



Emissions Trading System and Power Markets Reform 中国碳市场与电力市场化改革

Key findings from IEA-Tsinghua report *Enhancing China's ETS for Carbon Neutrality: Focus on Power Sector*
国际能源署-清华大学联合报告《加强中国碳市场助力实现碳中和：聚焦电力部门》主要结论

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China's national emissions trading system (ETS) in the context of the dual carbon goals 双碳目标下的中国全国碳市场

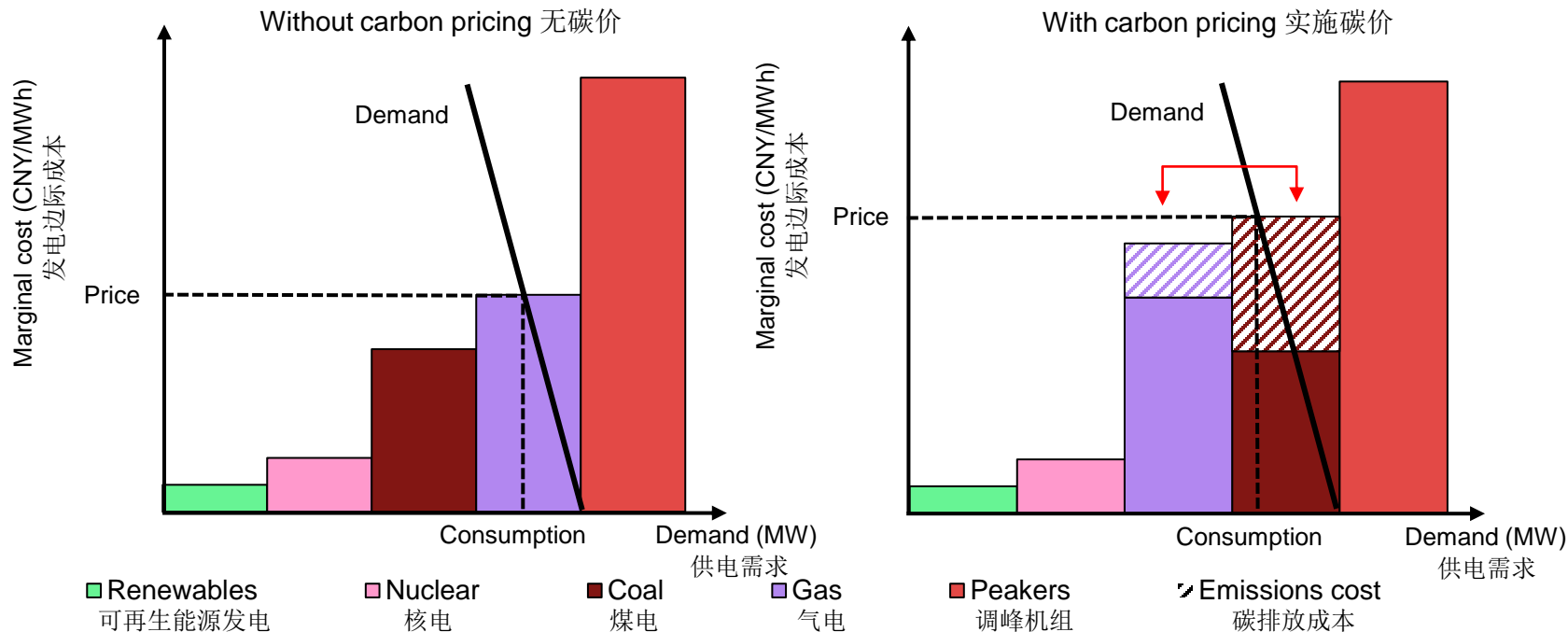
- In September 2020, President Xi Jinping announced that China have CO₂ emissions peak before 2030 and achieve carbon neutrality before 2060
2020年9月，习近平主席宣布中国将“力争二氧化碳排放于2030年前达到峰值、努力争取2060年前实现碳中和”
- China's national ETS came into operation in July 2021. 99.5% compliance rate for the 1st compliance period
中国全国碳市场于2021年7月启动交易. 碳市场第一个履约期履约率99.5%
- Currently covers the power sector which emits around 4.5 Gt CO₂ annually (~40% of China's energy sector CO₂ emissions)
目前，中国碳市场纳入发电行业，每年覆盖约45亿吨二氧化碳排放量（约占中国能源体系二氧化碳排放量的40%）
- Allowance price: ~CNY 40-60/t CO₂ (USD 6-8/t CO₂)
碳排放配额交易价格：~40-60元/吨二氧化碳（6-8美元/吨二氧化碳）
- **Output- and intensity-based allowance allocation** with emission intensity benchmarks for four categories of coal- and gas-fired units, without a predetermined emissions cap
中国碳市场采用**基于实际产出和排放强度的基准法**，根据四类煤电和气电机组类别设定碳排放强度基准分配配额，不预先设定排放总量上限
- **Free allocation**, possibility to introduce auctions in the future
碳市场初期**免费分配**配额，未来可能引入配额拍卖机制

Carbon pricing makes lower-carbon generation more cost-competitive

碳价机制使相对低碳的发电技术更具成本竞争力

Merit order and fuel switching under carbon pricing

碳价下的电力经济调度优先顺序与燃料替代



Under economic dispatch, internalisation of the carbon cost strengthens cost-competitiveness of lower-carbon technologies and drives fuel switching

在经济调度下，纳入碳排放成本将提高相对低碳的发电技术的成本竞争力，推动低碳能源对高碳能源的替代

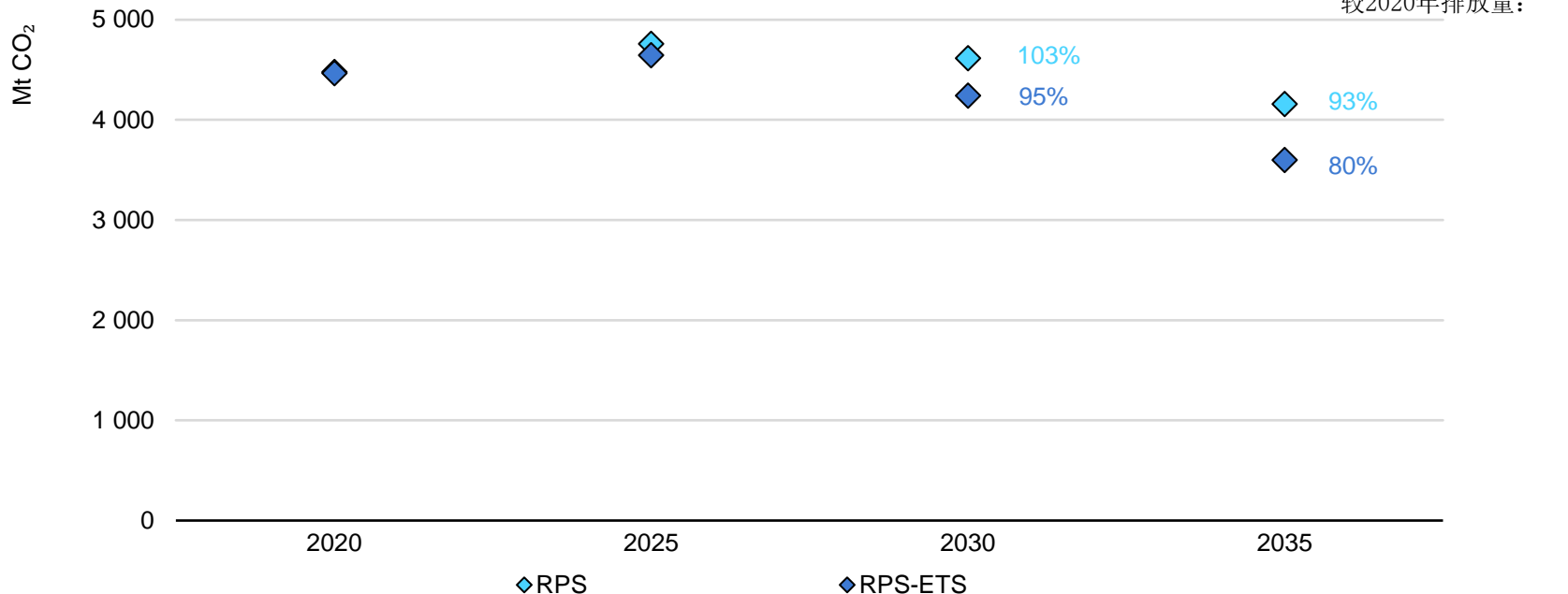
Emissions reductions channels through carbon pricing 碳价机制促进减排的主要途径	Challenges with regulated power market 受政府管制电力市场下面临的挑战
Prioritize lower-carbon generation sources in dispatch decisions as carbon price makes lower-carbon generation more cost-competitive 碳价使相对低碳的发电技术更具成本竞争力，从而在电力调度决策中提高较低碳发电技术的优先级	Administratively determined dispatch may not (fully) integrate the carbon price signal in dispatch decisions 通过行政决策决定的电力调度可能无法将碳价格信号（完全）纳入到调度决策中
Incentivizes investment in low-carbon technologies and assets by increasing their profitability vis-à-vis carbon intensive assets, while encouraging early retirement of the latter 通过提高低碳技术和资产相对于高碳资产的盈利能力，激励对低碳技术和资产的投资，同时推动高碳资产提前退出	Regulated pricing limits carbon pricing's effectiveness in making low-carbon alternatives more profitable and attractive for investors 受管制的定价机制可能削弱碳价在提高低碳技术利润和投资吸引力方面的有效性
Encourage efficiency in end use and demand reduction as the carbon price is passed through to consumers 随着碳价信号传导向消费者，激励终端能效提升和用能需求减少	Regulated pricing limits pass-through of the carbon price signal and its incentive for demand reduction 受管制的定价机制限制了碳价格信号的传导及其对需求侧响应的激励 Lack of carbon cost pass-through could put generators with existing fossil generation assets in financial difficulty 无法传导碳成本可能会使经营现有化石发电资产的企业陷入财务困境

Scenario 情景		Emissions Trading System (ETS) 碳市场	Power Market Reform 电力体制改革	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	Economic dispatch from 2025 自2025年起实施经济调度 Inclusion of interprovincial trade 考虑跨省电力交易	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		

Enhancements in ETS design can accelerate electricity sector alignment with a carbon neutrality trajectory

加强碳市场设计可推动发电行业排放轨迹更符合碳中和目标的需要

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

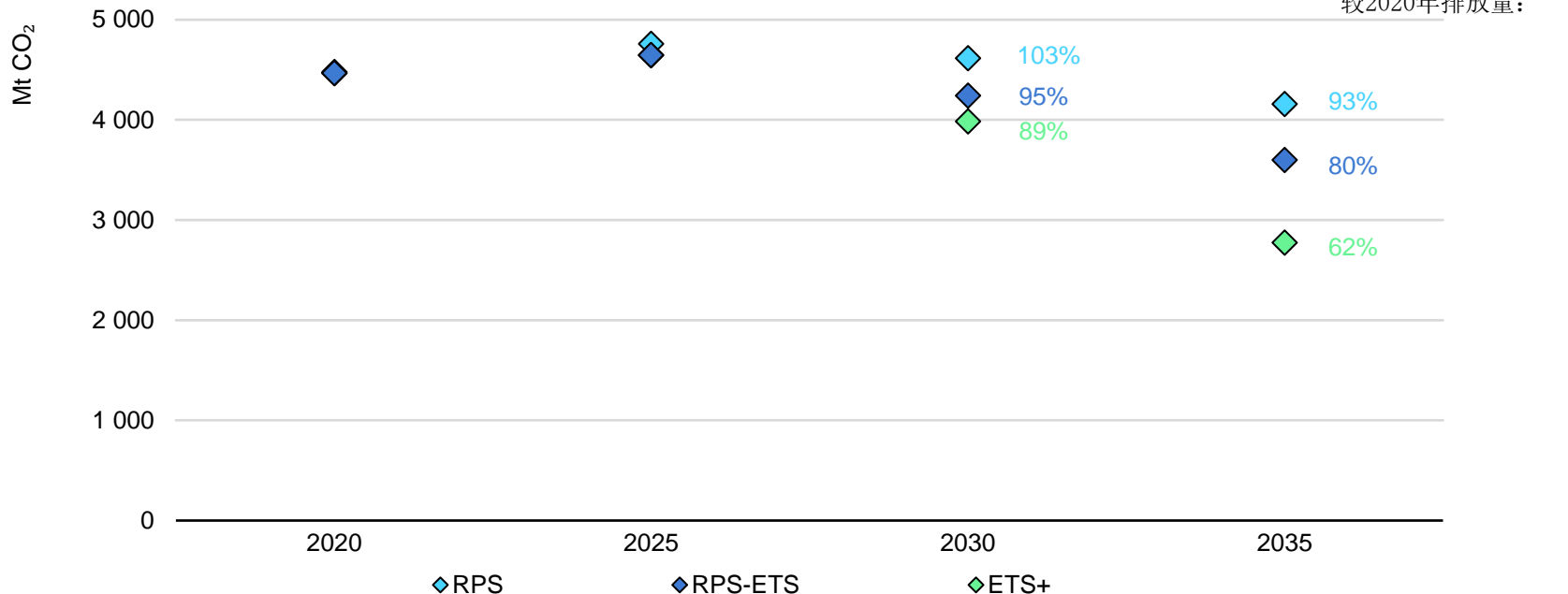


Electricity sector emissions peak before 2030 with current RPS and ETS policies...
在当前可再生能源配额制和碳市场政策的作用下，电力部门二氧化碳排放可在2030年前达峰

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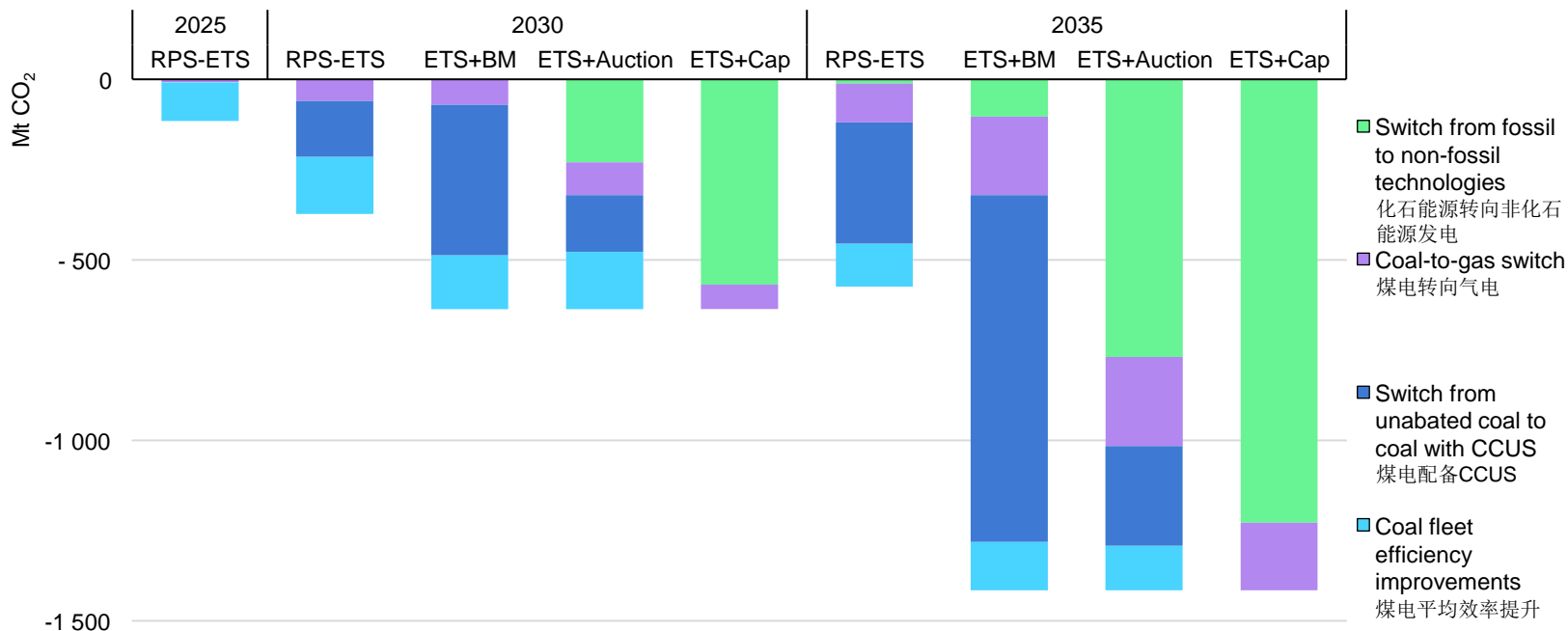


... while ETS design enhancements can double the CO₂ reduction of the RPS-ETS Scenario
加强碳市场设计可使二氧化碳减排量较可再生能源配额制-碳市场情景中翻倍

ETS and power market reform synergy in driving efficiency improvement and fuel switching

碳市场和电力市场改革协同提高发电效率并推动燃料替代

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



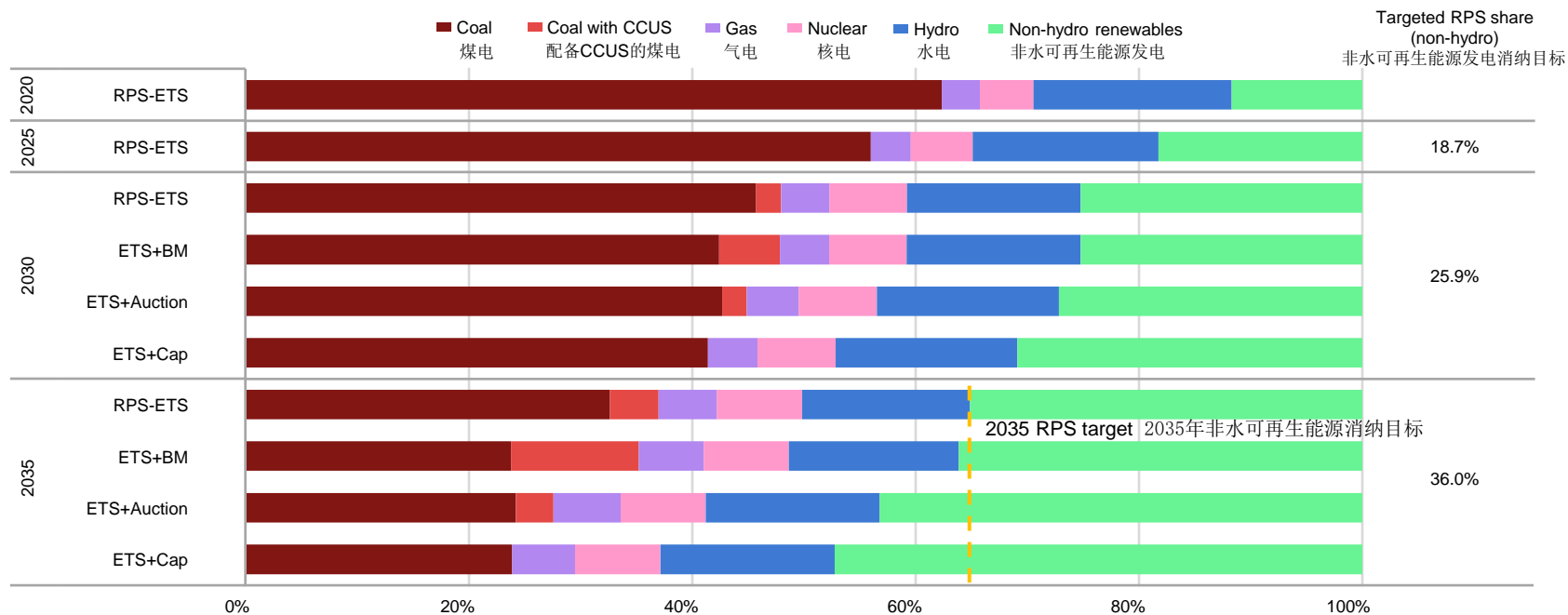
Stringent ETS benchmarks drive efficiency and CCUS; auctioning and a cap encourage fuel switching
严格的碳市场强度基准将推动能效提升和CCUS技术；配额拍卖和总量控制将鼓励燃料替代

Enhanced ETS accelerates transition of the generation mix

强化碳市场设计将加速发电结构转型

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

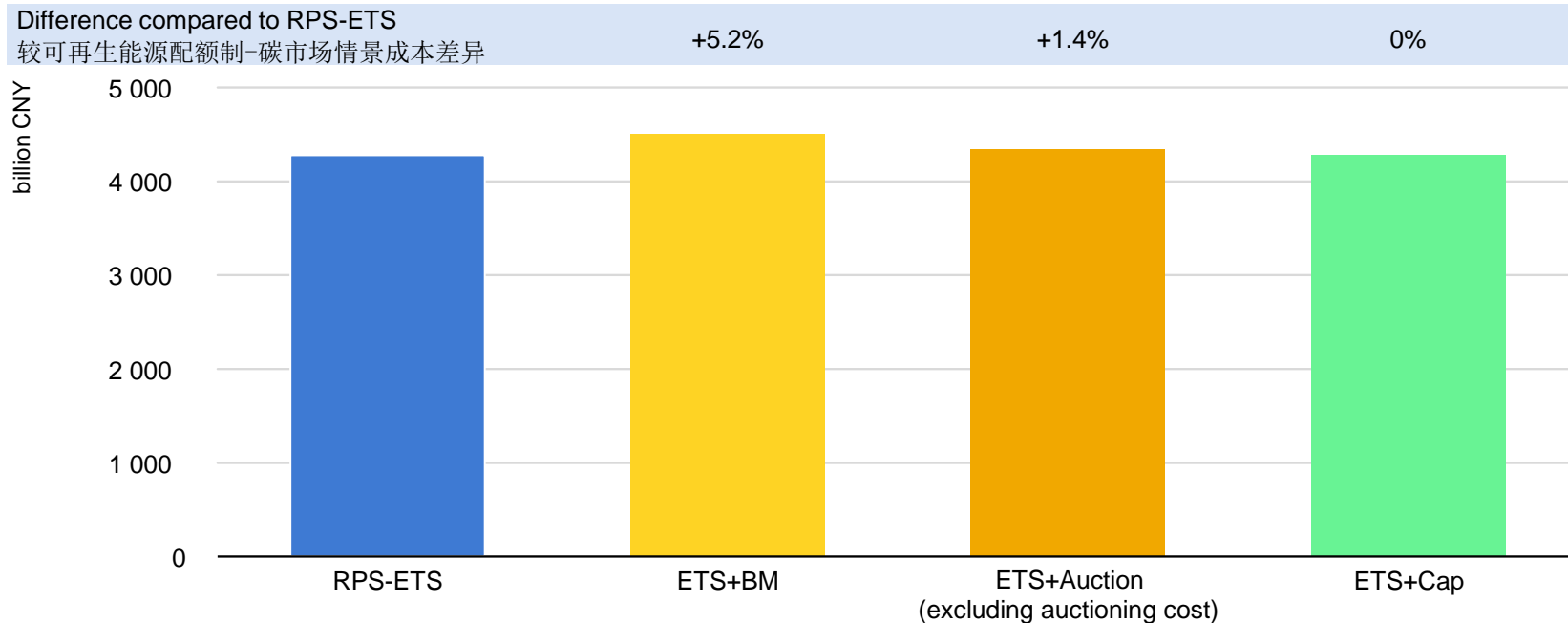
各碳市场加强方案都将加速未配备CCUS的煤电的逐步减少，但将推动电力结构向不同方向转型

ETS design opportunities for driving cost-effective transition

碳市场为推动更经济有效的低碳转型提供机遇

Total system cost by scenario, 2035

2035年各情景下的系统总成本



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

- **Strong synergy between national ETS and power markets reform** for promoting the use of efficient generation sources and driving low-carbon and cost-effective transition in the power sector
全国碳市场和电力体制改革在推动高效发电技术和经济有效地推动电力行业低碳转型方面有强协同作用
- **Timely power markets reform on dispatch and pricing mechanisms important for national ETS effectiveness**
及时对电力调度和定价机制等方面进行市场化改革对全国碳市场的有效性十分重要
- **An enhanced ETS can accelerate electricity sector alignment with a carbon neutrality trajectory**
加强碳市场设计可推动发电行业排放轨迹更符合碳中和目标的需要
- **The ETS can drive emissions reductions through different channels:** stringent emissions intensity benchmarks mostly drive efficiency improvements and CCUS deployment; auctioning and a cap encourage fuel switching to renewables
在不同的设计下，碳市场通过不同的机制推动减排：严格的碳市场强度基准主要推动能效提升和CCUS技术，配额拍卖和排放总量控制将鼓励燃料替代
- **Policy cost-effectiveness depends on ETS design:** transition to a cap-and-trade system can achieve the highest cost-effectiveness by prioritising the lowest-cost abatement opportunities, especially fuel switching to renewables
碳市场的经济效益将取决于其政策设计：过渡到基于总量控制的碳市场设计在推动电力低碳转型方面可实现更高的经济效益，因为这一设计将优先推动成本最低的减排机会，特别是可再生能源替代化石能源
- **Introducing partial allowance auctioning or a cap-and-trade ETS can help achieve renewables deployment targets by providing the required financial incentive**
通过引入配额拍卖或设置严格的排放总量上限，碳市场可提供实现可再生能源进一步增长目标所需的经济激励

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