



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

Enhancing China's ETS for Carbon Neutrality: Focus on Power Sector

加强中国碳市场助力实现碳中和：聚焦电力部门

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加强中国碳市场助力实现碳中和：聚焦电力部门

David FISCHER, Project Coordinator, Environment and Climate Change Unit, IEA
ZHANG Da, Associate Professor, Institute of Energy, Environment and Economy, Tsinghua University

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- Explore possible pathways of how an enhanced Emissions Trading System (ETS) could put the electricity sector on an emissions trajectory that accelerates its alignment with China's carbon neutrality target
探索如何通过增强碳市场作用推动电力部门更快脱碳、使其排放轨迹更符合中国碳中和目标的需要
- Explore the effects and interactions of China's ETS with its renewable energy policy in the electricity sector, namely renewable portfolio standards (RPS), and how the policy mix could be better coordinated
探索中国全国碳市场（ETS）与可再生能源政策，尤其是与可再生能源配额制（RPS）在电力行业的相互作用与政策效果，并研究如何加强这一政策组合的协同作用
- The analysis focuses on the impacts of three different potential ETS designs on CO₂ emissions, generation mix, costs and policy interaction with the RPS
分析三种不同碳市场设计方案对二氧化碳排放、发电结构、政策成本效益、以及碳市场与可再生能源配额制政策互动的影响

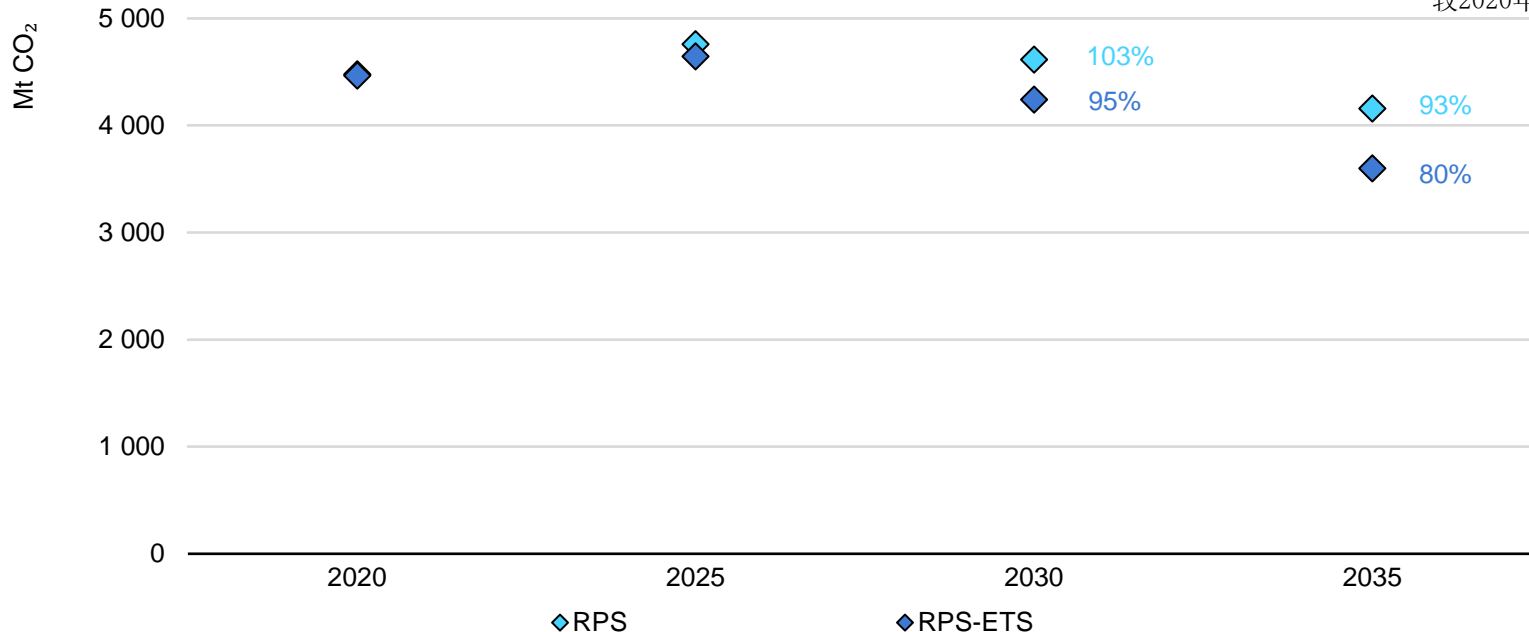
Scenario 情景		Emissions Trading System (ETS) 碳市场	Renewable Portfolio Standard (RPS) 可再生能源配额制
Counterfactual Scenario 反事实对照情景	RPS 可再生能源配额制情景	No emissions trading system 无碳排放权交易制度	Same non-hydro renewables share target 非水可再生能源占比目标 各情景中目标保持一致
Current Policy Scenario 当前政策情景	RPS-ETS 可再生能源配额制- 碳市场情景	Intensity-based ETS with free allocation (as implemented in China) 基于排放强度、免费分配配额的碳市场（如中国当前实施的碳市场设计）	
Enhanced ETS (ETS+) Scenarios 碳市场加强情景	ETS+BM 碳市场+基准收紧情景	Intensity-based ETS with strong tightening of the coal benchmarks used for allocation of allowances 基于强度的碳市场，大幅收紧用于配额分配的煤电基准	
	ETS+Auction 碳市场+拍卖情景	Intensity-based ETS with introduction of auctioning 基于强度的碳市场，引入部分配额拍卖	
	ETS+Cap 碳市场+总量控制情景	Cap-and-trade ETS with free allocation 设有碳排放总量上限、免费分配配额的碳市场	

CO₂ emissions 二氧化碳排放

CO₂ emissions trajectory from electricity generation by scenario, 2020-2035

2020-2035年各情景下的电力部门二氧化碳排放轨迹

In % of 2020 emissions:
较2020年排放量:



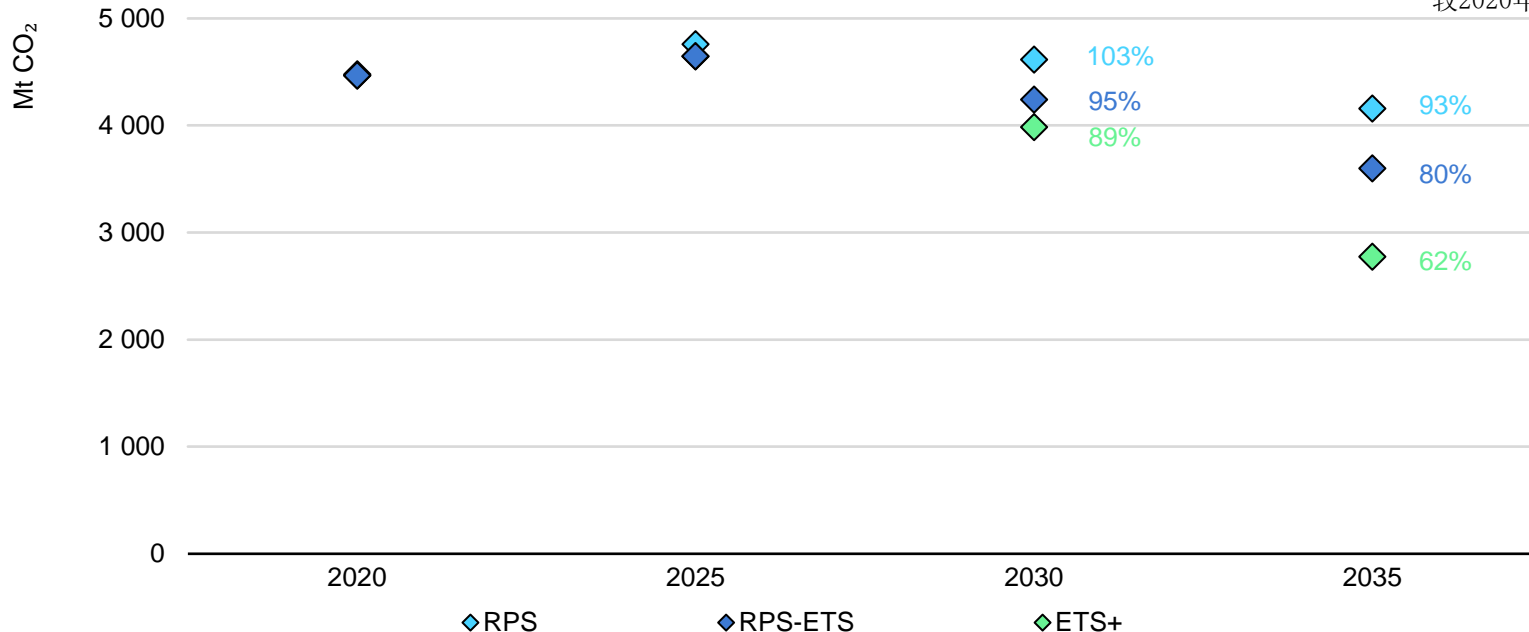
Electricity sector emissions peak before 2030 with current RPS and ETS policies...
在当前可再生能源配额制和碳市场政策的作用下，电力部门二氧化碳排放可在2030年前达峰

CO₂ emissions 二氧化碳排放

CO₂ emissions trajectory from electricity generation by scenario, 2020-2035

2020-2035年各情景下的电力部门二氧化碳排放轨迹

In % of 2020 emissions:
较2020年排放量:



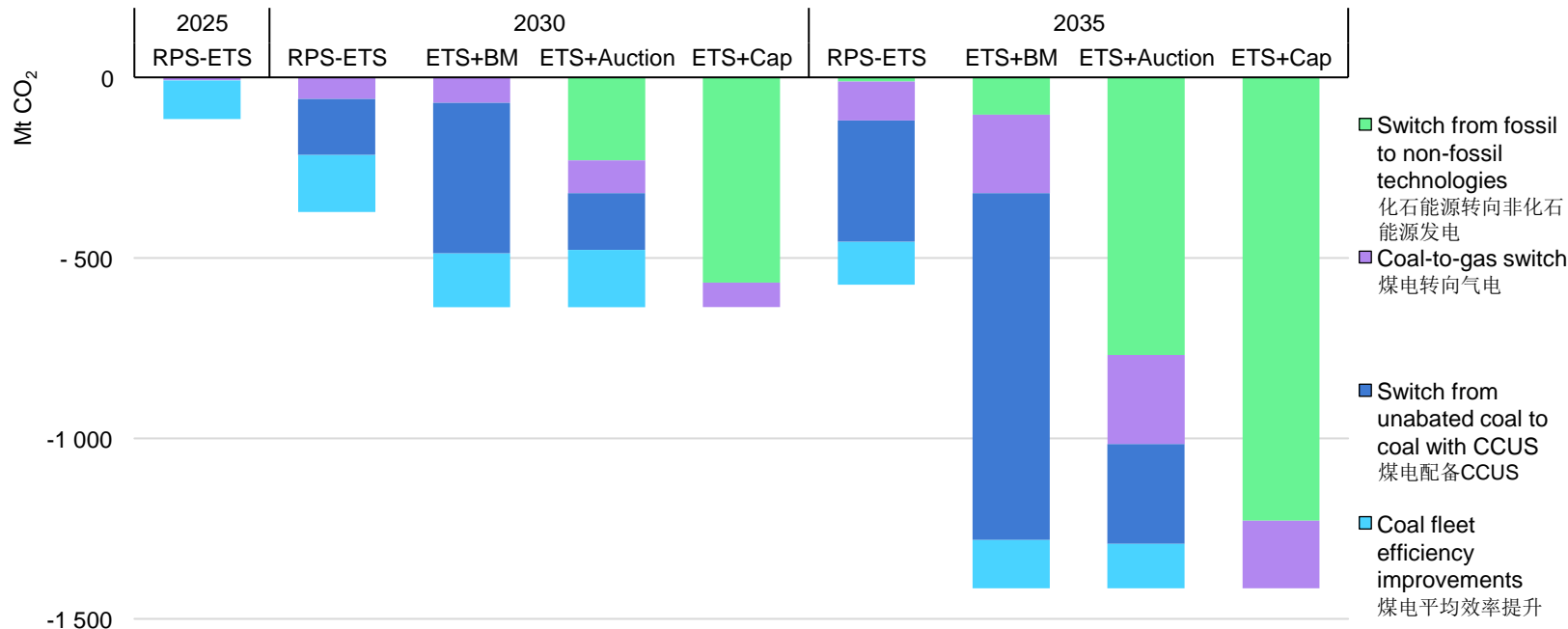
... while ETS design enhancements can accelerate electricity sector alignment with a carbon neutrality trajectory

加强碳市场设计可推动发电行业的排放轨迹更符合碳中和目标的需要

Decarbonisation drivers 减排途径

Additional emissions reductions by type compared with the counterfactual RPS Scenario, 2025-2035

2025-2035年各情景相比于可再生能源配额制情景的额外减排量分解

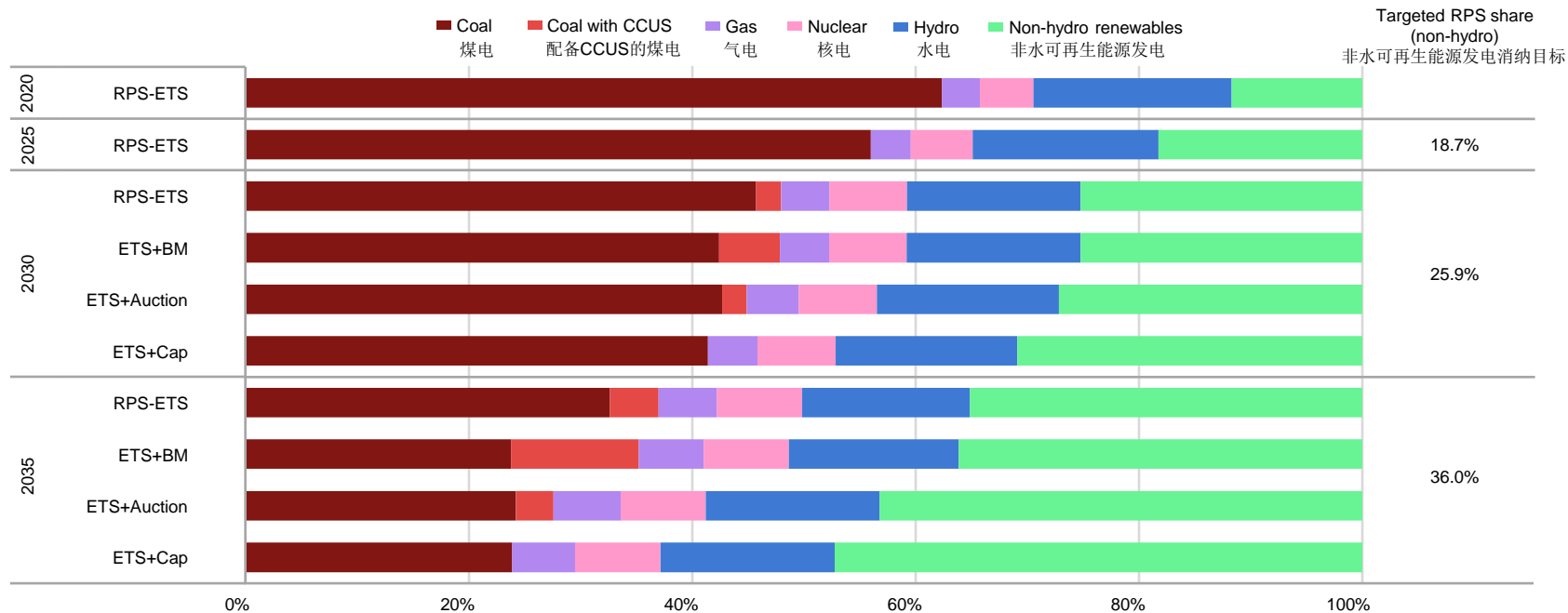


Stringent ETS benchmarks drive efficiency and CCUS; auctioning and a cap encourage fuel switching

严格的碳市场强度基准将推动能效提升和CCUS技术；配额拍卖和总量控制将鼓励燃料替代

Electricity generation mix by technology and scenario, 2020-2035

2020-2035年各情景下的发电结构



All Enhanced ETS designs accelerate phase-down of unabated coal but lead to very different generation mixes

各碳市场加强方案都将加速未配备CCUS的煤电的逐步减少，但将推动电力结构向不同方向转型

Total system cost by scenario, 2035
2035年各情景下的系统总成本

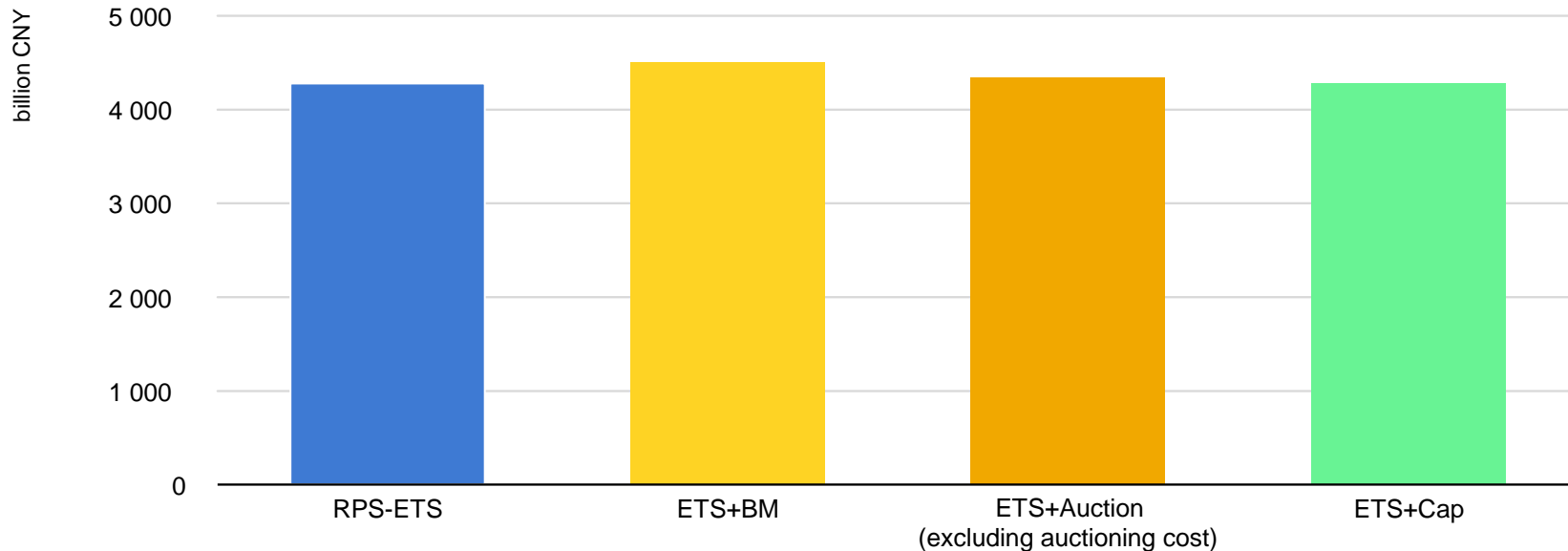
Difference compared to RPS-ETS

较可再生能源配额制-碳市场情景成本差异

+5.2%

+1.4%

0%



Cap-and-trade ETS could achieve more than 800 Mt additional CO₂ emissions reductions at no additional cost

碳市场+总量控制情景可在2035年系统总成本与当前政策情景相同的情况下，额外减少8亿吨的二氧化碳排放

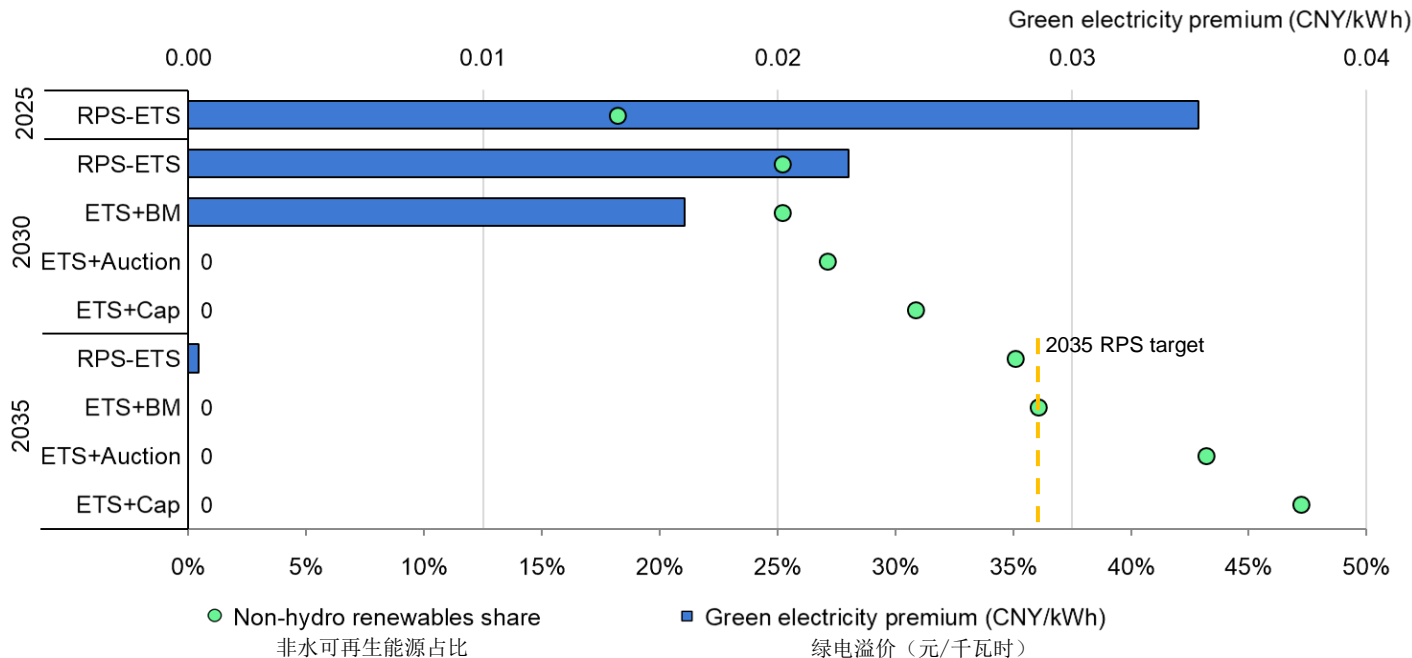
What is driving the results? 是什么造成各情景结果不同?

Scenario 情景	Means of allowance allocation 配额分配设计	Consequence 政策设计影响	Result 结果
RPS-ETS 可再生能源配额制- 碳市场情景	Free; technology-specific fossil fuel benchmarks 免费分配；针对化石燃料发电机组分技术设置基准	Non-fossil fuel technologies cannot receive allowances 非化石燃料发电技术无法获得配额	Emissions reductions through coal efficiency and expensive coal with CCUS 推动煤电能效提升和更为昂贵的CCUS技术的部署来减少排放
ETS+BM 碳市场+基准收紧情景	Free; more stringent technology-specific fossil fuel benchmarks 免费分配；针对化石燃料发电机组分技术设置更严格的基准	Non-fossil fuel technologies cannot receive allowances 非化石燃料发电技术无法获得配额	Emissions reductions through coal efficiency and expensive coal with CCUS 推动煤电能效提升和更为昂贵的CCUS技术的部署来减少排放
ETS+Auction 碳市场+拍卖情景	Partial auctioning; rest for free with technology-specific fossil fuel benchmarks 部分拍卖；其余配额通过针对化石燃料机组的分技术基准免费分配	Increase in cost for emitting power production and reduction in free allowances for coal with CCUS 提高化石燃料发电技术所面临的实际碳排放成本，同时减少配备CCUS机组可获得的免费配额	Emissions reductions through cheaper renewables and some coal with CCUS 推动成本更低的可再生能源和部分CCUS技术的部署来减少排放
ETS+Cap 碳市场+总量控制情景	Free; allocation through one technology-neutral benchmark 免费分配；通过统一的技术中立的基准进行分配	Non-fossil fuel technologies can receive allowances 非化石燃料发电技术可获得配额	Emissions reductions through cheaper renewables 推动成本更低的可再生能源发展来减少排放
<p>The way allowances are allocated in China's ETS has a significant impact on the results 中国碳市场的配额分配方式可对政策结果产生显著影响</p>			

Interaction with RPS 碳市场与可再生能源配额制的政策互动

Green electricity premium and non-hydro renewables share by scenario, 2025-2035

2020-2035年各情景下的绿电溢价和非水可再生能源占比



Auctioning or a stringent cap in the ETS could provide the financial incentives needed to increase renewables growth

通过引入配额拍卖或设置严格的排放总量上限，碳市场可提供可再生能源进一步增长所需的经济激励

- **Carefully examine different ETS design options in line with the intended policy objectives**, in particular with a view to the emissions reductions, resulting costs and the technology mix.

从预期的政策目标出发，权衡不同的碳市场设计方案，考量各方案对于减排成本、碳价和发电结构等的影响。

- **Communicate future plans on China's ETS design well in advance**, including the medium-term benchmark and/or cap trajectory (e.g. for the next 5-10 years), to provide visibility and planning certainty for market participants.

提前沟通中国碳市场未来的政策设计走向，包括中期（如未来5至10年）基准或总量上限轨迹等，为市场参与者提供合理预期和规划方面的确定性。

- **Establish a policy co-ordination process** involving all relevant government institutions that aims to analyse ex-ante the impact of different policy mixes to avoid unintended side-effects, and which regularly reviews policy outcomes.

建立旨在完善针对碳市场与其它政策衔接、涉及各相关政府部门的**政策协调机制**，事前评估不同政策之间的相互作用，避免政策之间冲突造成的负面影响，并定期评估政策效果。

- **Consider introducing allowance auctioning in the current 14th Five Year Plan (FYP) period (2021-2025)** to incentivise more diversified and lower-cost emissions abatement options, including renewables and CCUS. This would also enable the **use of auction revenues**.

考虑在“十四五”时期将配额拍卖逐步引入碳市场，以鼓励成本更低的、更多元的减排机制，同时鼓励可再生能源和CCUS技术的进一步发展。配额拍卖也将产生拍卖收入。

- **Consider transitioning to a cap-and-trade system with a stringent cap** later in the decade to position the ETS as a key instrument in China's path to carbon neutrality.

考虑在“十五五”时期过渡到总量控制与交易体系并设置严格的排放总量上限，使碳市场更好地发挥支持中国实现碳中和目标的关键作用。

- **Swiftly implement announced plans to extend the ETS to other sectors** to reduce costs by expanding possible options for emissions reductions, and to establish a cross-sectoral carbon price signal to help achieve carbon neutrality.

加快推进碳市场覆盖其它高耗能行业，通过纳入更多的减排机会降低减排成本，并建立覆盖多行业的碳价信号，支持实现碳中和目标。

