial stage, the national system adopts free allocation and is rate-based instead of mass-based, so the allowances allocated to corporations are ex-post adjusted depending on the actual output levels (Zhang et al., 2021).

4. In May 2022, the NDRC and NEA published the policy document *Implementation Plan for Promoting the High-quality Development of New Energy in the New Era*.

For compliance, corporations are allowed to offset up to 5% of carbon allowances by using Chinese Certified Emissions Reduction (CCER). CCER was first introduced in 2012 and covered a wide range of projects, including renewable energy, methane utilization, and forestry carbon sinks. The approval of new CCER projects has been suspended since 2017, while existing CCER projects are still available sources of offsets for ETS compliance purposes.

The carbon market and the CRE market inevitably interact closely. First, if there is no information exchange, there could be possibility of double issuing GECs and CCER to the same CRE projects. Cross-departmental collaboration is needed to avoid such risk after CCER re-opens [5]. Second, corporations included the ETS need to use the emissions factor of the nationwide power grid [6] to calculate GHG emissions associated with purchased electricity. Government departments should jointly design and publish carbon emissions reduction calculation for CRE, so that obligated corporations bear less risk of repeatedly paying the environmental costs.

3.3 Environmental integrity and recognition depend on procurement options and policies

Policies incentivize corporations and their suppliers to select CRE procurement options. However, options may be more or less aligned with considerations of environmental integrity and recognition, further affecting these choices. Table 6 identifies the performance associated with each CRE procurement option based on current policy and market conditions in China.

	Environmental integrity			Recognition		
	Additionality	**Materiality**	**Emissionality**	**Exclusivity**	**Legality**	**Legitimacy**
On-site renewables	With certain additionality due to the requirements of capital and other costs to build the project **	Both developers and investors contribute to the successful construction of projects **	Contribute to the decarbonization of the local power grid ***	If self-invested, it is relatively easy to make exclusive claims while needs to focus on the coverage of GECs **	Recognized by the Chinese government ***	Often recognized by stakeholders, but not applicable for all corporations **
GEC	Support additionality claims with clear environmental premiums **	GECs, especially subsidized-enabled GECs, help project investment and construction **	No geographical restrictions, while buyers can select projects based on disclosed location information **	The disclosure of GECs can reduce the risk of double counting between GECs and other EACs **	Regulated by the NDRC, MOF, and NEA and can be used to meet RPS goals ***	Adopted by some corporations, but fall short of international recognition **

5. *Implementation Plan for Promoting the High-quality Development of New Energy in the New Era* supports incorporating certified emissions reduction from eligible new energy projects into the national ETS for allowance clearance and offset.
6. The latest grid emission factor updated by the MEE in March 2022 is 0.5810 tCO2/MWh.

I-REC	Not likely to have additionality given generally low prices (based on publicly available information) *	Buyers unlikely to have material impacts on CRE projects *	Difficult to assess emissionality as only the country where the project is located is disclosed *	Similar to GECs, but disclose less information *	Not recognized by the Chinese government *	Internationally known, but effective use in China is at risk **
DPP	Not likely to have additionality due to the lack of environmental premiums and generally lower prices than conventional power procurement *	Promote CRE consumption especially in places with high curtailment **	Depend on the power grid structure at the location of the generators and consumers **	It is difficult to prove exclusivity based on the lack of official RCCs *	Organized by local governments and grid companies, but lack consistent support **	Common options in international markets but subject to bespoke rules in China **
GPT	With certain additionality because of the general environmental premiums ***	Similar to DPP **	Similar to DPP **	The combination of electricity and certificate is conducive to exclusivity, but its potential interactions with CCER need to be addressed ***	Organized by the NDRC and NEA and receive strong support ***	Widely viewed as a promising and reliable CRE procurement tool ***
Direct invest-ment	Provide direct financial support for project construction, thus supporting claims to a direct enabling role **	Related to the properties of the project and corporate input **	Similar to I-REC, but can have physical connection *	High uncertainty regarding exclusivity due to the unclear ownership; risk of weak enforcement of contractual instruments declaring ownership *	Government recognition can be limited because of vague regulations **	Not often used by corporations due to the need for capital and other concerns **

Table 6. The performance of each CRE procurement option on the standards of environmental integrity and recognition (* = low, ** = medium, *** = high)

In general, the scale of CRE procurement in China is rapidly expanding, and relevant policies and mechanisms are constantly being improved. As Table 6 shows, each CRE procurement option has advantages and disadvantages when examining various standards, and weighing them against economic, technical feasibility, or other considerations. On-site renewables, generally with promising economic benefits and relatively high emissionality, are expected to continue as a common CRE procurement option. The clear environmental premiums of GECs can support additionality claims, while GECs may fall short of international recognition. Compared to I-RECs, the information disclosure of GECs can reduce the possibility of double counting. In addition, relying on I-RECs in China can be risky since policymakers do not recognize or encourage their use. DPP could be a useful method to promote CRE consumption, especially in high-curtailment regions, while no RCCs are secured. Here the GPT has advantages because a support system is created by national-level power exchange centers for transacting green power and assisting transparent sourcing under the guidance of the NDRC and NEA. According to the performance on environmental integrity and recognition, GPT is likely to become a primary channel for sourcing CRE. In terms of direct investment, applying GPT

or GECs to purchase electricity from invested projects can better protect the ownership rights of environmental attributes.

3.4 The evolving policy landscape may constrain CRE procurement

In recent years, China's climate ambitions are evolving. In September 2020, President Xi announced the goal of achieving carbon neutrality in China by 2060 and indicated intentions to reach peak carbon emissions by 2030. Policymakers have subsequently clarified that the carbon neutrality goal applies to all GHGs. For now, the "1+N" Climate Policy Framework has basically been established, clarifying that multiple ministries and government offices will be involved in setting policies and plans to achieve the country's climate goals (NDRC, 2022).

Policy in China has introduced new mechanisms for incentivizing CRE purchasing as costs of technology have fallen over the past 20 years. Historically, China's policies have mainly focused on transforming the supply side through financial incentives, but the funding support has continuously fallen short, especially during periods of rapid CRE expansion. The FIT subsidies for onshore wind and solar energy generation are gradually being phased out. Replacing it are innovative mechanisms such as GECs for grid parity projects and the emerging GPT system. The new round of power sector reform starting from 2015 also offers a path to improving the integration of renewable energy while reducing its cost to the end user. The recently released *Implementation Plan for Promoting Green Consumption* proposed several suggestions to motivate CRE consumption, including long-term green power contracts, the integration of RPS with GECs and GPT, and the integration of the carbon market with GPT (NDRC et al., 2022).

Our research suggests that evolving policies and industry standards in ways that address concerns about environmental integrity and recognition could provide wide latitude to expand corporate and supplier procurement of CRE. Previously, on-site CRE was sometimes challenging because connecting these projects to the grid is not uniformly allowed, and this issue has been largely resolved. Compared to DPP, GPT provides a credible channel for corporations to purchase CRE with the official certification system.

In some international markets, a common mechanism used is the virtual power purchase agreement (VPPA), which is a purely financial contract that offers a fixed price to buyers who then receive renewable energy certificates (Kansal, 2019). Unlike traditional PPAs, under which the developer sells electricity to the buyer directly, the developer signing VPPA sells its electricity in the spot market (REN21, 2021). The way that VPPA hedge the risk of price fluctuations is through a regular financial settlement between developers and buyers, which is equivalent to contract for differences. The developer pays the difference back when the market price is higher than the strike price and gets paid when the market price is lower. Without the need for a physical connection, VPPA provides the geographic flexibility to source from a distant CRE provider, but additional institutional sophistication is required to support reporting, recordkeeping, and registration of swap-type transactions (3Degrees, 2018). It also requires wholesale power markets and cost-reflective tariffs. In China, VPPA is not yet accessible, but the development of the electricity spot market opens the door to more flexible CRE procurement choices, including VPPA.

04

Options for accelerating CRE deployment through government-industry collaboration

This research has identified several factors that may be constraining CRE development in China. Addressing them holds the potential to unleash a positive feedback loop, by satisfying concerns about environmental integrity and recognition in ways that encourage more corporations to source CRE while providing greater certainty to would-be buyers. We identify several initial steps that could help to set this process in motion in China:

(1) Problem: Current standards used to assess the environmental integrity of actions taken by corporations and their suppliers to achieve carbon neutrality goals are inconsistent and not widely accepted.

Proposed solution: Various departments need to work together to establish an official, secure and reliable information system to understand corporate emissions reduction-related goals, preferences, short and long-term CRE procurement intentions, and to promote the design of relevant standards and policies.

(2) Problem: The existing CRE procurement options are inconsistently recognized domestically and internationally, and changes in relevant Chinese policies may affect the environmental integrity and recognition of CRE claims by corporations and their suppliers.

Proposed solution: The government should create a list of procurement forms that are explicitly not recognized or expected to be superseded by the "GPT+GEC" system, while allowing flexibility for corporations to upgrade their past claims if they wish to demonstrate superior environmental performance.

(3) Problem: The set of options for CRE procurement is highly relevant to power sector reform, and China's electricity market is still under construction. VPPA used in some other international markets have not yet been available in China.

Proposed solution: Policymakers should continue and consider accelerating the current power sector reform path in ways that create greater flexibility to integrate intermittent renewable sources and value the demand response capabilities of end-users.

This inquiry marks the beginning of a broader effort to map the solution space for expanding CRE procurement in China. Corporations are major contributors to energy consumption and as such have the potential to be major market drivers of CRE procurement. Corporate demand for green power positively promotes the development of the CRE policy system in China including direct investment and the emerging GPT. Multinationals are increasingly active in the CRE market on account of their ambition in climate actions and requirements from clients and other stakeholders. In recent years, state-owned and large private domestic corporations have shown increased willingness to invest in CRE solutions. The engagement of corporations headquartered in China reached a new peak after President Xi announced the country's carbon neutrality pledge. The government could harness this collective ambition to drive the achievement of the country's carbon neutrality pledge.

References

Apple Inc. (2017). Environmental Responsibility Report 2017.
https://www.apple.com/environment/pdf/Apple_Environmental_Responsibility_Report_2017.pdf

Apple Inc. (2018). Apple Environmental Responsibility Report 2018.
https://www.apple.com/environment/pdf/Apple_Environmental_Responsibility_Report_2018.pdf

Beijing Power Exchange Center. (2022). Implementation Rules for Green Power Trading of Beijing Power Exchange Center.
https://mp.weixin.qq.com/s/7B-xWyi675wh8NGghaHwdA

BloombergNEF. (2021). Corporate Clean Energy Buying Grew 18% in 2020, Despite Mountain of Adversity.
https://about.bnef.com/blog/corporate-clean-energy-buying-grew-18-in-2020-despite-mountain-of-adversity/

Bronski, P. and McCormick, G. (2018). From additionality to 'emissionality': how companies can magnify their impact.
https://www.greenbiz.com/article/additionality-emissionality-how-companies-can-magnify-their-impact

Cames M., Harthan R.O., Füssler J., et al. (2016). How additional is the Clean Development Mechanism?
https://ec.europa.eu/clima/system/files/2017-04/clean_dev_mechanism_en.pdf

Carbon Trust. (2021). Make Climate Action Everyone's Business Conference (COP26 Forum).
https://www.carbontrust.com/news-and-events/events/2021/11/scope-3-emissions-carlsberg-carbon-trust

CDM Executive Board. (2012). Methodological tool: Tool for the demonstration and assessment of additionality (Version 07.0.0).
https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v7.0.0.pdf

China Energy News. (2021). Why domestic GEC receives low interest?
https://mp.weixin.qq.com/s/BrnQGsYC_NOsQxcjMbyZbw

CRS (Center for Resource Solutions). (2016). Additionality and Renewable Energy Certificates.
https://resource-solutions.org/wp-content/uploads/2016/03/RECs-and-Additionality.pdf

CRS. (2019). Accelerating Corporate Renewable Energy Engagement in China.
https://resource-solutions.org/wp-content/uploads/2019/11/Accelerating-Corporate-RE-Engagement-in-China.pdf

Cullenward, D. and Victor, D. G. (2020). Making Climate Policy Work.
https://www.cambridge.org/core/product/identifier/S2047102521000285/type/journal_article

Gillenwater, M. (2012). What is Additionality? Part 1: a long standing problem. Greenhouse Gas Management Institute.
https://ghginstitute.org/wp-content/uploads/2015/04/AdditionalityPaper_Part-1ver3FINAL.pdf

Google. (2021). 24/7 Carbon-Free Energy: Methodologies and Metrics.
https://www.gstatic.com/gumdrop/sustainability/24x7-carbon-free-energy-methodologies-metrics.pdf

Green Electricity Subscription Platform. (2022). Statistics data.
http://www.greenenergy.org.cn

Guangzhou Power Exchange Center, Guangdong Power Exchange Center, Guangxi Power Exchange Center, et al. (2022). Southern Region Green Power Trading Rules (Trial Implementation).
https://mp.weixin.qq.com/s/AWtZBhH4iP8oWPD9Tqr6jQ

Guo, J., Du, L., and Wei, C. (2019). Equity-efficiency trade-off in China's energy capping policy. Energy Policy, 126, 57–65.
https://doi.org/10.1016/j.enpol.2018.11.017

Haya, B. (2009). Measuring Emissions Against an Alternative Future: Fundamental Flaws in the Structure of the Kyoto Protocol's Clean Development Mechanism. SSRN Electronic Journal, (December).
https://doi.org/10.2139/ssrn.1562065

IEA (International Renewable Energy Agency). (2018). Corporate Sourcing of Renewables: Market and Industry Trends.
https://www. irena.org/publications/2018/May/Corporate-Sourcing-of-Renewable-Energy

I-REC Standard. (2021a). 2021 Market Statistics. https://www.irecstandard.org/2022/06/

I-REC Standard. (2021b). Change in issuance criteria for China following consultation.
https://www.irecstandard.org/news/change-in-issuance-criteria-for-china-following-consultation/#/

John, J. (2021). Location matters: The new science of siting clean energy to push more carbon from the grid.
https://www.canarymedia.com/articles/clean-energy/location-matters-the-new-science-of-targeting-clean-energy-to-push-more-carbon-from-the-grid

Kansal, R. (2019). Introduction to the Virtual Power Purchase Agreement.
https://rmi.org/wp-content/uploads/2018/12/rmi-brc-intro-vppa.pdf

Koo B. (2017). Preparing hydropower projects for the post-Paris regime: An econometric analysis of the main drivers for registration in the Clean Development Mechanism.
https://doi.org/10.1016/j.rser.2017.01.095

NDRC (National Development and Reform Commission), MOF (Ministry of Finance), and NEA (National Energy Administration). (2017). Trial implementation of renewable energy green electricity issuance and voluntary trading system.
http://www.nea.gov.cn/2017-02/06/c_136035626.htm

NDRC and NEA. (2019). Notice on the establishment and improvement of a safeguard mechanism for renewable electricity consumption.
https://www.ndrc.gov.cn/xxgk/zcfb/tz/201905/t20190515_962446.html?code=&state=123

NDRC and NEA. (2021). Reply letter to the working plan of green power trading pilot.
https://xueqiu.com/5273839515/197449319

NDRC and NEA. (2022). Implementation plan for promoting the high-quality development of new energy in the new era.
http://zfxxgk.nea.gov.cn/2022-05/30/c_1310608539.htm

NDRC. (2021a). Notice on the feed-in tariff policy of renewable energy in 2021.
https://www.ndrc.gov.cn/xxgk/zcfb/tz/202106/t20210611_1283088.html?code=&state=123

NDRC. (2021b). The Plan to Refine Dual-Control of Energy Intensity and Total Energy Consumption.
https://www.ndrc.gov.cn/xwdt/tzgg/202109/t20210916_1296857.html?code=&state=123

NDRC. (2022). Carbon Neutrality Leading Group Office held a meeting of liaison officers.
https://mp.weixin.qq.com/s/zWS1Gjub7uTWl2PTJfecMw

NRDC, MIIT (Ministry of Industry and Information Technology), MHURD (Ministry of Housing and Urban-Rural Development), et al. (2022). Implementation plan for promoting green consumption.
https://www.ndrc.gov.cn/xwdt/tzgg/202201/t20220121_1312525_ext.html

NDRC Jiangsu, MIIT Jiangsu, MHURD Jiangsu, et al. (2022). Implementation plan for promoting green consumption of the Jiangsu Province.
http://fzggw.jiangsu.gov.cn/art/2022/6/10/art_84097_10465280.html

Microsoft. (2021). 2020 Environmental sustainability report.
https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWyG1q

MEE (Ministry of Ecology and Environment). (2021). Administrative measures for carbon emissions trading (Trial).
https://www.mee.gov.cn/xxgk2018/xxgk/xxgk02/202101/t20210105_816131.html

REN21. (2021). Renewables 2021 Global Status Report.
https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf

RE100. (2021). RE100 technical criteria.
https://www.there100.org/sites/re100/files/2020-10/RE100%20Technical%20Criteria.pdf

Richardson, H. (2019). Could 'Emissionality' be the Next Big Thing to Disrupt Corporate Sustainability and Renewable Energy Procurement?
https://www.watttime.org/news/could-emissionality-be-the-next-big-thing-to-disrupt-corporate-sustainability-and-renewable-energy-procurement/

RMI (Rocky Mountain Institute). (2018). State of the Market 2018: Corporate Renewable Procurement in China.
https://www.rmi-china.com/static/upfile/news/nfiles/201811291357322940.pdf

RMI. (2019). State of the Market 2019: Corporate Renewable Procurement in China.
https://rmi.org/insight/state-of-the-market- 2019-corporate-renewable-procurement-in-china/

Schneider, L. (2009). Assessing the additionality of CDM projects: practical experiences and lessons learned. Climate Policy, 9(3), 242–254.
https://doi.org/10.3763/cpol.2008.0533

Shi, J. (2021). New energy generation policy and market development outlook.
https://mp.weixin.qq.com/s/rkOiNZtDusuwL0t2ndp8aw

Sievert, K. (2021). How can multinational companies (MNCs) achieve and demonstrate the additionality of renewable energy projects in the Chinese market? Master's Thesis.

State Council. (2015). Opinions on further deepening the reform of power system.
https://news.ncepu.edu.cn/xxyd/llxx/52826.htm

The Lantau Group. (2021). Volatility in Chinese Power Supply.
https://www.lantaugroup.com/file/brief_china_volatile_sep21.pdf

UNFCCC (United Nations Framework Convention on Climate Change). (1997). Kyoto Protocol To The United Nations Framework Convention On Climate Change.
https://unfccc.int/resource/docs/convkp/kpeng.html

Weng, S. (2022). Three questions to green power trading.
https://mp.weixin.qq.com/s/4p6AKbQDc13p1PYrTzfsxQ

WRI (World Resources Institute). (2019). Handbook: corporate green power consumption in China.
https://wri.org.cn/en/research/handbook-corporate-green-power-procurement-china

Xinhua. (2021). Key meeting stresses proper understanding of major issues in China's new development stage.
http://www.news.cn/english/2021-12/10/c_1310364991.htm

Zhang. (2022). Actively play the important role of the carbon market.
https://mp.weixin.qq.com/s/UkgIVEXIEfrVyecHpeFLIA

Zhang, X., Zhang, D., and Yu, R. (2021). Theory and practice of China's national carbon emissions trading system. Journal of Management World, 37(08), 80–95.
https://doi.org/10.19744/j.cnki.11-1235/f.2021.0108

3Degrees. (2018). Renewable energy power purchase agreements.
https://3degreesinc.com/resources/ppas-power-purchase-agreements/

(Source: Jun Song)

Valerie Karplus: vkarplus@andrew.cmu.edu
Da Zhang: zhangda@tsinghua.edu.cn