Next Steps for China's Carbon Emissions Trading System to Improve Efficiency, Achieve Climate Goals

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APRIL 2022

SUMMARY

In 2021, China's national carbon emissions trading system (CN ETS)[i] passed two milestones with the launch of its national carbon trading market and the first requirements for covered enterprises to account for their emissions through deposit of carbon allowances—tradable permits to emit carbon dioxide (CO_2). While the CN ETS is off to a respectable start, several policy recommendations can help the program reach its full potential as a pillar of China's decarbonization strategy.

- **Adopt a price collar, setting minimum and maximum carbon prices.** A price collar is the simplest, best approach to avoiding extreme carbon price volatility. By setting a clear, unbreachable price maximum, a price collar guarantees that carbon prices will remain below a given level, limiting economic risk.

- **Expand industry coverage.** Including sectors like aluminum, cement, and steel in the CN ETS will help these key industries achieve ambitious decarbonization targets. It will also boost innovation and improve their competitive position as demand for low-carbon products increases in the global market.

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[i] This report uses the more common term "emissions trading system," while noting that officials typically refer to China's program as the national carbon market.

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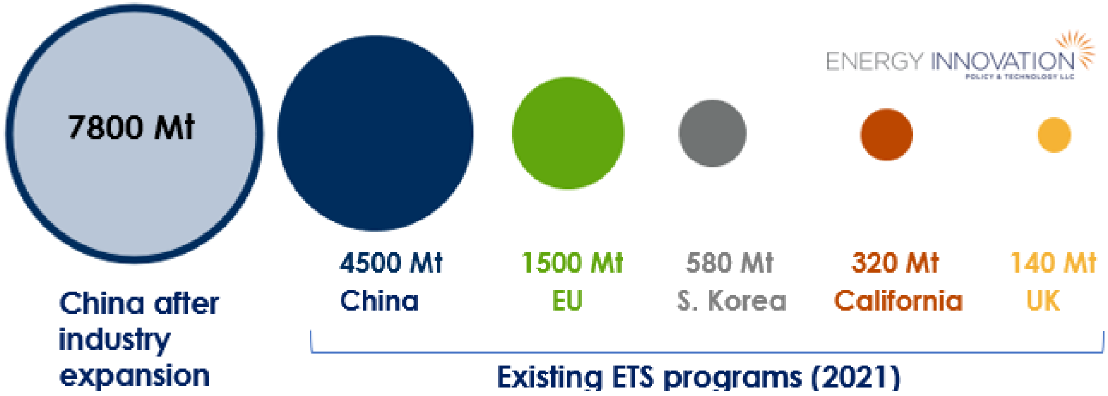
- **Transition to a mass-based cap, which provides a policy control variable better aligned with the goal of carbon peaking.**
- **Start immediately auctioning small quantities—2 percent to 5 percent of all allowances under the cap—and ramp up the share over time.** Even a small amount of auctioning will deliver significant benefits, including a higher-quality price signal, lower transaction costs for trading, and more liquidity. Auctions are also the best way to implement price collars.
- **Use consignment to overcome hurdles to auctions and, over time, introduce traditional auctioning, whereby some carbon costs are absorbed by enterprises as a factor of production.** Until the Ministry of Ecology and Environment (MEE) gains authority to collect and disburse revenue, consignment auctioning can sidestep legal barriers. By returning all auction revenue to enterprises, consignment auctioning can be entirely consistent with the goal of minimizing additional enterprise costs. In fact, considering the benefits of auctioning for effective carbon market function, and if all revenue from consignment auctions is returned to enterprises, instituting consignment auctioning should reduce compliance costs for covered enterprises.
- **Use non-GHG data already collected by the MEE's National Environmental and Monitoring Center to estimate and cross-check fuel combustion levels—a key data point in enterprise data reporting.** Increase monetary penalties for data falsification. Also, as quickly as feasible, transition lead responsibility for carbon emissions monitoring, reporting, and verification (MRV) to the National Environmental and Monitoring Center.

Many of these recommendations, such as expanding coverage and introducing allowance auctions, have already been announced as intended next steps. The lack of a specific timeline for the program's evolution is indicative of underlying implementation hurdles, which this report's recommendations aim to help overcome. For example, the suggested price collar may lend confidence in moving forward with a mass-based approach to cap setting.

Once expanded to industry, the CN ETS will cover more greenhouse gas (GHG) emissions than any other single climate policy in the world, leaving little doubt about the global importance of the CN ETS's success. Strengthening the system along our suggested lines will advance the policy's effectiveness as an efficient carbon emissions peaking tool while delivering domestic benefits, including well-known ones such as better air quality. It will also provide nearly invisible advantages aligned with China's economic strategy, such as faster domestic innovation and enhanced competitiveness for clean tech enterprises.

Figure 1. 2021 coverage of largest ETS programs in Mt (million metric tonnes of CO_2) [1,2,3,4,5]



INTRODUCTION

The CN ETS will be a crucial element of China's strategy for peaking emissions and reaching carbon neutrality. The CN ETS offers the promise of more emissions reductions than any other current global policy, and plans call for expansion to more industry sources. Given the urgency of the climate challenge, it is imperative that this potential is realized. This paper identifies key next steps for the CN ETS to fulfill its transformative potential. This overarching report is the first in a three-part series. The second report focuses on the topic of expanded coverage under the CN ETS, and the third report explores the implications for China of the European Union's proposed carbon border adjustment mechanism.

This paper begins by providing some background on the status of the CN ETS and policy design suggestions. The following section touches on related policy recommendations, recognizing the CN ETS does not operate in a vacuum. Before concluding, the "Challenges" section explores key hurdles and possible solutions. An appendix presents a glossary and a concise list of suggested actions.

CN ETS STATUS

The CN ETS is initially regulating CO_2 emissions from power plants, covering about 2,200 enterprises.[6] Power sector coverage includes fossil-combustion-fueled electricity plants connected to the electricity grid, as well as combined heat and power generators and captive power plants, i.e., generation capacity directly connected to factories in other industries. In 2021, the program first required covered enterprises to transfer allowances, or tradable permits, to the government to account for carbon emissions. Mandated MRV began in 2019.[7] This first incarnation of the program represents a learning phase, and such gentle starts are typical of ETS programs. For instance, California treated 2012—which was originally intended as the first year of mandatory compliance obligations for its program—as a practice year, starting the program in earnest in 2013.

Other specific features of the program will be discussed in conjunction with recommendations. Readers wanting more detail are directed to the International Climate Action Partnership's program brief, which is regularly updated.[8]

Price is the simplest measure of any ETS program's effectiveness. In 2018, the World Bank's High-Level Commission on Carbon Pricing and Competitiveness concluded most carbon pricing measures were inadequate. The analysis showed that higher carbon prices, in the range of $40 to $80 per tonne in 2020 and $50 to $100 per tonne in 2030, plus other supportive policies, would be needed to reach the goals of the Paris Agreement. More recent work found limiting global warming to 1.5°C would require a higher carbon price, starting at about $100 today.[9]

The preceding paragraph considers carbon price from a global perspective, without accounting for different development circumstances. For a China-specific outlook on carbon price, the most authoritative source is "China's Long-Term Low-Carbon Development Strategies and Pathways," a policy and technology roadmap for reaching China's carbon peaking and carbon neutrality commitments produced by Tsinghua University's Institute for Climate Change and Sustainable Development.[10] The least aggressive scenario, "Higher 2030 peak," models existing policy with no future strengthening, allowing China's emissions to rise until 2030. The most ambitious scenario, "Immediate peak," results in an emissions pathway consistent with limiting global warming to 1.5°C. Table 1 summarizes the four scenarios.

Table 1. Scenarios in Tsinghua University carbon neutrality analysis[11]

Scenarios	2030 emissions	Emission reduction rate post-2030
Higher 2030 peak	11.1 billion tonnes CO_2	0.9% average annual decrease
Lower 2030 peak	10.6 billion tonnes CO_2	2.6% average annual decrease
Peak by 2025	9.4 billion tonnes CO_2	5.7% average annual decrease
Immediate peak	7.4 billion tonnes CO_2	7.8% average annual decrease

Table 2. Carbon price levels in Tsinghua University carbon neutrality scenarios (¥/tonne in 2020 ¥)[12]

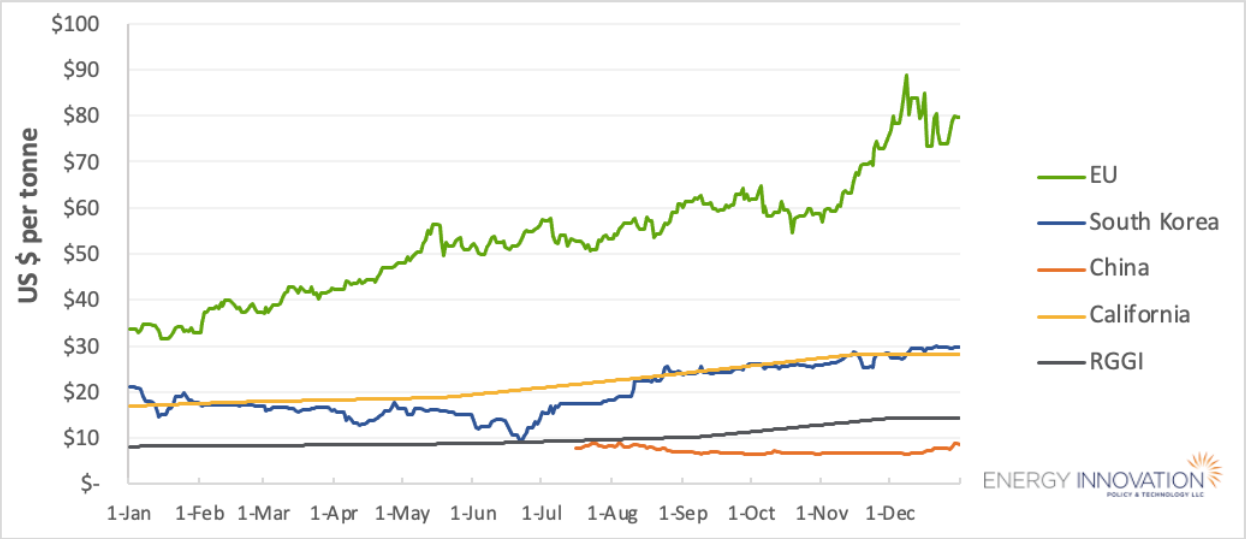
Scenarios	2020	2025	2030	2035	2040
Higher 2030 peak	¥58	¥91	¥124	¥174	¥240
Lower 2030 peak	¥58	¥99	¥133	¥190	¥298
Peak by 2025	¥58	¥108	¥158	¥249	¥430
Immediate peak	¥58	¥133	¥208	¥356	¥778

Table 2 lists carbon price levels associated with each emission outcome under Tsinghua University's carbon neutrality study, ranging from ¥91 to ¥133 per tonne ($14 – $21 per tonne) in 2025, increasing to ¥124 to ¥208 per tonne ($19 – $31 per tonne) in 2030. Each scenario has the same start year price of ¥58 per tonne.

In China, emission allowances began trading on the official national exchange in Shanghai on July 14, 2021.[13] The carbon price under the CN ETS has so far met expectations, with the price of emission allowances staying above ¥40 ($6.20) per tonne of CO_2, reaching a daily maximum of ¥58 ($9.10).

For comparison, the EU ETS has notched the most robust carbon price of any major ETS, reaching more than ¥450 ($70) per tonne in 2021. Through 2021, the EU's program is the only major program to experience prices above the minimum recommended by the High-Level Commission on Carbon Pricing and Competitiveness, i.e., above $40 per tonne. The carbon price under the Regional Greenhouse Gas Initiative, an ETS covering electricity generation in Eastern U.S. states, was below $5 per tonne for many years, but is trending upward, reaching a record of around ¥60 ($9.3) per tonne at auction.[14] Carbon prices are higher under California's cap-and-trade program—the other major North American ETS program—at above ¥200 ($30) per tonne.

Figure 2. Carbon prices in major ETS programs in 2021[15, ii]



CN ETS DESIGN RECOMMENDATIONS

This section provides detailed CN ETS design recommendations, including setting a price collar, hastening expansion to other industry sources, transitioning to a mass-based cap, using consignment auctioning to overcome legal and political obstacles, and leveraging non-GHG data already collected by the National Environmental and Monitoring Center of the MEE to cross-check carbon emissions data reported by enterprises.[iii]

SET A PRICE COLLAR

Set a price collar identifying a floor and a ceiling for carbon prices, thus "collaring" the cost of allowances within that range. A price collar is the simplest, most direct way to achieve carbon price stability and guard against unexpected price volatility, which carries economic and political risks.[16] Setting a price collar not only mitigates risk but also facilitates decarbonization investments by increasing certainty vis-à-vis future carbon prices.

The price ceiling element of a price collar sets an upper limit on compliance cost, eliminating the risk of economic shocks due to spiraling prices. No matter how stringent allocation benchmarks might be, allowance cost—the cost to emit one metric ton of CO_2—will stay at or below a known level if a price ceiling is in place. By ruling out worst-case scenarios, a price collar helps policymakers manage public relations and stakeholder engagement.

[ii] Data used to produce this graph are from the International Climate Action Partnership's ETS Price Explorer. Data for programs in China, the EU, and South Korea are spot market data, also sometimes called bilateral or secondary market data. Data for the California and Regional Greenhouse Gas Initiative programs exclusively reflect auction (primary market) results due to lack of easily accessible secondary price data for these programs. Further detail at: https://icapcarbonaction.com/en/documentation-allowance-price-explorer.

[iii] Energy Innovation's climate policy design manual offers a chapter on carbon pricing. Available at: https://energypolicy.solutions/policies/carbon-pricing/.

Auctions, sometimes called the primary market, are the best way to establish a price collar. A ceiling price can be achieved by offering unlimited allowances at the desired maximum price. A price floor can be achieved by setting a minimum price for allowances sold at auction, called an "auction reserve price." If no demand emerges for allowances at or above the floor price, allowances are held back from circulation. This automatic tightening of supply in the primary market puts upward pressure on the price of carbon allowances outside of auctions (i.e., in a secondary market where allowance holders may directly exchange allowances).

California's experience demonstrates that a price collar established at auction can also manage secondary market prices. The secondary market price for California carbon allowances consistently tracks auction prices. During periods of weak demand, the auction reserve price (i.e., the price floor element of the program's collar), leads to allowances being held back from the market, and secondary market prices remain tethered to the program's auction reserve price.[17]

EXPAND INDUSTRY COVERAGE

Use a two-part strategy combining a price collar and minimizing allocation benchmarks, aiming for one per product, to overcome challenges to expanding coverage to additional industries. Existing public plans call for industrial expansion, but do not detail a timetable, which is indicative of the implementation hurdles.

Reducing the number of benchmarks helps to limit information demands in the preparatory stage of policy design. A price collar also reduces the danger of imperfect information by limiting the economic risk attendant in price variability. This is particularly important if industries are added to the CN ETS because industries are more heterogeneous in operations and less well studied and technically documented than the power sector.

A price collar also offers advantages for industry expansion. The specific industries that will be added to the CN ETS are more energy and emissions intensive and trade exposed. Across the world, industry lobbyists are paid to raise concerns about leakage and competitiveness impacts of ETSs and climate policies in general, invariably inflating the challenge. Although leakage and competitiveness concerns are limited and manageable,[18] it can still be challenging for regulators to counter business objections in energy-intensive, highly traded sectors, particularly for climate policymakers charged with broad or even economy-wide portfolios. The price collar's ceiling provides a clear and visible counterpoint to exaggerated stakeholder claims. This topic is explored further in the second report.

TRANSITION TO A MASS-BASED CAP

Transition to a mass-based cap for the power sector in the CN ETS's second phase, starting in 2022. China's goals for carbon peaking and carbon neutrality depend on emissions levels, not intensity, making a mass-based approach to cap setting more closely aligned with policy objectives and a better choice. The influential China Council for International Cooperation on Environment and Development has called for adoption of a mass-based cap for this reason.[19]

In its first phase, covering emissions from electricity generation, the CN ETS has used an intensity-based approach to cap setting. With this approach, the number of allowances that are made available adjusts according to actual production levels. More production leads to more allowances being created and distributed. Such an approach is understandable in a pilot phase. Yet the intensity-based approach leads to a less-than-optimal automatic feedback mechanism. Increasing production, on its own, does not evidence unacceptably high carbon compliance costs.

By contrast, a mass-based approach to cap setting, paired with a price collar, creates a preferable link between allowance supply and the economic variable that matters most: carbon price. If allowance prices reach the upper end of the price collar, then allowance supply should be increased.

Sometimes, the mass-based approach is referred to as a "hard cap," to contrast with how the cap floats up or down with production in the intensity-based approach. Yet the "hard cap" label suggests more rigidity than the reality. Design options like a price collar may introduce significant flexibility into a mass-based cap through optimal linkages between the emissions reductions the program is demanding, its ambition, and the carbon price.

INTRODUCE CONSIGNMENT AUCTIONING

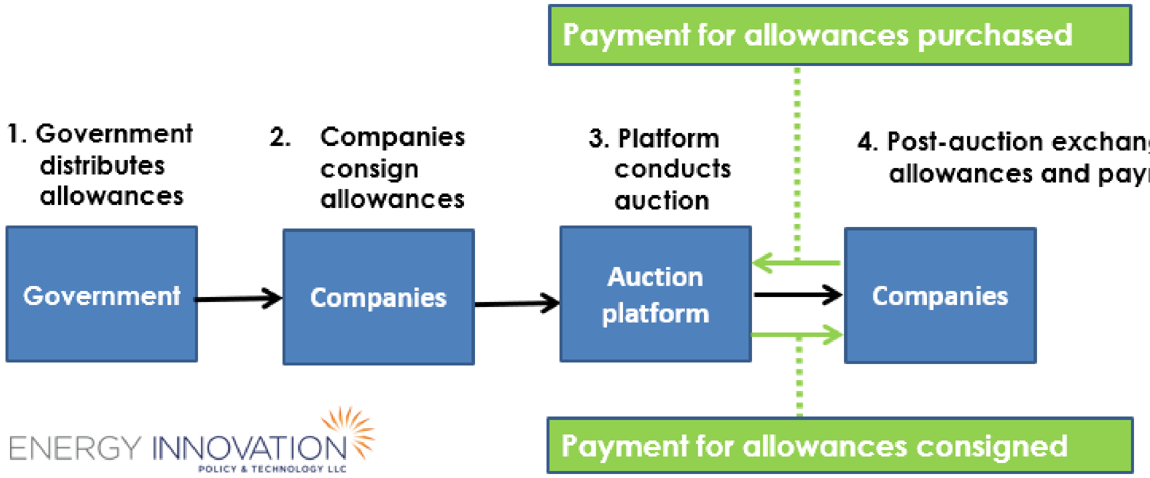
Begin consignment auctioning as soon as practical. Start with 2 percent to 5 percent auctioning and ramp up over time. Even such a small amount of initial auctioning would deliver significant advantages. Experience, new research by Chinese scholars, and economic modeling all underpin a conclusion that introducing some consignment auctioning into the CN ETS would reduce compliance costs for enterprises. Consignment can also overcome legal hurdles to auctioning.

Before digging in on advantages of consignment auctioning for China, we offer some background. "Consignment" refers to a transaction in which the party selling an item does not own it. As a less abstract illustration of how consignment auctioning works in an ETS, consider a real-world example of consignment sales: a business specializing in selling used cars. Figure 3 below offers two views of such an establishment, at left a street view, and at right an image focused on its window signage, which communicates the essence of consignment: "Let us sell your car!"

Figure 3. A used car dealership offers a real-world example of sale by consignment

In the context of ETS design, consignment auctioning involves selling allowances on behalf of regulated enterprises. Consignment auctioning can be boiled down to a four-step process. First, authorities freely distribute allowances to enterprises. Second, enterprises transfer allowances to a consignment auctioneer. Third, a consignment auction is held for enterprises to purchase allowances as needed, reflecting the enterprises' carbon emissions. Fourth, in the settlement phase after the auction, enterprises are compensated for the revenue collected from the sale of their allowances minus the cost of any allowances purchased.

Figure 4. Flowchart depicting four steps in consignment auctioning



In ETS design, consignment auctions are a way to combine features of free allocation and auctioning. Consignment auctioning occurs today in the California ETS and traces back to the 1990s, when it was used in the U.S. as part of a sulfur dioxide emissions trading program. In both cases, consignment auctions cost relatively little to construct and administer.[20]

Transitioning from this background to CN ETS design, consignment auctioning offers legal and economic advantages. To begin, consignment auctioning can address the legal hurdle presented by the current limits on the MEE's ability to hold or disburse revenue. Consignment auctioning can be structured such that auction revenue remains untouched by the MEE or any other government agency.[21]

The economic advantages of consignment auctioning are less straightforward but perhaps more significant. In the CN ETS's first phase, all allowances were directly and freely distributed, based on allocation benchmarks. Program designers were looking to minimize new costs for covered enterprises due to introduction of the CN ETS. Free allocation lowers enterprise costs compared to traditional auctioning. However, introducing consignment auctioning would deliver a more developed carbon market and lower enterprise costs overall.

Under consignment auctioning, allowances are still freely distributed to enterprises, as shown in the first step in Figure 4 above. The consignment auctioning that follows, however, delivers several market efficiencies. Auctions help efficiently uncover equilibrium prices, reducing transaction costs of trading and increasing liquidity. Absent the price signal an auction provides, bilateral negotiations between prospective buyers and sellers consume more time and carbon market prices are more likely to diverge from the true market price.

Recent research provides important new evidence of the economic advantages of consignment auctioning in China. A working paper from a team of researchers at Tsinghua and Xiamen universities examines a variety of allocation approaches, drawing on simulation data from training exercises for enterprise compliance staff as part of CN ETS capacity building.[22] The study finds that consignment auctioning delivers a superior price signal, reduced volatility, and increased compliance.[23]

PREPARE FOR TRADITIONAL AUCTIONING

Once legally permissible, introduce traditional auctioning whereby some carbon costs are absorbed by enterprises as a factor of production. This would be a second step after implementing the recommendation detailed above of immediately introducing a form of consignment auctioning under which auction revenue is returned to entities to balance their auction costs.

A recent report from a team of analysts at Tsinghua University and the International Energy Agency demonstrates that gradually introducing traditional auctioning would have significant decarbonization benefits at low cost.[24] The work compared the current approach to a scenario beginning with 10 percent traditional auctioning in 2025 and gradually increasing to 50 percent in 2035. The report finds that gradually introducing traditional auctions "strengthens the competitiveness of renewables-, nuclear- and gas-based technologies vis-à-vis coal-fired plants, leading to faster decommissioning of existing coal-fired units and fewer installations of new ones."[25]

The Tsinghua-International Energy Agency report's finding of much greater switching to lower-carbon energy with a gradual introduction of traditional auctioning is illustrated in Figure 5 below, which breaks down the sources of emissions reductions with and without traditional auctioning. At right, results with auctioning show the impact of switching to non-fossil technologies in green and switching to natural gas in purple. In contrast, at left, results without auctioning show very little switching to non-fossil technologies or natural gas.

Figure 5. Gradual introduction of traditional auctions increases switching to lower-carbon technologies[26]

These results stem from the CN ETS's technology-differentiated benchmarks, which act as distortionary subsidies. The benchmark for power plants that burn natural gas is less than half the level for coal plants, which fall into three different technology types. Note that the most generous allocation accrues to the most carbon-intensive types of coal plants: unconventional facilities burning coal waste, or a mix of coal and biofuel, including biowaste.[27] Carbon capture technology gains the greatest cost advantage from current benchmark design, while unabated coal investment is largely unaffected, accounting for free allocation, with a net cost increase estimated at ¥0.02 per kilowatt-hour in 2035.[28]

In sum, introducing traditional auctioning would lessen distortionary effects of the production subsidy created by the initial approach of benchmarked free allocation differentiated by technology. Likewise, introducing traditional auctioning would lessen the inefficiency created by low carbon prices for coal-fired power plants, improving the economics of competing zero-emission technologies.

SIMPLIFY ALLOCATION BENCHMARKS

Simplify allocation benchmarks, minimizing differential treatment by technology. Instead of using differentiated benchmarks for equity purposes, achieve the same ends by using auction revenue to fund benefits for disproportionately affected workers and communities. The choice of multiple benchmarks in the first phase of the program was motivated by understandable goals concerning fairness for highly affected communities, workers, and enterprises. As discussed in the context of the preceding recommendation, however, the initial multiple benchmark approach comes with an efficiency cost. Sending a different price signal to different producers based on technology in effect distorts the price signal, leading to suboptimal investment. It would be preferable to pursue the same equity goals using auction revenue while sending a stronger carbon price signal for investment.

CONTINUE PROGRESS ON MONITORING, REPORTING, AND VERIFICATION

The following recommendations focus on the government's "first-party" role as receiver of reported data and guarantor of its authenticity. Data quality is a prerequisite for ETS effectiveness, as for other regulations. In March 2020, the MEE invited public comment on detailed reporting rules for power sector enterprises.[29] Appendix A of Attachment 2 in the draft rules presents the core calculations, involving emissions factors (CO_2 emitted per gigajoule of energy combusted for different technologies and fuel types) and quantities of fuel combusted. The MEE's proposed reporting approach aligns with international best practices.

Include fourth-party checking of third-party verifiers in the CN ETS, as planned. The Beijing and Shanghai ETS pilots, with cutting-edge, fourth-party checks of third-party verification, represent an advancement in global best practice for MRV.[iv] Tsinghua researchers quantified improvements in data quality over time thanks to learning and incentives from this practice.[30]

Though on-site verification is unnecessary in most cases, independent cross-checks are essential. Unlike emissions of other pollutants, which require field readings, CO_2 emissions from fuel combustion are mostly unaffected by capital maintenance and operation, so are straightforward to calculate as a function of fuel combustion and emission factors.

Increase the severity of fines for data falsification. The current maximum penalty is ¥30,000 (about U.S. $4,400), providing an insufficient monetary disincentive for non-compliance. The MEE recently sanctioned four verification firms for negligence in approving inaccurate data.[31] While this is a promising development in that it demonstrates the capacity to detect fraudulent reports, stronger penalties are needed to discourage inadequate or deceptive data.

This area of policy design is ripe for advancement because of emerging big data analytical techniques, as well as increasing availability of low-cost sensors. In the near term, the CN ETS should **leverage local air pollutant emissions data currently collected by the MEE's National Environmental and Monitoring Center**

[iv] Fourth-party checking is key to ensuring that third-party verifiers' incentives align with the public good and to uncovering data problems. In ETS programs outside China, regulated enterprises select and compensate the third-party verifiers they work with. Allowing enterprises to choose their verifiers creates incentives for the verifiers to please the enterprises they check. The risk of inaccurate data in such situations was proved in a study of Indian industry authored by Nobel laureate Esther Duflo and colleagues: "Truth-Telling by Third-Party Auditors and the Response of Polluting Firms: Experimental Evidence from India," *The Quarterly Journal of Economics* 128, no. 4 (November 1, 2013): 1499–1545, https://doi.org/10.1093/qje/qjt024.

to calculate implied fuel combustion. Doing so would be an important and efficient step forward for the CN ETS that would also advance global best practices for data verification.

In time, designate the National Environmental and Monitoring Center as the lead on MRV, adding CO_2 to the pollutants monitored by on-site continuous emissions sensors. The suggested change would follow the example of sulfur dioxide and other pollutants of local concern, for which subnational authorities initially took the lead.

Provide data transparency. China already makes local air pollutant data publicly available. Doing so for covered CO_2 emissions and other aspects of CN ETS program performance will increase the number of eyeballs on the data, upping the likelihood that data inconsistencies will be discovered. More accessible information will also facilitate price discovery and trading.

Set MRV process standards for provinces, which are initially responsible for MRV. Such process standards should identify key minimum requirements, such as setting rotation schedules for third-party verifiers and how often to apply fourth-party verification.

Develop a culture of continuous improvement by requiring third-party verifiers to undergo periodic training and recertification. Also, avoid incentive misalignment through enforced rotation schedules for third-party verifiers. Under rotation scheduling, enterprises periodically select or are assigned a different third-party verification agency. This arrangement encourages third-party verifiers to remain true to their public interest mission and discourages them from becoming too close to the enterprise they are checking.

RELATED RECOMMENDATIONS

The following recommendations go beyond ETS policy design to consider other key factors in the program's success, covering policy interactions and the benefits to promoting the clean tech opportunity narrative.

ACCOUNT FOR POLICY INTERACTIONS

Continuously assess policy interactions to minimize friction and look for opportunities to leverage synergies. Use the China Energy Policy Simulator, a unique system dynamics tool for policy analysis, to better understand the sum effect of climate measures.[v]

China's climate policy strategy reflects the principle that there is no silver bullet when it comes to the climate challenge. Hence, while the CN ETS is a pillar of China's carbon peaking and neutrality strategy, it is also part of a larger package of policies. Considering and accounting for policy interactions is crucial to realizing the program's potential.

China has made important progress harmonizing separate policies through the policy of "dual control," a strategy guiding the country's energy sector for more than 15 years. Historically, "dual control" referred to energy intensity targets and caps on total energy consumption. Yet energy use limits, along with inflexible mechanisms for setting electricity prices, were main contributors to the instability in China's power sector during the fall of 2021.[32] Since then, China has retargeted "dual control" to focus on the goals of reducing total emissions as well as lowering emissions intensity of economic output. Certain provisions relax constraints on renewable energy, providing a boost relative to traditional energy sources, and are an

[v] https://china.energypolicy.solutions/.

example of aligning policy objectives.[33] These policies remove a potential barrier to zero-carbon energy growth and improve alignment among energy and climate policy goals.

COMPLETE POWER SECTOR REFORM

Complete power sector reform to remove impediments to the effectiveness of economic signals in electricity sector operation and planning.[34]

Power sector reform is a prominent example of the need to account for policy interactions. In China, dispatch rules (i.e., the rules that electricity system operators use to decide which available power to draw upon), have not been driven by economics. Rather, dispatch in China has been governed by the "three equals system," which allocates each plant a guaranteed share of demand based on technology. If cost does not drive dispatch, introducing a carbon price will have little effect on the power sector. Economic dispatch pilots have tested the concept at the subnational level. The CN ETS will only fulfill its role as an efficient driver of decarbonization when economic dispatch is the national norm for electricity system management.

RAISE AWARENESS OF SYNERGIES BETWEEN THE CN ETS AND NATIONAL ECONOMIC STRATEGY

Highlight growing clean tech opportunities to build supportive constituencies and counterbalance industry opposition. China has developed strong positions in key clean tech markets as they are taking off.[35] Expanding and strengthening the CN ETS will accelerate domestic technological progress and build Chinese enterprises' competitiveness in growing global clean tech markets, consistent with China's national economic strategy.[36]

Strengthening and expanding the CN ETS will induce faster clean tech innovation, lowering costs and enhancing competitiveness for Chinese firms in global markets. The value of these upsides is growing as demand for clean tech surges. Even amidst the pandemic downturn, overall clean tech investment grew to $501 billion in 2020 from $459 billion the year before.[37] Clean tech investment grew even faster in 2021, jumping by 25 percent to $755 billion.[38]

Consider how solar power provides evidence that domestic leadership in China can beget international export success. In 2021 more solar capacity was installed than any other technology, and solar is on track to set new records for deployment in coming years.[39] As solar power has come to dominate global investment in the power sector, China has established a strong position. Chinese firms make up seven of the top ten solar panel manufacturers in the world, supplying around 70 percent of the world's solar panels.[40] At home, China's solar industry employs about 2.3 million people—more than 60 percent of the global total.[41]

China has built far more solar power plants than any other country, installing around a third of global capacity.[42] China's solar capacity is more than three times the capacity in the next largest country, the U.S.[43] China's significant domestic investments were an essential factor in developing its strong export position, offering an example of what economists call the home market effect.[44, 45, 46]

In the past, policies other than carbon pricing, such as deployment mandates and incentives, have been the drivers of solar and other renewable energy deployment in China. Adoption of recommendations herein would enable the CN ETS to become a driver of innovation in the power sector going forward.

The second and third reports in this CN ETS series explore economic upsides due to expanded industry coverage, which will accelerate innovation in newly regulated sectors, such as in lower-emitting fuels. On this topic, the second report looks at economic opportunities due to global green hydrogen demand. The third report explores how the EU's proposed carbon border adjustment mechanism creates opportunities and presents a case study of the market for low-carbon steel.

The EU's proposed carbon border adjustment mechanism is just one example of a broader sustainability trend in international markets. Another is the Kigali Amendment to the Montreal Protocol, an agreement among 197 countries to phase out carbon-intensive chemicals used for refrigeration.[47] The movement of global markets toward electric vehicles is another example, with the U.S. committing to at least 50 percent electric vehicles by 2030 and the EU promising a 100 percent phase-out of fossil-combustion cars by 2035.[48] Increasingly, major international investments are applying sustainability screens, ruling out projects below minimum environmental standards.[49] All these market trends have the effect of increasing the value of emissions reductions achieved by the CN ETS.

CHALLENGES

Effective policy design demands acknowledgment of the difficulties ahead. Several factors make the suggested next steps challenging. There is some understandable resistance to additional government mandates from the companies and plants subject to the CN ETS, having undergone major disruptions over the last decade. Clean air and modernization campaigns forced the retirement of many older, less efficient plants and mines. Additionally, the affected workers and enterprises are clustered in the same regions, increasing the complexity of crafting equitable policies.

There are also technical and informational challenges. For regulatory analysts, or anyone trying to stay abreast of technological change, keeping up with fast-moving innovation is difficult—especially when looking at the entire economy. Academic research is too often disconnected from the real-world needs of public policymaking.

In part, this report's recommendations are designed to help overcome both technical and political challenges. A price collar helps manage informational and analytical challenges by containing the potential negative fallout from unintended effects, such undesirable high (or low) carbon prices from benchmarks set too high (or low). By setting a maximum price per allowance, a price collar also offers a readily explainable reply to inflated stakeholder concerns. Devoting resources to better understanding and characterizing the economic opportunity—as well as to communicating it—is another suggested stakeholder engagement strategy.

CONCLUSION

Once expanded to industry, the CN ETS will cover more greenhouse gas emissions than any other single climate policy in the world, leaving little doubt about the global importance of the CN ETS's success. Strengthening the system along our suggested lines will advance the policy's effectiveness as an efficient carbon emissions peaking tool while delivering domestic benefits, including well-known ones such as better air quality.

This report also highlights the less frequently discussed economic opportunities and alignment with China's economic strategy. These economic co-benefits are nearly invisible compared to important, well-established ones such as better air quality and higher-quality urban development. The case of solar power shows how domestic leadership can spur domestic innovation and enhanced international competitiveness for clean tech enterprises. The second report in this series explores the growing commercial potential of green hydrogen as part of a deeper consideration of hurdles and solutions to expanding CN ETS coverage to additional industries.

APPENDIX

GLOSSARY

Term	Definition
Allocation	The process of distributing allowances.
Allowances	The tradable permits to emit CO_2 that are the main compliance instrument under an ETS.
Allocation benchmark	An allocation benchmark sets the quantity of free allowances that firms receive per unit of output produced.
Consignment	In a consignment auction, and for consignment sales generally, the entity selling an item does not own the item being sold.
Intensity-based cap	In this ETS design, the number of allowances distributed and, by extension, allowable carbon emissions, adjust based on economic output. In its first phase, the CN ETS has used an intensity-based cap.
Mass-based cap	In this ETS design, the policy targets a specific level of emissions reductions, lowering to a specific quantitative target if cost containment measures remain untriggered.
Price collar	A price collar sets a floor and ceiling on carbon price, “collaring” the cost of allowances within that range.
Price ceiling	A maximum level for allowances and upper bound of a price collar.
Price floor	A minimum level for allowances and lower bound of a price collar.

CONCISE LIST OF RECOMMENDATIONS

CN ETS design

- Set a price collar identifying a floor and a ceiling for carbon prices, thus "collaring" the cost of allowances within that range.
- Use a two-part strategy combining a price collar and minimizing allocation benchmarks, aiming for one per product, to overcome challenges to expanding coverage to additional industries.
- Transition to a mass-based cap for the power sector in the CN ETS's second phase, starting in 2022. China's goals for carbon peaking and carbon neutrality depend on emissions levels, not intensity, making a mass-based approach to cap setting more closely aligned with policy objectives and a better choice.
- Begin consignment auctioning as soon as practical. Start with 2 percent to 5 percent auctioning and ramp up over time.
- Once legally permissible, introduce traditional auctioning whereby some carbon costs are absorbed by enterprises as a factor of production.
- Simplify allocation benchmarks, minimizing differential treatment by technology, aiming for one benchmark per unique product.
- Instead of using differentiated benchmarks for equity purposes, achieve the same ends by using auction revenue to fund benefits for disproportionately affected workers and communities.
- Include fourth-party checking of third-party verifiers in MRV, as planned.
- Increase the severity of fines for data falsification.
- Leverage local air pollutant emissions data currently collected by the MEE's National Environmental and Monitoring Center to calculate implied fuel combustion to provide a cross-check on reported data.
- In time, designate the National Environmental and Monitoring Center as the lead on MRV, adding CO_2 to the pollutants monitored by on-site continuous emissions sensors.
- Provide data transparency.
- Set MRV process standards for provinces, which are initially responsible for MRV.
- Develop a culture of continuous improvement by requiring third-party verifiers to undergo periodic training and recertification. Also, avoid incentive misalignment through enforced rotation schedules for third-party verifiers.

Other recommendations

- Continuously assess policy interactions to minimize friction and look for opportunities to leverage synergies. Use the China Energy Policy Simulator, a unique system dynamics tool for policy analysis, to better understand the sum effect of climate measures.
- Complete power sector reform to remove impediments to the effectiveness of economic signals in electricity sector operation and planning.
- Highlight growing clean tech opportunities to build supportive constituencies and counterbalance industry opposition.

REFERENCES

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[1] International Carbon Action Partnership, "China National ETS Detailed Information," November 17, 2021, https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=55.

[2] International Carbon Action Partnership, "EU Emissions Trading System," August 9, 2021, https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=43.

[3] International Climate Action Partnership, "Korea Emission Trading Scheme," August 9, 2021, https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=47.

[4] California Air Resources Board, "Unofficial Electronic Version of the Regulation for the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms," accessed November 12, 2021, https://ww2.arb.ca.gov/sites/default/files/2021-02/ct_reg_unofficial.pdf.

[5] International Climate Action Partnership, "UK Emission Trading Scheme," August 9, 2021, https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=99.

[6] International Carbon Action Partnership, "China National ETS Detailed Information."

[7] Hongqiao Liu, "In-Depth: Will China's Emissions Trading Scheme Help Tackle Climate Change?," *Carbon Brief*, June 24, 2021, https://www.carbonbrief.org/in-depth-qa-will-chinas-emissions-trading-scheme-help-tackle-climate-change.

[8] International Carbon Action Partnership, "China National ETS Detailed Information."

[9] Simon Dietz et al., "Economic Impacts of Tipping Points in the Climate System," *Proceedings of the National Academy of Sciences* 118, no. 34 (August 24, 2021): e2103081118, https://doi.org/10.1073/pnas.2103081118.

[10] Jiankun He, Zheng Li, and Xiliang Zhang, *China's Long-Term Low-Carbon Development Strategies and Pathways* (Institute of Climate Change and Sustainable Development, Tsinghua University: China Environment Publishing Group Co., Ltd., 2022), https://link.springer.com/content/pdf/10.1007%2F978-981-16-2524-4.pdf.

[11] He, Li, and Zhang, *China's Long-Term Low-Carbon Development Strategies and Pathways*.

[12] He, Li, and Zhang, *China's Long-Term Low-Carbon Development Strategies and Pathways*.

[13] Muyu Xu, David Stanway, and Ryan Woo, "China's Carbon Trading Scheme Makes Debut with 4.1 Mln T in Turnover," *Reuters*, July 20, 2021, sec. Sustainable Business, https://www.reuters.com/business/sustainable-business/chinas-national-carbon-emission-trading-opens-48-yuant-chinese-media-2021-07-16/.

[14] Regional Greenhouse Gas Initiative, Inc., "Allowance Prices and Volumes," accessed October 29, 2021, https://www.rggi.org/Auctions/Auction-Results/Prices-Volumes.

[15] International Carbon Action Partnership, "Allowance Price Explorer," accessed October 29, 2021, https://icapcarbonaction.com.

[16] Dallas Burtraw, Richard Morgenstern, and Karen Palmer, "Soft and Hard Price Collars in a Cap-and-Trade System: A Comparative Analysis" (Resources for the Future, 2011), https://www.rff.org/publications/working-papers/soft-and-hard-price-collars-in-a-cap-and-trade-system-a-comparative-analysis/.

[17] California Air Resources Board, "California Carbon Allowances Prices," n.d., https://ww2.arb.ca.gov/sites/default/files/classic/cc/capandtrade/carbonallowanceprices.pdf.

[18] Antoine Dechezlepretre et al., "Searching for Carbon Leaks in Multinational Companies" (Centre for Climate Change Economics and Policy, London School of Economics, n.d.).

[19] Jiefei Liu and Stian Reklev, "Top Advisory Body Calls for Absolute Emissions Cap in China ETS," *Carbon Pulse*, September 10, 2021, https://carbon-pulse.com/138058/.

[20] Dallas Burtraw and Kristen McCormack, "Consignment Auctions of Free Emissions Allowances Under EPA's Clean Power Plan," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, June 2, 2016), https://doi.org/10.2139/ssrn.2789825.

[21] Chris Busch et al., "Consignment Auctioning of Carbon Allowances in Cap-and-Trade Program Design" (Energy Innovation: Policy and Technology, LLC, June 2018), https://energyinnovation.org/wp-

content/uploads/2018/06/Consignment-Auctioning-of-Carbon-Allowances-in-Cap-and-Trade-Program-Design.pdf.

[22] Zhi Li, Da Zhang, and Xiliang Zhang, "Alternative Emissions Permit Allocation Designs: A Lab-in-Field Experiment in China" (Working Paper, Xiamen University and Tsinghua University, September 2021).

[23] Li, Zhang, and Zhang, "Alternative Emissions Permit Allocation Designs."

[24] International Energy Agency, "The Role of China's ETS in Power Sector Decarbonisation" IEA, April 2021, https://www.iea.org/reports/the-role-of-chinas-ets-in-power-sector-decarbonisation.

[25] International Energy Agency, "The Role of China's ETS in Power Sector Decarbonisation."

[26] International Energy Agency, "The Role of China's ETS in Power Sector Decarbonisation."

[27] International Energy Agency, "The Role of China's ETS in Power Sector Decarbonisation."

[28] International Energy Agency, "The Role of China's ETS in Power Sector Decarbonisation."

[29] Ministry of Ecology and Environment, People's Republic of China, "Draft Protocol on Enterprise Greenhouse Gas Reporting for Facilities (企业温室气体排放核算方法与报告指南 发电设施)," March 12, 2020, https://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/202012/t20201203_811443.html.

[30] Da Zhang et al., "Integrity of Firms' Emissions Reporting in China's Early Carbon Markets," *Nature Climate Change* 9, no. 2 (February 2019): 164–69, https://doi.org/10.1038/s41558-018-0394-4.

[31] Muyu Xu and David Stanway, "China Slams Firms for Falsifying Carbon Data," *Reuters*, March 15, 2022, sec. China, https://www.reuters.com/world/china/china-slams-firms-falsifying-carbon-data-2022-03-14/.

[32] Lauri Myllyvirta, "The Real Reasons Behind China's Energy Crisis: Cheap Pricing and Too Much Coal Are Leaving Chinese in the Dark," *Foreign Policy*, accessed November 10, 2021, https://foreignpolicy.com/2021/10/07/china-energy-crisis-electricity-coal-pricing-renewables/.

[33] Carbon Brief Staff, "China Briefing: Widespread Power Cuts; New Orders on 'Dual Control'; Emissions Peak Likely 'before 2028,'" *Carbon Brief* (blog), September 30, 2021, https://www.carbonbrief.org/china-briefing-30-september-2021-widespread-power-cuts-new-orders-on-dual-control-emissions-peak-likely-before-2028.

[34] International Energy Agency, "The Role of China's ETS in Power Sector Decarbonisation."

[35] Chris Busch et al., "China's Carbon Neutral Opportunity" (Energy Innovation: Policy and Technology, LLC, January 2021), https://energyinnovation.org/wp-content/uploads/2021/02/Chinas-Carbon-Neutral-Opportunity.pdf.

[36] State Council Information Office of The People's Republic of China, "Xi Stresses Solid Implementation of Decisions, Arrangements on Carbon Peaking, Neutrality," January 26, 2022, http://english.scio.gov.cn/m/topnews/2022-01/26/content_78011631.htm.

[37] Bloomberg New Energy Finance, "Energy Transition Investment Trends," January 19, 2021, https://assets.bbhub.io/professional/sites/24/Energy-Transition-Investment-Trends_Free-Summary_Jan2021.pdf.

[38] Nathaniel Bullard, "Where the Billions Pouring into the Energy Transition Are Going," *Bloomberg LP*, January 27, 2022, https://www.bloomberg.com/news/articles/2022-01-27/where-the-billions-pouring-into-the-energy-transition-are-going.

[39] Jennifer Dlouhy, "How China Beat the U.S. to Become World's Undisputed Solar Champion," *Bloomberg News*, June 4, 2021, https://www.bloomberg.com/news/articles/2021-06-04/solar-jobs-2021-how-china-beat-u-s-to-become-world-s-solar-champion.

[40] Liam Denning, "Biden Fights a New Cold War with Solar Panels," *Bloomberg Opinion*, April 9, 2021, https://www.bloomberg.com/opinion/articles/2021-04-09/biden-combines-green-new-deal-with-new-cold-war-to-fight-china.

[41] International Renewable Energy Agency and International Labour Organization, "Renewable Energy and Jobs - Annual Review 2021," 2021, https://www.irena.org/publications/2021/Oct/Renewable-Energy-and-Jobs-Annual-Review-2021.

[42] David Feldman, "Solar Industry Update" (National Renewable Energy Laboratory, April 2021), https://www.nrel.gov/docs/fy21osti/79758.pdf.

[43] Feldman, "Solar Industry Update."

[44] S.B. Linder, *An Essay on Trade and Transformation* (Uppsala: Almqvist and Wiksells, 1961), https://pdfs.semanticscholar.org/3e37/a898256b1601cd88059607ab53b27b87cbdd.pdf.

[45] Paul Krugman, "Scale Economies, Product Differentiation, and the Pattern of Trade," *American Economic Review* 70, no. 5 (1980): 950–59.

[46] Arnaud Costinot et al., "The More We Die, The More We Sell? A Simple Test of the Home-Market Effect," *The Quarterly Journal of Economics* 134, no. 2 (May 2009): 843–94.

[47] United Nations Environment Programme, "Frequently Asked Questions Relating to the Kigali Amendment to the Montreal Protocol," February 17, 2017, https://ozone.unep.org/sites/default/files/FAQs_Kigali_Amendment.pdf.

[48] Peter Mock and Zifei Yang, "2021: Another Chapter in the Global Race towards Electrification," *International Council on Clean Transportation* (blog), March 4, 2022, https://theicct.org/2021-global-race-evs-mar22/.

[49] Kimberly Chin, "Corporate Venture Investors Boost Climate-Tech Spending," *Wall Street Journal*, March 16, 2022, sec. WSJ Pro, https://www.wsj.com/articles/corporate-venture-investors-boost-climate-tech-spending-11647432001.