SUBNATIONAL CLIMATE CHANGE POLICY IN CHINA

Harvard Project on Climate Agreements

With the support of the Harvard Global Institute

In collaboration with Tsinghua University's Institute of Energy, Environment, and Economy

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

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February 2020

THE HARVARD PROJECT ON CLIMATE AGREEMENTS

The goal of the Harvard Project on Climate Agreements, which was established in 2007, is to identify and advance scientifically sound, economically sensible, and politically pragmatic public policy options for addressing global climate change. Drawing upon leading thinkers from around the world, the Harvard Project conducts research on policy architecture, key design elements, and institutional dimensions of international and domestic climate-change policy. The Harvard Project is directed by Robert N. Stavins, A.J. Meyer Professor of Energy and Economic Development, Harvard Kennedy School. For more information, see the Harvard Project's website: www.hks.harvard.edu/hpca.

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The Harvard Global Institute provided generous support for the preparation of this volume of briefs and for a research workshop in July 2019 upon which the volume is based. Tsinghua University's Institute of Energy, Environment, and Economy, directed by Professor Zhang Xiliang, hosted the research workshop; Professor Zhang and his colleagues have collaborated closely with the Harvard Project throughout.

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INTRODUCTION

Climate change is a global commons problem and therefore necessitates cooperation at the highest jurisdictional level – that is, international cooperation among national governments – if it is to be adequately addressed. Both national governments and subnational governments can significantly advance efforts to mitigate climate change. Provinces and municipalities around the world have indeed undertaken initiatives – sometimes working together across national boundaries – to reduce greenhouse-gas emissions. This includes jurisdictions in the largest-emitting countries – China, the United States, and India – as well as in the European Union.

This volume examines subnational climate-change policy in China – including how Chinese provinces and municipalities work with the central government to implement policy. The volume focuses to a considerable degree on carbon-pricing policy in China, including how China's subnational (pilot) emissions-trading systems can inform the emerging national carbon-pricing system.

The briefs in this volume draw on presentations and discussion at a research workshop organized by the Harvard Project on Climate Agreements in Beijing on July 18 – 19, 2019. The workshop was hosted and co-sponsored by Tsinghua University's Institute of Energy, Environment, and Economy, directed by Professor Zhang Xiliang. Workshop participants included 24 researchers and practitioners from China, Australia, Canada, India, Norway, the United Kingdom, and the United States. Chinese participants were based in Guangdong Province, Hubei Province, and Shanghai, as well as Beijing. The agenda and participant list for the workshop are included at the end of the volume.

This volume – and the July 2019 workshop – are part of a larger initiative of the Harvard Project on Climate Agreements examining and comparing subnational climate-change policy in China, India, the United States, and Canada. The Harvard Project is conducting a similar workshop in New Delhi in the summer of 2020 and will release a volume of briefs on subnational climate-change policy in India in early 2021.

This volume begins with an overview and framing, first in a brief by Zhang Xiliang and Zhou Li that details policies adopted by Chinese provinces and municipalities to address climate change. Ye Qi and Xiaofan Zhao then describe what they see as the most important drivers of climate-change policy in China, providing context for the volume.

Next, institutional perspectives are provided in four briefs by experts on center-provincial institutional dynamics in China, with applications to climate-change policy. Michael Davidson explores China's "quasi-federalist" system, and discusses how this system might be leveraged to develop effective institutions for addressing climate change.[1] Gørild Heggelund focuses on

1 Davidson explores this topic in more depth in his paper – also released by the Harvard Project on Climate Agreements: "Creating Subnational Climate Institutions in China." December 2019. www.belfercenter.org/publication/creating-subnational-climate-institutions-china.

China's national emissions-trading system (ETS), concluding that, among other things, "Capacity building at the subnational level is…needed to strengthen understanding of how emissions trading works."

Tan Xianchun provides a concise yet detailed analysis of China's administrative systems and procedures for addressing climate change – both carbon pricing and other approaches to reducing emissions, including the results of modeling that estimates the potential impact of a range of "[l]ow-carbon measures and policies" in Chongqing municipality and Guangdong Province.[2]

Providing the final institutional perspective, Christine Wong discusses how the implementation and enforcement of environmental policy in China have evolved over the last decade. She finds that although the central government places greater emphasis on environmental policy than in the past and has provided considerable financial support for implementation and enforcement, renewed financial constraints in a period of low economic growth may prompt subnational officials to favor carbon pricing over more traditional top-down policy approaches.

The next section of the volume focuses on emissions trading systems in China, both at the national and sub-national levels, because China's central government and many observers see carbon pricing as China's primary policy tool for addressing climate change.

First, three contributors examine lessons for national policy design from experience with the pilot ETSs. Shaozhou Qi assesses the performance of the seven[3] pilot ETSs. Tian Qi provides insights based on his study of Hubei's pilot ETS, focusing on allowance allocation, as well as the closely-related topics of auction design and market-stability measures. Zeng Xuelan examines a range of GHG emissions-reduction policies in Guangdong Province, noting that Guangdong's pilot ETS has been its "main mechanism for reducing provincial emissions."

Zeng also notes the possibility of the central government terminating Guangdong's ETS after lessons have been incorporated into the national carbon-pricing system. The fate of the pilot ETSs more broadly is the subject of Valerie Karplus's brief. She discusses three scenarios: "(1) coexistence, that is, maintaining separate subnational trading systems alongside the national system; (2) partial integration, which would mean allowing credits from one system to be used in other systems; and (3) full integration, which would involve subsuming the seven subnational pilots under a single national ETS." Karplus discusses the tradeoffs among these options and then suggests an approach to strengthening the pilot ETSs that is somewhat independent of the path chosen.

The final four briefs on China's ETSs focus on the development of the national carbon-pricing system, though in each case with some reference to the subnational pilots. Pu Wang identifies a set of important challenges to the implementation of the national system, concluding in

2 These policies and measures are referred to as "pilots"; they include but are not limited to the two jurisdictions' pilot ETSs.

3 Fujian Province launched the eighth pilot ETS in December 2016, later than the other seven provinces and municipalities, and is not included in this assessment.

part – as did Heggelund – that “institutional capacity related to the carbon market needs to be significantly enhanced at all levels, from the central government to the local level.”

Wu Libo discusses the results of a modeling initiative that explores subnational distributional impacts of various trading-intensity and allowance-allocation scenarios. Zhang Jianyu presents ten policy recommendations for the implementation of the national system. Among these, he suggests that the pilot ETSs can continue to play a useful role after the national system is implemented, and that the central government should continue to support the pilots. (See also Karplus’s brief.)

Finally, Fei Teng examines the important relationship between the power sector in China and the performance of the national carbon-pricing system. The power sector is highly regulated, though the central government is pursuing market-oriented reforms. Teng presents three options for passing through higher electricity costs resulting from carbon-pricing to electricity consumers, with one option including trading in generation rights.[4]

The last section of the volume includes three briefs providing cross-national comparative context on subnational climate-change policy. Radhika Khosla writes on India, Robert Stavins on the United States, and Katie Sullivan and Ellen Lourie on Canada.

Each of the seventeen briefs in this volume begins with several key points, and the seventeen sets of key points are compiled immediately following this introduction. We hope that this structure renders the insights, research results, and analysis contained in the briefs more readily accessible.

The Harvard Project on Climate Agreements is grateful to the Harvard Global Institute, which provides generous support for the initiative of which this volume and the July 2019 workshop in Beijing are part. We are also grateful for our ongoing collaboration with Professor Zhang Xiliang and his colleagues – a collaboration that has yielded insights that we hope prove useful to researchers and policy makers working to address the problem of climate change.[5]

Robert N. Stavins
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Harvard Project on Climate Agreements

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4 Davidson states at the end of his brief that “[u]ltimately, the success of the national carbon market will depend on electricity market reforms, which are being pursued in parallel, though with an uncertain end-date.” He elaborates in more detail in his longer paper, referenced above.

5 The Harvard Project would also like to thank Marika Tatsutani, who edited the briefs; Bryan Galcik, who designed the volume; and Raymond Song and Yuanchen Wang, who translated the Introduction and Compilation of Key Points.

引言

气候变化是全球共同面临的问题，因此，想要充分解决气候变化问题，就必须在最高管辖层面展开合作，即开展各国政府间的国际合作。国家和地方政府都可以显著推进减缓气候变化的行动。世界各地的省市都已经开展行动——有时是跨越国界的合作——来减少温室气体排放。这包括了排放量最大的国家（中国，美国和印度）以及欧盟的司法管辖区。

本卷分析了中国地方政府应对气候变化的政策——包括中国各省市如何与中央政府合作来执行政策。本卷将关注点主要聚焦在中国的碳定价政策，其中包括中国地方政府的（试点）排放交易体系将如何影响即将实行的国家碳定价体系。

本章的简介依托于哈佛气候协议项目于2019年7月18日至19日在北京组织的研讨会上的演讲和讨论。该研讨会由张希良教授领导的清华大学能源环境经济研究所共同举办。研讨会的参与者包括来自中国，澳大利亚，加拿大，印度，挪威，英国和美国的24名研究人员和从业人员。中国参与者分别来自广东省，湖北省，上海市和北京市。研讨会的议程和嘉宾名单在本卷的末尾。

本卷以及2019年7月的研讨会是哈佛气候协议项目一项更大的计划的一部分，该计划旨在研究和对比中国，印度，美国和加拿大的地方气候变化政策。哈佛气候协议项目将在2020年夏天于新德里举办一个类似的研讨会并在2021年初发布一卷关于印度地方气候变化政策的综述。

本卷以概述和框架开始，在第一章是张希良和周丽撰写的综述，详细阐述了中国各省市所采取的应对气候变化政策。然后，齐晔和赵小凡描述了他们认为的中国气候变化政策最重要的推动力，为本卷提供了背景。

接下来，专家们在四篇简述中提供了有关中国中央和地方政府制度关系的系统观点，并将其应用于气候变化政策。Michael Davidson探索了中国的 “确保中央权威，又充分调动地方推动发展积极性”的制度，并讨论了如何利用该制度建立有效的机构来应对气候变化。[1] Gørild Heggelund专注于中国的国家碳排放交易体系（ETS），并总结除此之外，“为了加强对碳排放交易体系运行机制的理解……我们需要地方层面的能力建设。”

谭显春提供了一个简要而具体的关于中国应对气候变化的管理制度和步骤的分析——通过碳定价和其他方法来减少排放，包括一个“ 低碳措施和政策” 在重庆市和广东省的潜在影响的建模分析结果。 [2]

最后一位为本章提供观点的是Christine Wong，她讨论了过去十年中国在环境政策的贯彻和落实层面是如何发展的。她发现尽管中央政府比以往更加重视环

境政策，并为贯彻和落实提供了可观的财政支持，但在经济增长逐渐放缓的时期，财政方面带来的限制可能会促使地方官员更青睐于碳定价政策而非传统的自上而下的政策。

本卷的下一章节侧重于排放在中国的排放交易体系在国家和地方层面的情况，因为中国的中央政府和许多专业人士认为碳定价将作为中国应对气候变化的主要政策工具。

首先，三位作者分析了排放交易试点的实践可能为国家政策设计带来的经验。齐绍洲评估了七个 [3] 排放交易试点的表现。田启提供了基于他对湖北省碳交易试点研究的见解，主要介绍了额度的分配，以及与拍卖设计和市场稳定措施密切相关的话题。曾雪兰分析了广东省的一系列温室气体减排政策，并指出广东省的排放交易试点一直是该省"减排的主要机制" 。

曾雪兰还提出一种可能：中央政府可将广东省排放交易试点的经验吸纳入国家碳定价体系后，将省内试点终止。Valerie Karplus主要介绍了碳交易试点未来的命运。她讨论了以下三种情况：" （1）共存，即独立的地方排放交易体系将与国家体系共存；（2）部分整合，这意味着一个体系的额度可以被用于其他体系；（3）全面整合，这意味着七个试点体系将被纳入一个国家碳交易体系。" Karplus讨论了这些选项的利弊，并提出了一种在未来三种情况都适用的当前加强地方碳市场试点的方法。

最后四份关于中国碳交易体系的概述着重于国家碳定价体系的发展，尽管每篇都提到了在地方层面的试点项目。王溥指出了实施国家体系的一系列重要挑战，部分结论（如Heggelund所述）为：" 从中央政府到地方政府，碳市场有关的各级机构都需要大大提高其能力。"

吴立波讨论了一项通过建模来分析不同的碳交易强度和额度分配情形在地方的影响分布的研究结果。张建宇介绍了实施国家碳交易体系的十项建议。其中他提到，碳交易试点可以在国家体系实施后继续发挥有益的作用，因此中央政府应继续支持试点项目。（另请参阅Karplus的概述。）

最后，滕飞分析了中国电力行业与国家碳定价体系之间的重要关系。尽管中央政府正在推行以市场为导向的改革，但电力行业依旧受到严格的监管。滕飞提出了三种选择来将碳交易体系造成的高额电价传递到消费终端，其中包括发电权交易。[4]

该卷的最后一部分通过三个针对不同国家的地方气候变化政策研究，为读者提供了该议题的跨国比较分析。Radhika Khosla撰写了关于印度的文章， Robert Stavins撰写了关于美国的文章， Katie Sullivan和Ellen Lourie撰写了关于加拿大的文章。

本卷中的十七篇概述中的每一个都以几个要点开头，这十七组要点被整合在本章简介之后。我们希望这个结构可以使概述中包含的见解、研究结果和分析更易阅读。

哈佛气候协议项目感谢哈佛全球研究所对包含本卷和2019年7月在北京举行的研讨会的项目的慷慨支持。我们也非常感谢与张希良教授及其同事的持续合作——我们希望这项合作产生的研究成果对致力于解决气候变化问题的研究人员和决策者能够提供帮助。[5]

Robert Stavins
主任

Robert Stowe
联合主任

[1] Davidson在他的论文中也更深入地探讨了这个话题，该论文由哈佛气候协议项目发布："建立中国的地方气候变化机构"。2019年12月 www.belfercenter.org/publication/creating-subnational-climate-institutions-china.

[2] 这些政策和措施被称为"试点"; 它们包括但不限于在两个辖区试点碳交易体系。

[3] 福建省于2016年12月启动了第八个碳交易试点，晚于其他七个省市，因此未纳入评估范围。

[4] Davidson在其概述的结尾指出："最终全国碳市场的成功将取决于同时进行的电力市场改革，尽管其结束日期尚不确定。"他在较长篇幅的论文中详尽地阐述了这一点。引用于上方。

[5] 哈佛气候协议项目同时想感谢其他两位重要作者：Marika Tatsutani编辑了此概要，Bryan Galcik设计了版式，宋瑞明与王元辰翻译了简介与要点。哈佛项目对他们表示感谢。

COMPILATION OF KEY POINTS

Overview and Framing: Climate-Change Policy in China

Subnational Climate-Change Policies in China
ZHANG Xiliang and ZHOU Li

- Provinces and municipalities in China have adopted a number of measures that are delivering progress on climate-change mitigation beyond the policies introduced by the central government.
- For example, local governments have established targets and developed plans for reducing carbon intensity, in some cases assigning disaggregated targets to cities and counties.
- A number of low-carbon pilot projects have been launched at the local level, including in cities and industrial parks, and 73 provinces and municipalities have set target dates for reaching peak greenhouse-gas emissions.
- Other notable subnational policy initiatives include the introduction of pilot emission-trading systems, new subsidy policies to promote switching from coal to natural gas in rural areas, and incentives for "new-energy" vehicles.

Ten Drivers of Climate Policy Making in China
Ye QI and Xiaofan ZHAO

- In recent years, China has demonstrated a strong determination to address global climate change. This paper explores ten drivers behind climate-related policy making in China.
- Pressure to address air pollution problems, especially fine particle pollution, is the most important driver of climate-related policies in China in recent years. Related drivers are the energy transition and industrial development patterns currently underway in China as the country reduces its overall energy intensity and shifts investments in new generating capacity to emphasize renewable energy sources.
- Other important drivers of climate policy making in China include scientific research, which has highlighted the potentially devastating impacts of global warming; international collaboration and governance, in which China is increasingly working with other countries to address climate change; marketization, which has enabled the evolution of market-based instruments for enforcing and incentivizing climate governance; President Xi's commitment to "ecological civilization" as part of the Communist Party's Five Major Development Concepts; and pressure from environmental NGOs.

Institutional Perspectives

Creating Subnational Climate Institutions in China
Michael DAVIDSON

- China's particular governmental system – variously referred to as "quasi-federalist" or "fragmented authoritarian" – gives large autonomy to lower levels of government.
- The prioritization of climate goals is not uniform across governmental agencies, and gaps in the overall institutional framework persist.
- Effective climate policy in China must make creative use of centralization and local autonomy to advance a national carbon market and other efforts to address climate change.

Subnational Implementation Pathways for China's National Pricing System: Challenges and Opportunities
Gørild HEGGELUND

- China's leadership is pushing a national emissions-trading system (ETS) as one of several policy tools for reducing greenhouse-gas emissions.
- Policy implementation at subnational levels presents challenges and opportunities: proactive subnational efforts in provinces and cities (such as pilot ETS cities) can be used to push policy implementation and raise targets and goals.
- One critical area for successfully implementing an ETS in China is the establishment of a *legal basis* to ensure effective implementation and potential punishment of non-compliance.

China's Low-Carbon Policies and Results from a Regional Case Study
TAN Xianchun

- China has established a systematic institutional and policy framework to deal with climate change, including top-down policy-design guides, government-agency administrative orders, a carbon-emissions-data-collection and -monitoring system, and a national carbon market.
- China has developed a low-carbon-development policy system. These policies are applied to several jurisdictional levels, involving various regions and industries in China.
- Similar policy options may achieve different results at different times, depending on the province's or city's stage of industrial development. Additional investments are required to achieve carbon reductions in economically underdeveloped areas (such as Chongqing).

- Large-scale changes in China's low-carbon-development system and policy mechanisms are needed to achieve long-term carbon reduction, and emissions reduction must gradually shift from production to consumption.

More Sticks and Fewer Carrots? Looking Ahead to Implementation of Environmental Policy Under the "New Normal"
Christine WONG

- Environmental policy has evolved significantly in China over the last decade. With a new emphasis on these issues at the highest levels, environmental laws, regulations, and action plans – many with ambitious targets and aggressive measures – have proliferated.

- The central government has worked to strengthen policy implementation by covering a large share of implementation costs and by increasing resources for monitoring and enforcement – including an emphasis on inspections – at the local level.

- Local governments continue to face constraints with regard to environmental enforcement, however. There are greater restrictions on borrowing by local governments, reduced local revenue flows as a result of other policies and macroeconomic changes, and declining fiscal support from the central government as China adjusts to a "new normal" of slower overall growth. Against this backdrop, carbon pricing may look increasingly attractive.

Emissions-Trading Systems in China: Subnational and National

—Lessons for National Policy Design from the Pilots

Have China's Emissions Trading Pilots Been Effective? A Multi-Dimensional Post-Assessment
Shaozhou QI

- A multi-dimensional, empirical assessment of the results of China's seven pilot emissions-trading systems (ETSs) is important to inform the design of a national ETS.

- Results from such an assessment indicate that the ETS pilots had a significant effect on carbon emissions, carbon intensity, per capita emissions, and energy structure in the covered regions and industries. The more energy-intensive the industry, the larger the effect. The pilots also reduced revenues in energy-intensive industries, but had no significant effect on employment or return on assets (ROA) in these industries.

- Allowance allocation based on benchmarking rather than grandfathering and historical carbon intensity method resulted in larger emissions and carbon-intensity reductions among covered industries, while grandfathering and historical carbon intensity method increased ROA for affected industries.

Preliminary Considerations for Carbon-Pricing Policy Based on Experience with Hubei Province's Carbon Market

TIAN Qi

- The level and stability of the carbon price is an important consideration in the design of carbon markets.
- In developing its own carbon market, Hubei Province took several steps to establish an effective carbon-price mechanism, including setting a base allowance price, promoting market stability through greater investor participation, and allowance "put in" (auctioning) and "buy back" provisions.
- Hubei offers some lessons based on experience for the construction of carbon markets, including the need for tight control of allowance allocations and diversified investor demand, and the importance of information disclosure and policy continuity.

Guangdong's Emissions-Reduction Progress and Innovative Policy Measures

ZENG Xuelan

- Guangdong Province faces challenges in reducing its carbon emissions, due to uneven levels of economic development across different areas of the province, limited potential for further energy savings, and insufficient non-fossil energy resources.
- Guangdong has been taking innovative steps to reduce provincial carbon emissions, including a carbon market, the "Tanpuhui" mechanism (an incentive mechanism to promote public emissions reduction), the zero-carbon demonstration zone, and the Carbon Capture Use and Storage (CCUS) Center.
- Guangdong's emissions-trading system (ETS) is, on the one hand, regulated strictly, according to clear and specific provisions. On the other hand, having been so regulated, it operates relatively independently of government intervention. Guangdong's ETS is also characterized by well-ordered management, active trading, and effectiveness in reducing emissions.
- Guangdong will continue to improve its ETS until the central government decides to shut down local trading systems in favor of a national carbon market.

Emissions-Trading Systems in China: Subnational and National

—The Fate of the Pilot ETSs under a National Pricing System

Coexistence or Obsolescence? The Fate of China's Emissions-Trading Pilots Under a National System

Valerie J. KARPLUS

- As China proceeds to establish a national emissions-trading system (ETS) for CO_2, the fate of the country's seven subnational pilot ETSs, which have been in operation since 2013, remains an open question.
- Going forward, the three main options are (1) coexistence, that is, maintaining separate subnational trading systems alongside the national system; (2) partial integration, which would mean allowing credits from one system to be used in other systems; and (3) full integration, which would involve subsuming the seven subnational pilots under a single national ETS.
- Each option presents tradeoffs. Full integration would probably be most economically efficient but there are several challenges: Local governments would have to relinquish control; in the near term, some local emissions sources would no longer be covered because the national ETS will initially be limited to the power sector; and full integration requires unified rules and a clear transition plan.
- In light of these challenges, attention should be directed toward strengthening and harmonizing guidelines for measurement, reporting, and verification (MRV) in all existing systems and to pursuing opportunities for greater mitigation ambition in the subnational systems, which can serve as a training ground for firms that will eventually be included in the national ETS.

Emissions-Trading Systems in China: Subnational and National

—Designing and Implementing China's National ETS

Challenges for China's National ETS

Pu WANG

- China's national emissions-trading system (ETS) is likely to face significant challenges, due to its complexity, large scale, and China's socioeconomic and political realities.
- The national ETS needs to be able cope with increasing market volatility, as China's economy undergoes a structural transition from manufacturing to services.
- Market-oriented reforms in energy sectors and state-owned enterprises are needed to create a supportive institutional environment for the ETS.

Assessing Regional Implementation Pathways Toward a Nationwide Emissions-Trading System in China
WU Libo

- The seven pilot emissions-trading systems (ETSs) launched in China in preparation for a nationwide ETS have not produced significant changes in industrial structure or emissions intensity, perhaps because they were designed with loose caps to ensure market stability and focus on gaining experience.
- Modeling studies find that different ETS designs have different impacts in terms of the "pollution-haven" effect (i.e., companies' incentive to relocate to areas with less stringent environmental regulation) and in terms of emissions reductions, economic losses, and welfare effects.
- To inform the design of an efficient nationwide ETS for China, the author uses a computable general equilibrium (CGE) model to study regional impacts under different trading scenarios. The results show that allowance trading significantly reduces economic and welfare losses from a carbon constraint.
- Further, an emissions-based allowance allocation produces fewer economic losses and distortions than an output-based allocation, which effectively functions as a production subsidy. A welfare-based allocation produces the largest income transfers between regions. Emissions trading with allowance auctioning minimizes the pollution haven effect.

Accelerating the Establishment of China's National ETS
ZHANG Jianyu

- Emissions trading has been an important part of China's efforts to address climate change since 2011, when seven cities and provinces were selected to host pilot-emissions-trading systems.
- This brief offers ten recommendations for next steps to build an effective national carbon market in China.
- It is suggested that China needs to advance international cooperation on carbon-pricing mechanisms, to be consistent with the "Green Belt and Road" initiative as well as to promote low-carbon transitions in other countries.

China's National ETS: Impacts on Costs in the Power Sector
Fei TENG

- The interaction between China's national emissions-trading system (ETS) and electricity-market reform will affect how the ETS develops in the future.
- The ETS will impose costs on power generators in the short term; these costs could amount to 5%–12% of fossil generators' profits.
- This brief proposes three options for compensation arrangements to offset cost impacts.

Comparative Perspectives on Subnational Policy

India and Subnational Climate Change: An Emerging Discourse
Radhika KHOSLA

- Indian climate policy began at the national level and has been rapidly diffusing to states and cities over the last few years, resulting in the gradual mainstreaming of climate-change policy into the subnational level.
- The starting point for subnational climate action in India is the linkage between local development objectives and climate change.
- Effective subnational climate action in India requires capacity and strategic understanding to negotiate the institutional complexities that arise from the country's multilevel and federal governance arrangements.

Subnational Carbon-Pricing Policy in the United States
Robert N. STAVINS

- Given the global commons nature of climate change, international cooperation is essential, and policy actions by the highest level of geographic jurisdiction (typically nations) are likely to be the most effective environmentally, as well as the most cost-effective.
- But subnational climate change policies may – in some cases – be desirable when national policies appear to be insufficient.
- However, the interactions between a subnational system and a national policy in which it is nested can be problematic, benign, or positive, depending on the relative scope and stringency of the policies and the specific policy instruments employed.
- These various types of interactions are exemplified by the history of conventional air pollution regulation, as well as by more recent climate-change policies.

The Evolution of Carbon Pricing Across Canada: Lessons for Subnational Climate-Change Policy in China

Katie SULLIVAN and Ellen LOURIE

- The Canadian experience with innovative provincial climate and carbon-pricing policy spans more than a decade. This once highly fragmented subnational activity helped form the foundation for the country's new pan-Canadian carbon-pricing program.
- The flexible nature of the pan-Canadian approach not only accommodates existing subnational carbon-pricing actions and infrastructure but has been – and continues to be – deeply reliant on cross-federal, provincial, and territorial governance and greenhouse-gas policy coordination efforts.
- Canada's multi-level, collaborative experience is a prime model to inform more cohesive carbon-pricing activities in other regions, including China.
- Examples of areas where comparative lessons can be gleaned from Canada include: joint development of a framework for greenhouse-gas offsets; consistent greenhouse-gas quantification, inventories, and guidance; coordinated actions on supplementary measures to complement carbon pricing; and coordinated strategy to harness international market opportunities under Article 6 of the Paris Agreement.

要点汇编

概述和框架：中国的气候变化政策

中国地方气候变化政策

张希良和周丽

- 在中央政府出台的政策之外，中国的省市采取了许多措施并在减缓气候变化方面取得了成效。
- 例如，地方政府制定了降低碳强度的目标并制定了相关计划，在某些情况下将目标细化并分配到市级和县级。
- 在地方一级已经启动了许多低碳试点项目，包括城市和工业园区，并且有73个省市为温室气体排放达峰设定了目标日期。
- 其他值得注意的地方政策包括引入试点排放交易试点，新的补贴政策以促进农村地区煤改气，以及对“新能源”汽车的激励政策。

中国气候政策制定的十大推动力

齐晔和赵小凡

- 近年来，中国表现出了应对全球气候变化的坚定决心。本文探讨了中国气候变化政策制定背后的十个推动因素。
- 近年来，解决空气污染问题（尤其是细颗粒物污染）的压力是中国与气候变化相关的政策最重要的推动因素。相关推动因素还包括中国目前正在发生的能源转型和工业发展模式转变，它们促进了中国总体能源强度的降低与新能源发电的投资增加。
- 中国气候政策制定的其他重要推动力还包括科学研究，这凸显了全球变暖的潜在严重后果；国际合作和治理，中国正在不断加强与其他国家的合作以应对气候变化；市场化，这促进了基于市场手段来执行和激励气候治理的发展；习近平主席对“生态文明”的承诺是中国共产党的“五位一体”总体布局的重要组成部分；来自环保组织的压力。

制度观点

建立中国的地方气候机构

Michael DAVIDSON

- 中国特定的政府体制（确保中央权威，又充分调动地方推动发展积极性）赋予了下级政府很大的自治权。
- 在政府机构之间，气候目标的优先次序并不统一，并且体制框架中的分歧依然存在。
- 中国有效的气候政策必须创造性地利用中央统一领导和地方自治来推动全国碳市场和其他应对气候变化的举措。

中国国家定价体系在地方的实施途径：挑战与机遇

Gørild HEGGELUND

- 中国领导人正在推动国家排放交易体系（ETS）作为减少温室气体排放的几种政策工具之一。
- 地方层面的政策实施带来了挑战和机遇：在省市（如碳交易试点）中积极的努力可以用来推动政策实施并提高减排目标。
- 在中国成功实施碳交易体系的一个关键是建立法律基础，以确保政策的有效实施和对于潜在违规的处罚。

中国低碳政策与区域案例研究的结果

谭显春

- 中国建立了系统性体制和政策框架来应对气候变化，包括自上而下的政策设计指导，政府机构行政命令，碳排放数据收集和监测系统，以及全国的碳市场。
- 中国制定了低碳发展政策体系。这些政策适用于多个等级的司法辖区，涉及中国的各个地区和行业。
- 因为省市的工业发展阶段不同，相似的政策选择可能在不同的时间取得不同的结果。为了实现经济欠发达地区（例如重庆）的减排，还需要继续加大投资。
- 中国的低碳发展体系和政策机制需要进行大规模变革，以实现长期减排，同时减排必须逐步从生产行业转向消费行业。

更多的大棒和更少的胡萝卜？展望“新常态”下的环境政策的实施

Christine WONG

- 在过去的十年中，中国的环境政策已发生了重大变化。随着最高层对这些议题的全新强调，环境法律，法规和行动计划（其中许多都有雄心勃勃的目标和强力的措施）已经遍地开花。
- 中央政府通过支付大部分政策实施的费用并增加地方一级的监督和执行资源（包括对监察的强调）来加强政策实施。
- 但是，地方政府在环保执法方面仍然面临限制。而且，由于其他政策和宏观经济变化导致地方资金流减少，随着中国适应经济增长放缓的“新常态”，中央政府的财政支持也会降低，地方政府借款将受到更大限制。在这种背景下，碳定价可能看起来越来越有吸引力。

中国的排放交易体系：地方和国家层面

碳交易试点对国家政策设计的启示

对中国的排放交易试点有效性的多维度评估

齐绍洲

- 对中国的七个排放交易试点（ETS）的结果进行多维度实证评估对于设计国家排放交易体系非常关键。
- 评估结果表明试点项目对覆盖区域和行业的碳排放，碳强度，人均排放以及能源结构均产生了重大影响。该行业的能源密集度越高，效果越显著。试点项目还减少了能源密集型行业的收入，但对这些行业的就业或资产回报率（ROA）却没有明显影响。
- 基于基准而非祖父条款或历史碳强度方法分配配额可更大程度降低所涵盖行业的排放量和碳强度，而祖父条款和历史碳强度的配额分配方法增加了覆盖行业的资产回报率。

基于湖北省碳市场经验的碳定价政策初探

田啟

- 碳价格的水平和稳定性是碳市场设计中的重要考虑因素。
- 在发展自身的碳市场中，湖北省采取了几个步骤来建立有效的碳价格机制，包括设定基本配额价格，通过增加投资者的参与来促进市场稳定性以及配额“投入” （拍卖）和“回购”规定。
- 湖北对碳市场的建设提供了许多经验，包括对配额分配的严格控制，多元化的投资需求，以及信息披露和政策连续性的重要性。

广东省减排进展与创新的政策措施

曾雪兰

- 由于广东省不同地区的经济发展水平不均衡，进一步节能的潜力有限以及非化石能源资源对不足，广东省在减少碳排放方面面临诸多挑战。
- 广东省一直采取创新措施来减少地方碳排放，包括碳市场的 “ 碳普惠 ” 机制（一个促进公众减排的激励机制），零碳示范区，和碳捕获和储存（CCUS）中心。
- 一方面，广东省的排放交易体系（ETS）根据明确而具体的规定受到严格监管。另一方面，由于受到监管，它的运行相对独立于政府干预。广东碳交易体系的特点还在于管理井井有条，交易活跃，减排有效。
- 广东将继续改善其碳交易体系直到中央政府决定将其关闭并用国家碳市场取而代之。

中国的排放交易体系：地方和国家层面

国家定价体系下碳交易试点的命运

共存还是关闭？国家碳市场体制下中国排放交易试点的命运

Valerie J. KARPLUS

- 随着中国继续建立国家的碳 排放交易体系（ETS），自2013年以来一直在运作的七个地方排放交易试点的命运仍然是一个悬而未决的问题。
- 展望未来，三个主要选择是：（1）共存，即在国家体系外维持独立的地方交易体系；（2）部分整合，这意味着一个体系的信用额可以用于其他体系；（3）全面整合，这将涉及将七个地方试点纳入一个国家碳交易体系。

- 每个选项都有利弊。全面整合可能在经济上最优，但是存在以下几个挑战：地方政府将不得不放弃控制权；在短期内，地方的一些行业的排放源将不再被涵盖，因为国家排放交易体系最初将仅包括电力行业；全面整合需要统一的规则和清晰的过渡计划。

- 鉴于这些挑战，应将注意力集中在加强和协调所有现有体系中的可检测、可报告、可核查（MRV）准则上，并寻求在地方体系中寻求更强的减排雄心，这可以作为以后会被纳入国家交易体系的公司的训练机会。

中国的排放交易体系：地方和国家层面

设计和实施中国的国家碳交易体系

中国国家碳交易体系面临的挑战

王溥

- 由于其复杂性，规模巨大，以及中国的社会经济和政治现实，中国的国家排放交易体系（ETS）可能面临显著挑战。

- 随着中国经济经历从制造业到服务业的结构性转变，国家碳交易体系需要能够应对不断增加的市场波动。

- 我们需要能源行业和国有企业的市场化改革来为碳交易体系创造有利的制度环境。

评估中国建立全国排放交易体系的区域实施途径

吴立波

- 为准备全国范围的碳交易体系而在中国启动的七个排放交易试点（ETS）并未在产业结构或排放强度方面产生巨大影响，这也许是因为它们的排放额度设计较为宽松，以确保市场稳定为主要目的并专注于积累经验。

- 建模研究发现不同的碳交易设计在"污染天堂"效应（即公司有激励迁往环境法规不严格地区）以及减排、经济损失和福利效应方面具有不同的影响。

- 为了为中国设计一个有效的全国性碳交易体系，作者使用了可计算一般均衡（CGE）模型来研究不同交易情景下的区域影响。结果表明配额交易显著减少了碳排放限制带来的经济和福利损失。

- 此外，与基于产出的分配相比，基于排放的配额分配产生的经济损失和扭曲更少，从而有效地充当了生产补贴。基于福利的分配在区域之间产生最大的收入转移。通过配额拍卖进行排放交易可以最大程度地减少污染天堂的影响。

加快建立中国国家碳交易体系

张建宇

- 自2011年以来，排放交易一直是中国应对气候变化工作的重要组成部分，2011年，七个省市被选为排放交易试点。
- 本概述为下一步在中国建立有效的全国碳市场工作提供了十项建议。
- 建议中国在碳定价机制上推进国际合作，遵照“绿色一带一路”倡议，并促进其他国家的低碳转型。

中国的国家碳交易体系：对电力行业成本的影响

滕飞

- 中国国家排放交易体系（ETS）与电力市场改革之间的相互作用将影响未来排放交易体系的发展。
- 排放交易体系将在短期内使发电端施加成本；这些成本可能占化石燃料发电企业利润的5%–12%。
- 本概述提出了三种用以抵消成本影响的补偿安排。

地方政策的比较分析

印度与地方气候变化：一个新兴话题

Radhika KHOSLA

- 印度的气候政策始于国家层面，并在过去几年迅速发展到各州和各个城市，使气候变化政策在地方层面逐渐成为主流。
- 印度地方气候行动的出发点是建立地方发展目标与气候变化之间的联系。
- 在印度，鉴于该国多层次和联邦治理所产生的体制复杂性，有效的地方气候行动需要能力和战略理解。

美国的地方碳定价政策

Robert N. STAVINS

- 鉴于气候变化的全球性，国际合作必不可少，在最高辖区（通常是国家）采取的政策行动可能是最具环境效益，也是最具成本效益的措施。
- 但是，在国家政策可能不足的特定情况下，可能需要制定地方气候变化政策。
- 然而，地方体系和其属于的国家体系间的相互作用可能是负向的、无影响的或正向的，这取决于政策的相对规模和严格程度以及使用的具体政策工具。
- 文章进一步使用传统空气污染监管的历史政策以及更近期的气候变化政策来举例说明这些不同类型的相互作用。

加拿大各地碳定价的演变对中国地方气候变化政策的启示

Katie SULLIVAN和Ellen LOURIE

- 加拿大在创新性地方气候和碳定价政策方面已有超过十年的经验。这些曾经高度分散的地方活动为该国全新的泛加拿大碳定价计划奠定了基础。
- 泛加拿大计划的灵活性使其不仅能够包括先有的地方碳定价行动与基础设施，并且将继续深深依托于联邦、省和地区的治理以及温室气体政策的协调工作。
- 加拿大的多层次合作经验为包括中国在内的其他地区开展更有效的碳定价活动提供了宝贵参考。
- 可以从加拿大汲取比对经验的领域包括：共同发展温室气体补偿框架；一致的温室气体量化方法、清单和指导；就碳定价的补充措施采取协调行动；根据《巴黎协定》第六条制定协调战略以利用国际碳市场的机会。

OVERVIEW AND FRAMING: CLIMATE-CHANGE POLICY IN CHINA

Subnational Climate-Change Policies in China

ZHANG Xiliang
ZHOU Li
Tsinghua University

Key Points

- Provinces and municipalities in China have adopted a number of measures that are delivering progress on climate-change mitigation beyond the policies introduced by the central government.
- For example, local governments have established targets and developed plans for reducing carbon intensity, in some cases assigning disaggregated targets to cities and counties.
- A number of low-carbon pilot projects have been launched at the local level, including in cities and industrial parks, and 73 provinces and municipalities have set target dates for reaching peak greenhouse-gas emissions.
- Other notable subnational policy initiatives include the introduction of pilot emission-trading systems, new subsidy policies to promote switching from coal to natural gas in rural areas, and incentives for "new-energy" vehicles.

Local governments have played a significant role in addressing climate change in China. Apart from implementing policies adopted by the central government, provinces and municipalities have also introduced a series of local policy measures that have yielded progress in several areas:

1. Local low-carbon transformation plans and disaggregation of emissions-intensity targets

China has broken down its reduction targets for CO_2 emissions per unit of GDP for the 13th Five-Year Plan period and assigned specific targets to local governments. All local governments have incorporated substantial reductions in emission intensity into their regional economic and social development programs, annual plans, and government work reports, and have formulated detailed work guidelines accordingly. As of June 2018, 31 provinces (including autonomous regions and municipalities directly under the central government) had published their general or related plans or programs for controlling greenhouse-gas (GHG) emissions during the 13th Five-Year Plan period, including nineteen provinces that also released detailed plans for reducing emissions and addressing climate change in their respective jurisdictions during this period. In these nineteen plans, targets for reducing emissions intensity (i.e., carbon emitted per unit GDP) were disaggregated and assigned to cities and counties.

2. Low-carbon pilot projects at multiple levels

The National Development and Reform Commission(NDRC) approved a total of six provincial and 81 municipal-level low-carbon pilots from 2012 to 2017. In 2015, eight national low-carbon city (town) pilots and 51 national low-carbon industrial park pilots were approved. In 2014, the NDRC required local governments to launch low-carbon community pilots. This included incorporating low-carbon development goals into local governments' five-year plans for economic and social development, integrating low-carbon development in local government planning efforts, and proposing targets, tasks, and measures to control GHG emissions and develop a low-carbon economy. Main approaches, key projects, and supporting measures tailored to regional low-carbon development conditions were also put forward in an effort to explore low-carbon development models and paths.

3. Announcement of regional goals for reaching peak emissions

In 2015, eleven provinces and municipalities in China co-founded the "Alliances of Peaking Pioneer Cities"and announced their targets for reaching peak GHG emissions, along with corresponding policies and actions. As of 2017, a total of 73 provinces and municipalities had proposed such targets in various ways. As of 2018, Beijing, Tianjin, Shanxi, Shandong, Hainan, Chongqing, Yunnan, Gansu, Xinjiang, and others had set a clear target for reaching peak emissions as part of their implementation plans or programs for controlling GHG emissions during the 13th Five-Year Plan period. Beijing, for example proposed to reach peak emissions by 2020 or sooner; for Tianjin, the target is around 2025; for Yunnan, it is around 2025; and for Shandong, it is around 2027.

4. Pilot emissions-trading systems (ETSs)

In 2013, Shenzhen launched the first pilot market for carbon trading in China; similar pilots were subsequently launched by Shanghai, Beijing, Guangdong, Tianjin, Hubei, and Chongqing. Fujian Province launched its ETS in December 2016, becoming the eighth region or city to initiate carbon trading in China. All the pilot trading regions have made great progress in exploring and improving carbon markets, including developing supporting policies and regulations; market elements; monitoring, reporting, and verification (MRV) systems; emission-allowance allocation and compliance-management systems;and trading-supervision systems, as well as basic support systems and capacity building.

5. Local subsidy policies

Some local governments have introduced subsidy policies to promote switching from coal to gas in rural areas. For example, Beijing has increased subsidies to encourage clean-energy transformation for coal boilers; Hebei will set up a special fund to provide subsidies and policy support for natural gas use and coal-to-gas conversion of coal boilers; Tianjin will provide subsidies to gas supply companies for the part of the cost of supplying gas that exceeds the government-set household gas price; Henan has adopted subsidies for natural gas that will decline year by year; major cities in Shanxi Province released subsidy criteria; and Shandong Province allocated 600 million yuan to subsidize six cities. With respect to transportation-sector emissions, as of June 2018, fifteen provinces and municipalities had launched subsidy or other incentive policies for "new-energy" vehicles, including Shanghai, Shenzhen, Chongqing, Guangdong, Guangzhou, Xi'an, Wuhan, Jiangxi, Henan, Anyang, Hainan, Yunnan, Qinghai, Putian, and Heilongjiang.

Ten Drivers of Climate Policy Making in China

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Xiaofan ZHAO
Tsinghua University

Key Points

- In recent years, China has demonstrated a strong determination to address global climate change. This paper explores ten drivers behind climate-related policy making in China.
- Pressure to address air pollution problems, especially fine particle pollution, is the most important driver of climate-related policies in China in recent years. Related drivers are the energy transition and industrial development patterns currently underway in China as the country reduces its overall energy intensity and shifts investments in new generating capacity to emphasize renewable energy sources.
- Other important drivers of climate policy making in China include scientific research, which has highlighted the potentially devastating impacts of global warming; international collaboration and governance, in which China is increasingly working with other countries to address climate change; marketization, which has enabled the evolution of market-based instruments for enforcing and incentivizing climate governance; President Xi's commitment to "ecological civilization" as part of the Communist Party's Five Major Development Concepts; and pressure from environmental NGOs.

As the world's largest national emitter of greenhouse gases, China has demonstrated a strong determination to address global climate change. President Xi Jinping said during his meeting with former U.S. Secretary of State John Kerry in 2014 that addressing climate change "is not at others' demand but our own will. We have already taken many measures and will do more in the future." China's nationally determined contribution (NDC) under the Paris Agreement sets several specific goals: to reach peak carbon emissions around 2030, reduce carbon dioxide (CO_2) emissions per unit of GDP in 2030 by 60%–65% from 2005 levels, and increase the share of non-fossil fuels in primary energy consumption to around 20% by 2030. Fulfilling these pledges is integral to global climate-change mitigation efforts in general, and to meeting the Paris Agreement's objective of limiting average global temperature increase to less than 2°C in particular. This paper explores ten drivers behind climate-related policy making in China.

Driver 1: Air Pollution Governance

The first and foremost driver for climate-policy making in China is air pollution governance. The health effects of airborne fine particulate matter($PM_{2.5}$) have become a focus of intense concern for China's growing urban middle class in recent years (Li and Tilt 2018). The $PM_{2.5}$ crisis erupted in November 2011. In response, the State Council commissioned the (then) Ministry of Environmental Protection to take the lead in drafting an Air Pollution Prevention and Control Action Plan for the period 2013–2017. The Plan is commonly known as the "National Ten Measures" (*guoshitiao*), (MEP 2013). Released by the State Council in September 2013, it set concrete $PM_{2.5}$ and PM_{10} reduction targets for 2017 for key regions and the rest of China, respectively. These targets were over-fulfilled by 2017 (see Table 1).

Table 1. Target Performance for the Air Pollution Prevention and Control Action Plan

		Reduction Targets for 2017	Actual pollution reduction†
$PM_{2.5}$ reduction	Beijing-Tianjin-Hebei area;	25%	39.6%‡
	Yangtze River Delta region;	20%	34.3%
	Pearl River Delta region;	15%	27.7%
$PM_{2.5}$ concentration in Beijing		below 60 μg/m3	58 μg/m3
PM_{10} reduction in cities at the prefecture-level		10%	22.7%

Source: (Ruan 2018)

Notes: †While the pollution reduction targets set for 2017 were relative to 2012 levels, the official statistics for actual pollution reductions were relative to 2013 levels.

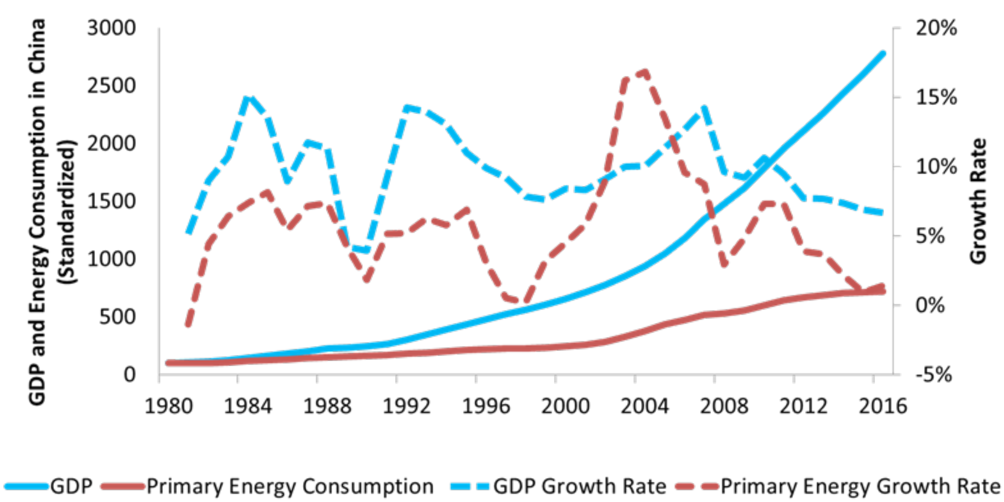
‡ UNEP (2019a) finds that $PM_{2.5}$ concentrations in the Beijing-Tianjin-Hebei area were reduced by 25%.

Driver 2: Energy Transition

The second driver behind climate-related policy making in China is the country's energy transition, defined as shifts in the composition, use, and efficiency of China's energy system in response to changing technology, infrastructure, and institutions. Several megatrends in China's energy transition are worth particular attention, including most prominently a deceleration in the growth of energy consumption (Figure 1); a peaking of coal consumption around 2014, which is much sooner than earlier projections (Qi *et al*. 2016); an all-time low in energy intensity; a steady increase in electrification; the mainstreaming of natural gas; and accelerated decarbonization of the energy system (Qi 2019).

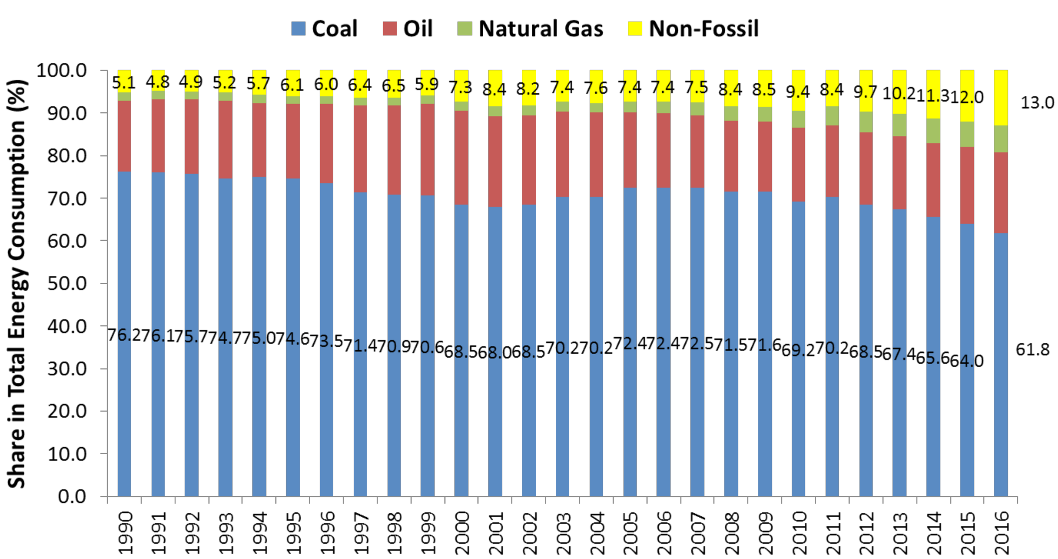
In 2016, the Chinese government released its Strategy for Revolutionizing Energy Production and Consumption (2016–2030), which set an explicit target for limiting China's total energy consumption to six billion tons coal equivalent (tce) by 2030. China, along with Denmark, is one of few countries in the world that has ever implemented a nation-wide energy consumption cap (Qi 2018). China's energy-cap policy is revolutionary, given the long history of human development in the industrial era, when growth in fossil-fuel consumption was linked to growth in economic output.

Figure 1. Decelerated growth in energy consumption



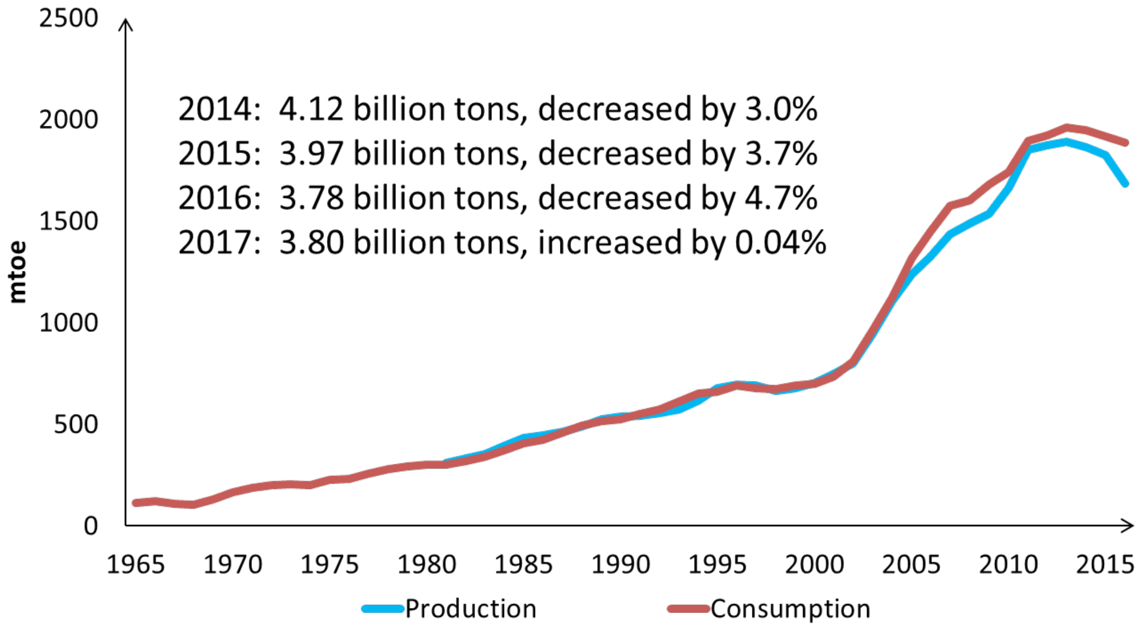
Source: China Statistical Yearbooks.

Figure 2. Change in China's energy structure



Source: (Qi and Zhang 2018)

Figure 3. Peak coal use and the end of coal-fired growth



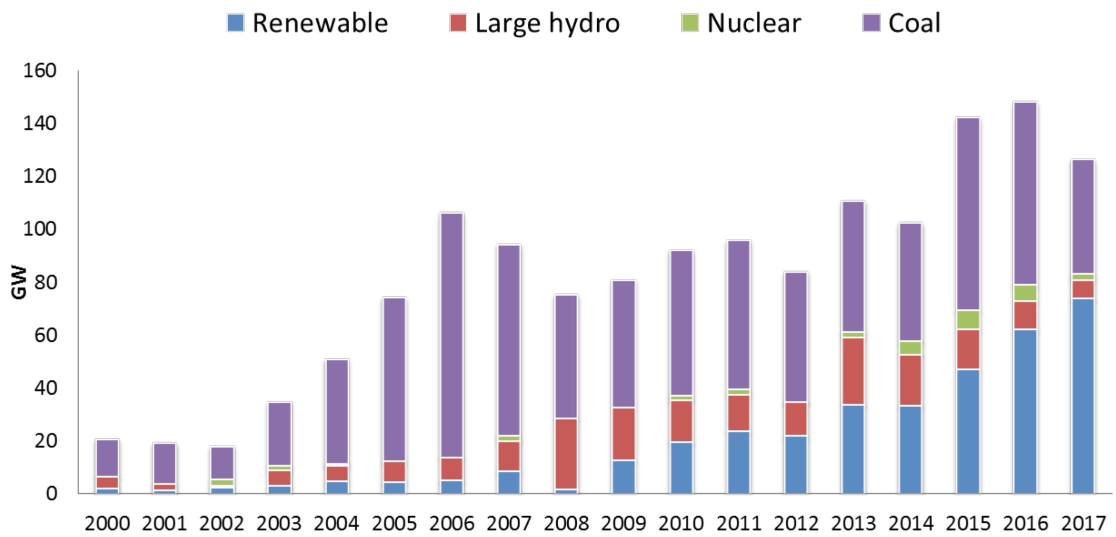
Source: (Qi and Zhang 2018)

Driver 3: Industrial Development

China leads the world in renewable energy installations and investment. In 2015, China's investment in renewable energy contributed to more than one-third of the global total. Although this share slightly decreased in 2016, China continued to lead the world in renewable energy investment in 2017 and increased its share of the global market even further. Domestic investment in renewable energy reached US$126.6 billion, approximately 45% of global total (Qi 2018).

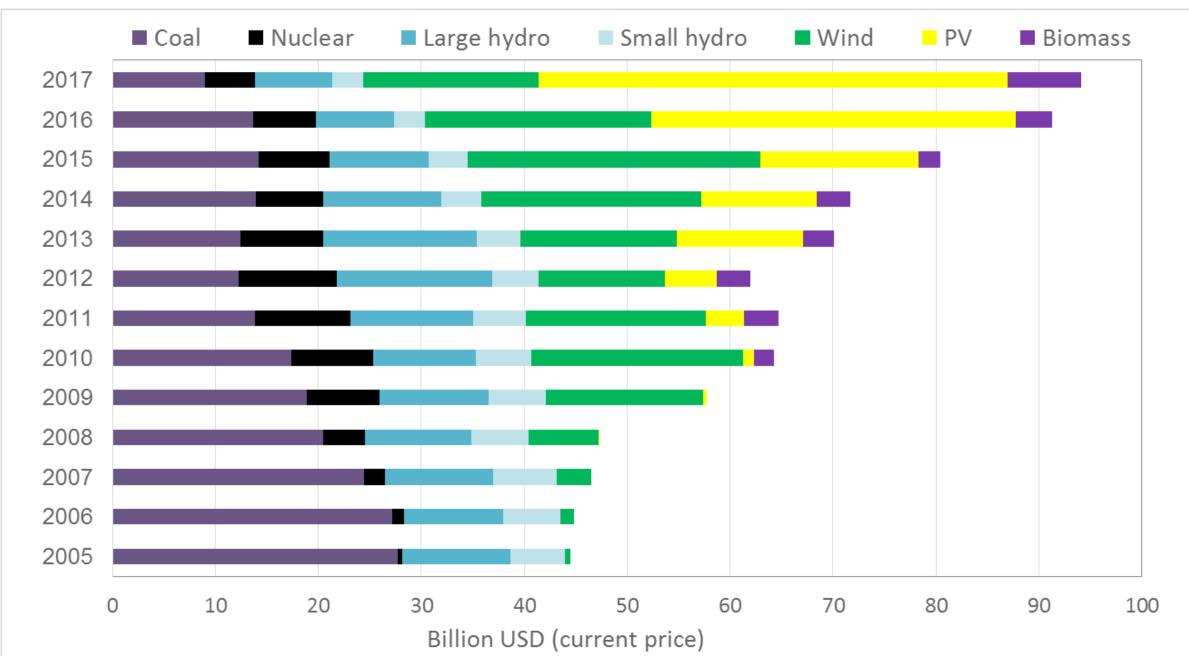
In 2017, renewable energy (excluding large hydro) accounted for 21.9% of China's total generating capacity additions (Figure 4). Renewable energy – including large hydro – contributed 58.4% of China's new installed capacity in 2017, within which 43% was from solar photovoltaic (PV) and 13% from wind. New PV installations amounted to 53 gigawatts (GW) of generating capacity, more than 50% of the global PV total. In addition, China installed 15GW of new wind capacity, approximately one-fourth of the global wind total. Meanwhile, the share of overall new capacity investments that went to renewables increased from 13% in 2005 to 77% in 2017 (Figure 5).

Figure 4. New installed capacity for electric power generation (2000–2017)



Source: (Qi and Zhang 2018)

Figure 5. Share of capacity investment in renewable energy



Source: (Qi and Zhang 2018)

Driver 4: Scientific Research

Scientific evidence has made clear the significant, disastrous impact that global climate change may have on the world in general and on China in particular. The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) states that recent anthropogenic emissions of greenhouse gases are the highest in history and that recent climate changes have had widespread impacts on human and natural systems. In particular, cumulative greenhouse-gas emissions in the 1970–2010 period accounted for approximately half of cumulative anthropogenic emissions in human history, and 78% of the added emissions were CO_2 emissions from fossil-fuel combustion and industrial processes.

Continued emissions of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive, and irreversible impacts on people and ecosystems. If no strong actions are taken to address climate change, greenhouse-gas emissions from anthropogenic sources can be expected to lead to a 4°C rise in global average temperature by the end of the 21st century, according to the IPCC's AR5. Limiting climate change will require substantial and sustained reductions in greenhouse-gas emissions, which, together with adaptation, can limit climate change risks. The target of limiting global temperature rise to 2°C above pre-industrial levels by 2100 can only be achieved by revolutionizing the energy system on a global scale, optimizing land use, and developing carbon dioxide removal as one of the key technologies to be applied.

Driver 5: International Climate Negotiations

International climate-change negotiations also act as a strong catalyst for China's increasingly ambitious climate commitments and efforts. During the Fifteenth Conference of the Parties (COP-15) of the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in 2009, the Chinese government put forward an independent emissions reduction target to reduce national CO_2 intensity by 40%–45% compared to 2005 levels by 2020; to increase the share of non-fossil energy in China's primary energy mix to 15%; and to increase forest stocks by 1.3 billion cubic meters (m3) compared to 2005 levels. In 2016, the Chinese government submitted its NDC mitigation pledges under the 2015 Paris Agreement of the UNFCCC. In its NDC, China pledged to reduce CO_2 intensity by 60%–65% compared to 2005 levels by 2030, to increase the share of non-fossil energy in national primary energy consumption to 20%, and to reach peak CO_2 emissions around 2030 or earlier.

Driver 6: International Collaboration

China has worked closely with major economies around the world to address global climate change through bilateral and multilateral platforms. In 2015 alone, China made joint announcements on climate change with the European Union in June, with the United States in September, and with France in November. China also played a critical role in facilitating climate collaboration on multilateral platforms such as the G20 Summit, BRICS Meetings,[1] and Major Economies Forum on Energy and Climate.

1 BRICS is an acronym for an association of five major emerging national economies: Brazil, Russia, India, China, and South Africa.

The G20 Summit provides an example. As the host state for this event in 2016, China effectively advanced the multilateral process on climate change under the G20 framework. China, along with the United States, submitted its ratification document for the Paris Agreement to Ban Ki-moon, then Secretary General of the United Nations; launched a Climate Finance Study Group, in addition to the Green Finance Study Group; and announced the Presidency Statement on Climate Change at the G20 Sherpa Meeting.

Driver 7: Global Governance

China has also assumed an increasingly active role in global governance in recent years. At the center of President Xi's diplomatic philosophy is the concept of "a community of common destiny" (*mingyun gongtongti*), an idea culturally rooted in the Confucian concept of "*tianxia*," meaning "all under heaven" and emphasizing win-win cooperation rather than confrontation. Through its Belt and Road Initiative and the Asian Infrastructure Investment Bank, China is seeking to reshape global governance and transform the existing international system to reflect its values and interests, transforming its role from a rule-taker that "keeps a low profile,"to a rule-maker that "strives for achievement" (Yan 2014). The country's growing leadership in global climate governance is illustrative. As President Xi has said, "taking a driving seat in international cooperation to respond to climate change, China has become an important participant, contributor, and torchbearer in the global endeavor for ecological civilization."

Driver 8: Marketization

In the climate-change arena, market-based instruments for enforcing and incentivizing climate governance have gradually evolved. In October 2011, China launched pilot carbon markets in two provinces (Guangdong and Hubei) and five cities (Beijing, Chongqing, Shanghai, Shenzhen, and Tianjin). These seven pilot carbon markets have been trading since June 2013 (Table 2). And, as of May 2019, they covered more than 20 industries, including power generation, cement, iron and steel, and chemical production. Nearly 3,000 key emitting entities participated in trading, with an accumulated turnover of almost 580 million tons of CO_2 or just more than 12 billion yuan. A nationwide carbon market is being developed over the last two years for the electric power industry and would eventually cover all carbon-emitting industries.

Table 2. Overview of the seven carbon-trading pilots in China

	Launch date	Accumulated transaction amount, 31 July 2019 ($mtCO_2$)	Accumulated transaction turnover, 31 July 2019 (millionyuan)
Guangdong Province	December 2013	112.30	1,588.80
Hubei Province	April 2014	322.19	7,452.12
Beijing	November 2013	29.69	642.02
Chongqing	June 2014	8.91	32.99
Shanghai	November 2013	36.76	443.21
Shenzhen	June 2013	62.50	1,795.60
Tianjin	December 2013	6.83	89.90

Source: (UNEP 2019b)

Driver 9: Building an Ecological Civilization

China's development priority has shifted from speed to quality. "Innovation" has become the new driver of economic growth. "Coordination," "green," "openness," and "sharing" reflect the transition toward higher-quality development that emphasizes a balance among social equity, economic growth, and environmental protection objectives. Ecological civilization (*shengtai wenming*), characterized by harmonized, sustainable human–environment relations, will supersede industrial civilization as the new form of civilization and has been highlighted as one of the major pillars of Xi Jinping Thought.

Driver 10: Environmental NGOs

Environmental non-governmental organizations (NGOs) have facilitated climate policy making in China by deploying different strategies, depending on their target groups. Some environmental NGOs try to exert pressure on China's domestic climate policy making by influencing the international community in international negotiations and international communications. Other NGOs target the Chinese government at all levels by participating in research consultation, policy advocacy, and collaborative research projects. Still other environmental NGOs are known for their critical roles in promoting corporate social responsibility, capacity building, and information disclosure, with businesses as the main targets (Baron 2009; Delmas and Young 2009). Last, but not least, there are environmental NGOs that directly interact with the public through education outreach and advocacy in hopes of influencing policy by raising awareness of climate change. The environmental NGOs tend to advocate more proactive climate policies for the government to make.

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INSTITUTIONAL PERSPECTIVES

Creating Subnational Climate Institutions in China

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Key Points

- China's particular governmental system – variously referred to as "quasi-federalist" or "fragmented authoritarian" – gives large autonomy to lower levels of government.
- The prioritization of climate goals is not uniform across governmental agencies, and gaps in the overall institutional framework persist.
- Effective climate policy in China must make creative use of centralization and local autonomy to advance a national carbon market and other efforts to address climate change.

China's party-state consists of multiple hierarchies of bureaucrats and officials accountable to a common leadership, yet it also gives substantial autonomy to lower levels of government in pursuing various objectives. By some fiscal measures, China is the most decentralized country in the world. As such, China's particular flavor of "quasi-federalist" – also referred to as "fragmented authoritarian" – control, as well as its integration of party and state, will heavily influence and constrain options for controlling greenhouse-gas (GHG) emissions in the economy.

Climate policy merits an extended look at the subnational Chinese state for several reasons.[1] First, large institutional transformations are required to align the incentives of government bureaucracies with the new goal of reducing GHGs – extending across a wide range of established government functions. Second, the local political economy embedded in these institutions ensures that this task is significantly more complicated than prescribing a single set of ideal institutions (e.g., based on international best practices). There will likely be extended periods of geographic variation in policies and institutions. Third, effective policy prescriptions will thus require creative use of centralization where local interests diverge substantially from national interests, but also where the central government can align with and exploit local government authorities to advance rapid reforms in other areas.

In terms of institutional functions, China's central agencies have a great deal of power over economic planning, tax policy, some pricing, and standard setting. Meanwhile, local governments control much permitting, other aspects of pricing, portions of production, and land

1 A longer paper by the author describes the evolution of decentralization in China over the reform period beginning in 1978, different theories of institutional change in the country, and how both the empirical and theoretical literatures help us understand the development of institutions for governing GHG-emitting activities. That paper was prepared for the initiative on subnational climate-change policy, conducted by the Harvard Project on Climate Agreements and Tsinghua University's Institute of Energy, Environment, and Economy – as was this brief. See: "Creating Subnational Climate Institutions in China." December 2019. www.belfercenter.org/publication/creating-subnational-climate-institutions-china.

policy. Within these functions, climate change concerns are increasingly reflected since around 2007, though the prioritization of reducing GHG emissions is by no means uniform across central and local government institutions. Additionally, there remain crucial gaps in the overall institutional framework that would elevate the importance of climate change. Central enforcement of policy implementation generally increases when policies align with other, arguably more salient, policy goals, such as reducing local air pollution.

Personnel decisions crucially determine many aspects of implementation: local officials are directed and constrained by superiors via cadre-leadership selection and promotion, administrative mandates, and budgets. Strong relationships – and consonance of interests – between provincial and central authorities and institutions may facilitate policy implementation by provinces. However, such strong ties may also reduce local officials' flexibility in adapting policies to local conditions – and hence reduce policy effectiveness. On the other hand, if the implementation process primarily reflects local interests, state objectives may not be achieved.

These findings have implications for the design and implementation of the national carbon market set to start around 2020. The newly created Ministry of Ecology and Environment is the locus for climate-change policy, but its authority within China's complex institutional framework is still being developed, at both central and local levels. One important component of fully implementing a national carbon market will be to harmonize existing pilot programs with the goal of generating efficient prices and eliminating cross-provincial trading barriers. However, this will be difficult, given differing local policy designs and industry structures. More fundamentally, the interests of the provinces and municipalities with considerable (though not exclusive) authority over their pilots must be aligned with the central priority of advancing the national system.

Another challenge is the absence of a well-functioning market for electricity – the first sector targeted under the national carbon market. Designers of the national carbon market are therefore developing second-best "rate-based" approaches and "indirect emissions" permit systems. Ultimately, the success of the national carbon market will depend on electricity market reforms, which are being pursued in parallel, though with an uncertain end-date.

Subnational Implementation Pathways for China's National Pricing System: Challenges and Opportunities

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Key Points

- China's leadership is pushing a national emissions-trading system (ETS)as one of several policy tools for reducing greenhouse-gas emissions.
- Policy implementation at subnational levels presents challenges and opportunities: proactive subnational efforts in provinces and cities (such as pilot ETS cities) can be used to push policy implementation and raise targets and goals.
- One critical area for successfully implementing an ETS in China is the establishment of a *legal basis* to ensure effective implementation and potential punishment of non-compliance.

Introduction

Climate change is a growing concern in China and has led to an active, more aggressive climate policy domestically. Globally, China continues to support the Paris Agreement, as the Chinese government expressed at the June 2019 G20 meeting in Osaka. China accounts for roughly 30% of global CO_2 emissions, and remains the world's leading emitter. To address emissions, China has turned toward market mechanisms due to perceived shortcomings of the command and control approach; in 2011 the government opted to implement a national emissions-trading system (ETS) as a policy tool to reduce greenhouse-gas (GHG) emissions. Seven pilots were launched in 2013 and 2014 to gain experience for use in the national ETS.[1] This brief analyzes broader drivers for China's ETS that are central to the subnational implementation of the carbon market. It also identifies challenges and opportunities for implementation of the ETS – and, to some degree, climate-change policy more generally – at the subnational levels.

Leadership support at the national level is pushing China's ETS

The Chinese leadership's stated support for reducing energy-related GHG emissions – and for the carbon market – is important for the development and implementation of the ETS at the subnational level. The policies set by the central government and statements made by high-level officials – including from the highest levels (President Xi Jinping) – send strong political signals and provide a policy framework within which the provinces and municipalities can act.

1 The pilots were implemented in areas at different levels of economic development: Beijing, Tianjin, and Shanghai are all relatively well off, with average per-capita incomes (in 2015) above US$14,000. By contrast average per capita income in Guangdong is at US$10,000 – 12,000, while incomes in Chongqing and Hubei are in the range of US$8,000 – 10,000.

Xi Jinping announced during his 2015 state visit to the United States that China's ETS would be launched in 2017. The national carbon market was indeed officially launched in December 2017, though with a two-year trial period. Premier Li Keqiang, in July 2019, presided over the National Leading Group Meeting on Climate Change, Energy Conservation and Emission Reduction and stressed the need to actively respond to climate change – and deepen efforts on energy conservation and emission reductions. One of the key messages from the meeting was to speed up the establishment of the carbon market, further illustrating support for this policy from the top.

Local air pollution is one of the key drivers for climate action in China and one of the strongest motivations for reforming the country's energy sector, which is largely coal-based. An energy revolution was launched in 2014 (by Xi Jinping) with the objective of increasing the share of non-fossil energy (including renewables) and reducing coal consumption. The carbon market, when up and running, is regarded as an instrument for addressing air pollution and energy concerns; real emissions trading in the important power sector is expected to start in 2020.

Policy implementation at the subnational level: Challenges and opportunities for the ETS

Local authorities are expected to implement the policies set by the central government, which divides responsibility for meeting national targets among the different provinces. The provinces in turn distribute decision-making targets among their jurisdictions: prefectures, counties, and cities. China's large size and population, its competing development interests, and uneven levels of economic development in different parts of the country will affect prospects for implementation. Sometimes local governments will try to hinder or slow down the implementation of national policies, as these policies may not be well understood or may conflict with local interests, such as promoting economic development and poverty reduction.

Yet, there are opportunities to utilize the existing potential for subnational implementation – at the provincial and city levels – to reduce emissions, including through emissions trading. In particular, China's more economically-advanced areas are more inclined to push for stringent environmental regulations and to set ambitious energy and climate goals. For instance, Beijing and Shenzhen, two ETS pilot cities, have set the goal of reaching peak emissions ahead of the 2030 national goal—in 2020 and 2022, respectively. This is possible due to the presence of proactive and committed municipal governments (including mayors and municipal-level authorities, such as development reform commissions and ecology and environment bureaus [EEBs]), greater understanding and knowledge of the issues in question, and access to data and supporting research from experts. Transferring lessons and best practices between provinces and cities could move things forward in less advanced areas, while keeping in mind that differentiated approaches will be needed, given China's diversity in terms of economic development.

Recent *structural change*s in the country's bureaucracy may also affect ETS implementation. At the National People's Congress (NPC) in 2018, the Ministry of Ecology and Environment (MEE) was strengthened and given responsibility for climate change, including responsibility for the national ETS, from the powerful National Development and Reform Commission (NDRC). What impact might this have on ETS implementation? On the positive side, MEE has inspection and monitoring experience in the provinces and can follow up closely on implementation. Additionally, the consolidation of environmental responsibilities in one ministry could help align different environmental strategies and policies, including the ETS. A potential challenge is that responsibility for energy policy still remains with the NDRC and National Energy Administration, thus requiring close coordination between these ministries. On the positive side, the power sector has a high share of state-owned enterprises (SOEs), which have data collection and reporting systems in place and could potentially serve as good case studies for the ETS. Also, speeding up capacity building is key to implementation because, when ETS-related responsibilities in all pilots were moved from the provincial development reform commissions (DRCs) to EEBs, DRC staff did not always move to the EEBs.

Looking ahead…

China continues to work on implementing and refining its national ETS since the official launch of this initiative in December 2017. One of the most critical areas for successful implementation of emissions trading in China is the establishment of a *legal basis* to ensure effective implementation and potential punishment of non-compliance. Industrial associations have asked for legislation to be adopted quickly, to ensure predictability for industries and businesses. On March 29, 2019, the Chinese government released draft ETS regulations for public consultation, thereby moving one step closer to establishing a legal foundation. Capacity building at the subnational level is also needed to strengthen understanding of how emissions trading works. Again, the pilot ETSs have provided valuable experience, such as in Beijing and Shenzhen, where the local People's Congresses have passed ETS legislation. Sharing experience from these and other pilots is worthwhile to help ensure a successful carbon market in China.

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China's Low-Carbon Policies and Results from a Regional Case Study

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Key Points

- China has established a systematic institutional and policy framework to deal with climate change, including top-down policy-design guides, government-agency administrative orders, a carbon-emissions-data-collection and -monitoring system, and a national carbon market.
- China has developed a low-carbon-development policy system. These policies are applied to several jurisdictional levels, involving various regions and industries in China.
- Similar policy options may achieve different results at different times, depending on the province's or city's stage of industrial development. Additional investments are required to achieve carbon reductions in economically underdeveloped areas (such as Chongqing).
- Large-scale changes in China's low-carbon-development system and policy mechanisms are needed to achieve long-term carbon reduction, and emissions reduction must gradually shift from production to consumption.

1. China's Low-Carbon Institutional and Policy Framework

In order to meet its carbon-emissions reduction goals, China is using a portfolio of policy tools that range from command-and-control mandates and standards to market mechanisms. China has required all levels of government to implement mandates from the central government, including translating the national carbon-intensity target into provincial-level targets, to support enforcement. China's low-carbon institutional and policy framework can be divided into the following three main parts.

Put forward a series of guidance documents to address climate change. These top-down documents establish a clear direction for China's economic and social development to ensure the realization of greenhouse-gas emission-reduction goals. These guidance documents usually involve China's major economic sectors and are published as medium- and long-term development plans. Between 2011 and 2015, the Chinese government promulgated a series of guidance documents to deal with climate change, such as the *National Plan on Climate Change (2014-2020)*[1] and the *Action Plan for Energy Development Strategy (2014-2020)*.[2]

1 www.scio.gov.cn/xwfbh/xwbfbh/wqfbh/2014/20141125/xgzc32142/Document/1387125/1387125_1.htm

2 www.gov.cn/zhengce/content/2014-11/19/content_9222.htm

Steadily promote multi-level low-carbon pilots. Many of China's cities are very large and include multiple districts, counties, and neighborhoods; each one can serve as the locus of a separate low-carbon pilot. The main forms of low-carbon pilot projects involve cities, provinces, carbon trading, industrial parks, and product certification. These pilots are designed by local officials and informed by guidelines from the central government. Thus, China will have many policy experiments taking place simultaneously. Lessons from these pilots will be used to develop national and provincial programs and guidelines for shaping future local initiatives across the country. These pilots are the ultimate example of "learning by doing."

Promote and perfect greenhouse-gas statistics, monitoring, and assessment systems. Data, inventories, and monitoring are the basis for achieving low-carbon development. The Chinese government is also constantly developing and improving greenhouse-gas statistics, monitoring, and assessment systems to advance low-carbon development in China. Between 2011 and 2015, the Chinese government released three documents, *The Second National Information Bulletin*,[3] *Guidelines of GHG Emissions Inventory at the Provincial Level*,[4] and *Measures to Examine and Evaluate the Carbon Emission Intensity Target*.[5]

2. China's Low-Carbon Policy Tools

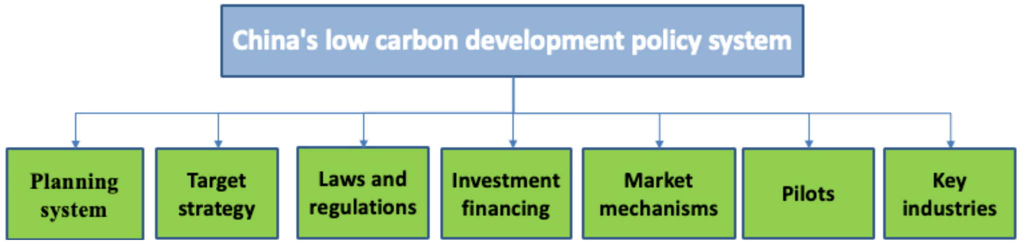
To guarantee the achievement of emissions-reduction goals, **China is pursuing a comprehensive approach that consists of low-carbon development goals, energy conservation, emissions-reduction laws and regulations, government-agency administrative orders, low-carbon economic incentives, carbon-market mechanisms, and low-carbon pilot demonstrations**. Low-carbon measures and policies include adjusting industry structure, increasing energy efficiency, optimizing energy structure, controlling greenhouse-gas emissions from non-energy activities (transportation, buildings, and individual activities), and increasing carbon sinks. China's more than 300 low-carbon policies can be divided into the crucial sectors of energy, industry, transportation, building, agriculture, and forestry. At present, 90% of China's carbon policies are command-and-control-type policies. There are relatively few market-based policies, so the government should encourage the development and use of economic incentives (carbon trading and carbon taxes.) and voluntary tools, while also exploring and conducting research on the combined effects of policy tools. Figure 1 shows China's low-carbon policy framework.

3 www.ccchina.org.cn/Detail.aspx?newsId=39275&TId=70

4 www.cbcsd.org.cn/sjk/nengyuan/standard/home/20140113/download/shengjiwenshiqiti.pdf

5 http://zfxxgk.ndrc.gov.cn/web/iteminfo.jsp?id=1953

Figure 1: China's low-carbon policy framework



3. Case Study and Findings

In 2010 and 2017, China's National Development and Reform Commission (NDRC) approved pilot projects to reduce carbon emissions in six provinces and 81 cities. The province of Guangdong and the city of Chongqing are hosting two typical low-carbon pilots – in eastern and western China, respectively. Guangdong Province is located at the southern tip of mainland China, neighboring the South China Sea, Hong Kong, and Macao; it has the most prosperous, active, and open economy in China. Chongqing is one of the largest cities in the world, measured by area (82,400 square kilometers) or by population (30 million people).

The energy-supply sector is the main contributor to greenhouse-gas emissions in Guangdong Province. In 2014, this sector accounted for 45% of the province's carbon emissions. Over the period 2010 to 2015, the average annual growth of carbon emissions in Guangdong Province slowed dramatically, to 1.4%, and the province entered a low-carbon development phase. Chongqing adopted 41 low-carbon action policies and 28 pilot projects. These measures came on top of a 21% reduction in energy intensity, which exceeded the city's five-year target between 2006 to 2010.

To assess the impact of Guangdong's and Chongqing's low-carbon pilot projects and project their impacts into the future, we developed two complementary models. The first is a bottom-up model that allows analysts to assess carbon-emission-reduction potential, as well as the costs and benefits of specific policies and programs. The second is a top-down model for evaluating the macroeconomic impacts of policies in terms of sector-based employment, production output, and the impact on GDP and inflation. The second model has been used throughout the country and has separate input–output databases for almost all of China's 26 provinces and most of its larger cities.

Using these models, researchers made the following findings:

- Applying these models to the Guangdong and Chongqing case study shows that the same policies may achieve different results at different stages of economic development and may have significantly different costs.

- Compared with Guangdong Province, adjustments to Chongqing's energy structure are more costly. This suggests that additional resources are required to achieve low-carbon development in economically underdeveloped areas. This is partly because less developed regions have to make investments not only in low-carbon technology and management but also in industrial restructuring.

Although energy and industry are key sectors for reducing emissions in both pilots, the proportion of carbon reductions attributable to these two sectors is gradually decreasing. Meanwhile, the share of reductions attributable to traffic and construction increases year by year. This suggests that emission reduction efforts need to gradually shift focus from production to consumption. This shift needs the support of future policies. However, China's current policy framework is centered on energy and industry, which may not be able to meet the requirements of future low-carbon development. Therefore, large-scale changes in low-carbon development policies and mechanisms are needed in the future.

More Sticks and Fewer Carrots? Looking Ahead to Implementation of Environmental Policy Under the "New Normal"

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Key Points

- Environmental policy has evolved significantly in China over the last decade. With a new emphasis on these issues at the highest levels, environmental laws, regulations, and action plans – many with ambitious targets and aggressive measures – have proliferated.
- The central government has worked to strengthen policy implementation by covering a large share of implementation costs and by increasing resources for monitoring and enforcement – including an emphasis on inspections – at the local level.
- Local governments continue to face constraints with regard to environmental enforcement, however. There are greater restrictions on borrowing by local governments, reduced local revenue flows as a result of other policies and macroeconomic changes, and declining fiscal support from the central government as China adjusts to a "new normal" of slower overall growth. Against this backdrop, carbon pricing may look increasingly attractive.

Environmental policy has evolved over the past decade in China. Legally binding environmental targets were introduced for the first time only in 2006 in the 11th five-year plan (FYP), but by the following FYP, the targets had multiplied and become more detailed. Since then, the trend has ratcheted further upward under President Xi Jinping, who has embraced environmental progress as a central component of the "China Dream" and who went so far as to declare "war" on air pollution in February 2014. Also in 2014, the United States–China Joint Announcement on Climate Change and Clean Energy Cooperation was signed at the Asia-Pacific Economic Cooperation (APEC) summit with President Obama, enshrining environmental policy as a core part of China's foreign policy agenda (Wong and Karplus 2017).

With environmental protection prioritized by its top leader, laws, regulations, and action plans to support climate goals have proliferated in China. A partial list includes:

- "The ten articles on air pollution" (September 2013), "the ten articles on water pollution management" (April 2015), and "the ten articles on soil management" (May 2016) issued by the State Council;

- An independent system of eco-environmental monitoring (2015);[1]
- The 13th Five-Year Plan for Ecological Environmental Protection (2016);[2]
- The Environmental Tax Law (December 2016);
- The Revised Water Pollution Prevention and Control Law (June 2017);
- The Trial Management Measures for Soil Pollution (2016), and the Trial Management Measures for Farmland Ecology (2017); and
- In March 2018, "ecological civilization (生态文明)" was written into China's constitution.

These measures are typically bold and ambitious, and many of them call for deep cuts in emissions and pollution to be achieved using command-and-control mechanisms that include a mix of mandatory cuts in production, retrofitting equipment, and outright plant closures. To ameliorate implementation costs, the central government has been providing financial support. In 2013, for example, even though more than 90% of environmental measures were undertaken by local governments, fully half the costs were covered by central government transfers. For measures such as investments in renewable energy, more than 70% of costs were borne by the central government (Wong and Karplus 2017).

To combat longstanding weaknesses in policy implementation, especially in monitoring and enforcement at the local levels, reforms over the past six years have focused on building institutions to strengthen the legal framework and monitoring capacity for policy implementation.[3] In addition, the Ministry of Ecology and Environment (MEE) has been given additional staffing and resources, as well as greater authority over local branches. The National Audit Office has been elevated and given broad authority to oversee government activities, including environmental policy implementation. Likewise, the Central Discipline Inspection Commission has been given greater powers to supervise the conduct of local officials in their work for the government as well as in their Party roles.

Inspections have been the hallmark of monitoring efforts in recent years. In July 2015, the Inspection Plan for Environmental Protection was rolled out, with detailed guidelines that called for month-long, nationwide inspections to be conducted on provincial and prefectural governments. The guidelines called for inspections to be led by a high-level group headed by a current or recently retired leader at the provincial level, with a vice-minister-level official from MEE as deputy leader, and with a staff composed of senior officials from the Central Discipline Inspection Commission, the Central Organisation Department, or other units of the central government. The inspections will target not only enterprises but also local party committees and

1 State Council General Office Document No. 56, July 2015.

2 This was followed by the issuance of sectoral five-year plans for urban wastewater treatment and recycling facilities, urban solid waste treatment facilities, nuclear safety and radioactive pollution prevention, etc.

3 For other aspects of institution-building in the Xi Jinping administration, see Wong (2018).

governments, and findings will be sent to the Central Organisation Department, to be used in performance evaluations of cadres.[4]

Irresistible force meets immovable object

China's current approach to environmental protection policy finds local governments caught between the proverbial rock and hard place. On the one side, the effort to build infrastructure to support policy implementation has largely eliminated the situation that Kostka (2016) characterized as "command without control." Environmental policies are now supported by a legal framework that sets out clearly defined standards and assignment of responsibilities. Implementation is aided by inspections that are led by powerful monitors with the authority to impose heavy penalties. Although punishments were mostly light after the first round of nationwide inspections held during 2015–2016, authorities seem to be getting tougher in subsequent years. In the first half of 2018 alone, 72,192 cases of environmental violations led to 16,000 people being prosecuted, and 5.85 billion yuan in fines levied.[5] With the general population mobilized through the inspections regimen to act as watchdogs, environmental complaints will likely proliferate. And compliance is now tightly linked to the personnel management system, with control turned over to Party organs that determine the career paths of civil servants.

On the other side, the economics of environmental protection are little changed. In China's decentralized system, the costs of environmental measures fall largely on local economies, and the intergovernmental fiscal system leaves local governments with large structural deficits and dependent on central government transfers. Promises to radically reform the system to realign revenues and expenditures have not come to fruition.

While central transfers have helped to pay for some pollution abatement and clean-up costs to date, they do little to offset losses of economic output, and associated losses in tax revenue and local jobs, which can be steep given the large adjustments sometimes demanded by strict enforcement of environmental policies. For example, the Air Pollution Action Plan required the province of Hebei to cut its steel and plate glass output by a quarter, and its cement output by nearly half,over a 3–4 year period from 2013 to 2017. For the cuts in steel alone, the city of Tangshan faced losing nearly a fifth of its tax revenues and 7% of jobs in the nonfarm sector (Wong and Karplus 2017). In Chongqing municipality, the loss of a steel mill for reasons of pollution control caused GDP to fall by one-third in the affected district.

In the past, local governments had been allowed to make investments in new sectors to make up for such losses, but these investments required borrowing – a channel that is now restricted under the current campaign to reduce local government debt and clean up shadow banking practices.

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4 To underscore the use of Party discipline to hold local officials (and hence local governments) in line, the State Council issued a document stating that the responsibility for environmental policy implementation rests with Party and government officials.

5 "Are penalties 'biting' the offenders? Environmental protection fines totalled 5.85 billion yuan with 16 thousand people prosecuted in the first half of 2018." *New Capital Daily*. August 17, 2018. http://www.bjnews.com.cn/graphic/2018/08/17/499981.html. Accessed November 15, 2019.

As China has exited its "miracle growth" period, the "new normal" of mid-single-digit growth will reduce the government's capacity to provide growing fiscal support for environmental policy. This is already evidenced by a relatively reduced flow of transfers from the central government. In 2018, combined own expenditure and transfers from the central government financed only 43% of environmental protection measures in the budget, down from more than 52% in 2013.

At the same time, local governments are facing a significant deterioration in their own fiscal status as a result of multiple hits on their revenue flows over the past 2–3 years for reasons that include slowing economic growth, a slowing housing market and tepid land sales, and a series of uncompensated/partially compensated tax and fee cuts that have been introduced to stimulate the economy. In this tightening macro-financial environment, and facing unrelenting pressure to meet climate-change mandates, carbon pricing is looking like an increasingly attractive choice.

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EMISSIONS-TRADING SYSTEMS IN CHINA: SUBNATIONAL AND NATIONAL

—Lessons for National Policy Design from the Pilots

Have China's Emissions Trading Pilots Been Effective? A Multi-Dimensional Post-Assessment

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Key Points

- A multi-dimensional, empirical assessment of the results of China's seven pilot emissions-trading systems (ETSs) is important to inform the design of a national ETS.
- Results from such an assessment indicate that the ETS pilots had a significant effect on carbon emissions, carbon intensity, per capita emissions, and energy structure in the covered regions and industries. The more energy-intensive the industry, the larger the effect. The pilots also reduced revenues in energy-intensive industries, but had no significant effect on employment or return on assets (ROA) in these industries.
- Allowance allocation based on benchmarking rather than grandfathering and historical carbon intensity method resulted in larger emissions and carbon-intensity reductions among covered industries, while grandfathering and historical carbon intensity method increased ROA for affected industries.

At the end of 2011, China's national government designated five cities (Beijing, Shanghai, Tianjin, Chongqing, and Shenzhen) and two provinces (Guangdong and Hubei) as jurisdictions that would pilot emissions-trading systems (ETSs). After two years preparing institutions and measurement, reporting, and verification (MRV) tools, the seven ETS pilots started emissions trading and compliance activities in 2013 and 2014. Over the last six to seven compliance years, there has been research and pre-assessment about the effects of the ETS pilot policy in China. However, there have been few multi-dimensional post-assessments of the policy using empirical, econometric regression analysis.

China is now preparing to launch a national ETS based on experience with these pilots. Thus, some post-assessment of the effect of the ETS pilots is needed to support the design of a national trading system. Using an econometric regression analysis at the provincial and sector level, we attempt to determine whether the ETS pilots actually reduced energy consumption and carbon emissions, increased energy efficiency, and prompted restructuring in the energy sector. We also try to address the government's concerns about whether emissions trading influenced employment and returns on the assets of covered industries. Finally, we compare the success of ETS implementation in the different pilot regions and assess which allowance allocation methods were more effective.

Considering the ETS pilot regions in general, our findings are as follows:

1. China's ETS pilots significantly reduced CO_2 emissions and carbon intensity. They also achieved reductions in total energy consumption and structural changes in the energy sector.

2. From 2012 to 2016, with progress in implementing the pilots and improvements in emission-trading mechanisms, as well as program expansion to cover more sectors, the effects of the ETS pilots grew stronger.

3. When the ETS pilots were first implemented in 2013, their impacts on the energy sector were not significant. Since 2015, however, these impacts have become more significant, and the longer the pilots are in place, the stronger the effect they are having.

4. Beijing's ETS pilot was clearly the most effective in producing reductions in energy consumption and carbon emissions, increasing efficiency, and prompting structural changes. Hubei's ETS pilot also achieved outstanding results in terms of carbon and carbon intensity reductions, as well as lower energy consumption. Results from the Shanghai ETS were also impressive in terms of energy and industry structure.

Looking at the industries that were covered by the ETS pilots, we find that:

1. Emissions trading resulted in carbon and carbon-intensity reductions in energy-intensive industries. The more energy-intensive the covered industry, the greater the resulting reductions in CO_2 emissions, per-capita CO_2 emissions, CO_2 intensity, and total energy consumption, as well as energy intensity.

2. The ETS pilots had no significant effect on the energy structure of covered industries.

3. The ETS pilots reduced the revenues of energy-intensive industries but had no significant effect on employment and return on assets (ROA) in those industries.

4. Reductions in CO_2 emissions, CO_2 intensity, energy consumption, and energy intensity were not significant in 2012, before trading began under the ETS pilots. Significant reductions began to be seen in and after 2013, when trading got underway. This confirms the finding that reductions occurred in response to trading under the ETS pilots.

5. Concerning the allowance allocation method used, covered industries that received allowances based on a benchmarking method made a larger contribution to total CO_2 reductions, per capita CO_2 reductions, and CO_2 intensity reductions compared to industries that received grandfathered allowances.

> The same result was seen in terms of energy structure and employment, as well as per capita energy consumption. However, allowance allocation based on a grandfathering or historical carbon intensity method (instead of benchmarking) resulted in increased ROA for covered industries.

These results indicate that while there were some differences between different ETS pilot regions and industry coverage, the pilots achieved significant results in terms of reducing energy consumption and carbon emissions, while also increasing efficiency and causing structural improvements. There was no significant negative influence on employment and ROA in industries covered by the ETS pilots.

Experience with this pilot policy provides a strong signal that the benefits from emissions trading more than exceed any losses from trading. A national ETS can help China realize its nationally determined contribution (NDC) under the Paris Agreement and bring about needed transformation in the country's energy sector. China's national government should pay more attention to the successful experiences, lessons learned, and key differences that emerged in the ETS pilots to inform the design of national policy and speed up the development of a national ETS.

Preliminary Considerations for Carbon-Pricing Policy Based on Experience with Hubei Province's Carbon Market

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Key Points

- The level and stability of the carbon price is an important consideration in the design of carbon markets.
- In developing its own carbon market, Hubei Province took several steps to establish an effective carbon-price mechanism, including setting a base allowance price, promoting market stability through greater investor participation, and allowance "put in" (auctioning) and "buy back" provisions.
- Hubei offers some lessons based on experience for the construction of carbon markets, including the need for tight control of allowance allocations and diversified investor demand, and the importance of information disclosure and policy continuity.

A carbon price plays a decisive role in the allocation of resources in a carbon market. The level of the carbon price will directly incentivize enterprises to reduce emissions and ultimately reduce emissions in aggregate. As part of the process of developing a carbon market, Hubei Province took several steps to establish an effective carbon-price mechanism:

1. **Determination of the base price.** Based on specialized research, including research into enterprises, markets, and experience from other pilot carbon markets, Hubei set the initial price for its carbon market at 20 yuan per unit of carbon allowance.
2. **Initial auction.** Before the formal start of carbon trading, Hubei Province auctioned two million tons of carbon allowances subject to a price minimum (or "floor") of 20 yuan/ton. The auction helped build liquidity in the carbon market and facilitated preliminary discovery of the market price for carbon.
3. **Allowance trading and measures to promote market stability.** Once trading got underway, Hubei Province took steps to ensure that the market would form a stable carbon price. These included measures to reduce the cost of entering the market, expand the scope of market subjects, introduce trading institutions and investors, actively guide the enterprises that were involved in market transactions, improve market transparency and liquidity, and provide a fair and open environment for allowance transactions. These measures helped the market maintain a stable carbon price that ranged from a minimum of 10 yuan per ton to a maximum of 57 yuan per ton over a five-year span.

4. **“Put in” and “buy back” provisions.** To prevent abnormal fluctuations in the carbon price, Hubei Province formulated measures for managing the “put in” and “buy back” of emissions allowances. These measures will be used to cope with over or under pricing in the carbon market, to help reduce market risks, and improve market stability.

The experience of Hubei Province suggests that carbon market construction should pay close attention to carbon pricing by formulating relevant countermeasures to improve market performance and promote price stability.

First of all, **allowance allocation should be moderately tight.** Experiences from pilot areas can be learned to avoid over-allocation which lead to allowance surplus. For example, in order to prevent allowance accumulation, the amount of cross-year retention allowances can be deducted in the next year’s distribution through market adjustment factors, and a valid period can be set for free distributed and untraded allowances. The government can also establish other market adjustment mechanisms to control excess allowances and price risks caused by economic downturns (for example, through buyback provisions if the allowance price falls below a certain threshold).

A second lesson is the need **to establish diversified demand for investment in allowances**. Investors are an important source of demand in a carbon market and play an important role in market liquidity and price discovery. Therefore, it is necessary to diversify investment demand for allowances by lowering the entry threshold for institutions and individuals, expanding the number of investors, attracting the participation of professional financial institutions to the market. Efforts also should be made to support the development of a market-maker system, promote financial innovations such as carbon-assets custody, advance voluntary carbon offsets, expand market demand, and gradually expand the scope of inclusion and increase the number of compliance enterprises over time.

Thirdly, **governments should establish information disclosure systems.** Information related to carbon market supply and demand should be transparent and made publicly available in a timely manner to ensure full and open market competition and to create a healthy trading environment. The competent authority should strengthen the management of carbon-emissions exchanges, improving their management abilities and service quality. Governments are also suggested to establish a risk control system, to prevent price manipulation and other anti-competitive behaviors and ensure an orderly trading market.

A last important step is **maintaining policy continuity**. Once a policy is established, government requires continuous implementation. It is beneficial for enterprises and institutions to form a stable medium and long-term expectations for the carbon market. This in turn will help them to make management- or financial-level arrangements on emissions reduction in the long run.

Guangdong's Emissions-Reduction Progress and Innovative Policy Measures

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Key Points

- Guangdong Province faces challenges in reducing its carbon emissions, due to uneven levels of economic development across different areas of the province, limited potential for further energy savings, and insufficient non-fossil energy resources.
- Guangdong has been taking innovative steps to reduce provincial carbon emissions, including a carbon market, the "Tanpuhui" mechanism (an incentive mechanism to promote public emissions reduction), the zero-carbon demonstration zone, and the Carbon Capture Use and Storage (CCUS) Center.
- Guangdong's emissions-trading system (ETS) is, on the one hand, regulated strictly, according to clear and specific provisions. On the other hand, having been so regulated, it operates relatively independently of government intervention. Guangdong's ETS is also characterized by well-ordered management, active trading, and effectiveness in reducing emissions.
- Guangdong will continue to improve its ETS until the central government decides to shut down local trading systems in favor of a national carbon market.

Guangdong Province is facing challenges in reducing its carbon emissions. With a GDP that reached nearly 10 trillion yuan (around US$1.4 trillion) in 2018, Guangdong has led all other Chinese provinces in economic output for 30 consecutive years. However, different areas and cities in Guangdong are at very different stages of economic development. The Pearl River Delta, which accounts for only 23% of the geographic area of the province, currently accounts for 80% of its GDP. Thus, Guangdong Province needs to take into account the different economic status of its respective regions when formulating emissions-reduction strategies. However, coordinating emissions-reduction measures with different economic conditions is very difficult.

In addition, despite industrial sectors that account for 41.8% of its overall economic output, Guangdong's energy consumption per unit of GDP is still the second lowest in China, behind only the city of Beijing, with its largely service-based economy. With this in mind, Guangdong has already achieved an advanced level of energy efficiency relative to other parts of China.

Nonetheless, the central government has tasked Guangdong with the most stringent energy-saving and emissions-reduction targets of any of the provinces. During the 13th Five-Year Period, Guangdong is expected to reduce its energy consumption per unit of GDP by 17%, and its carbon emissions per unit of GDP by 20.5%. Meanwhile, due to insufficient local non-fossil energy resources, Guangdong's energy structure has limited potential for further decarbonization.

Despite these challenges, Guangdong has been taking a series of innovative actions to reduce carbon emissions at the provincial level. For example, Guangdong established its own emissions-trading system (ETS), which is the largest in China and the third largest in the world (after the ETSs of the European Union and South Korea). Guangdong also extended the concept of carbon trading to practices of low-carbon society and low-carbon consumption, and invented the "Tanpuhui" mechanism to incentivize low-carbon behaviors. To promote Tanpuhui, Guangdong selected six cities for pilot programs that focus on various aspects of residents' life, including waste, gas and electricity use, low-carbon transportation, forestry carbon sinks, and low-carbon products. In addition, Guangdong is exploring the potential to develop zero-carbon demonstration zones in five areas, including the county of Nan'ao and the town of Wanshan, etc. In the meantime, Guangdong has established the Sino-UK (Guangdong) Carbon Capture Use and Storage (CCUS) Center, and set up a carbon-capture test platform at the China Resources Haifeng Power Plant. These innovative measures have produced satisfactory results.

As the main mechanism for reducing provincial emissions, the Guangdong ETS covers six industries and approximately 65% of the province's total emissions. After six compliance years, the Guangdong ETS has achieved remarkable results: First, the emissions market is becoming more active as measured by transactions and prices. Between 2017 and 2018, the price of allowances increased by 60%, and the volume of transactions increased by 164%. Second, awareness of carbon asset management among enterprises has apparently improved, as indicated by the fact that the concentration of transactions just ahead of the compliance date has tended to decline. Third, the market is having an obvious effect on emissions reductions. More than 80% of covered enterprises have achieved a reduction in carbon emissions per unit of product, and 85% of covered enterprises have implemented emissions-reduction measures.

The Guangdong's ETS has, on the one hand, been regulated strictly, according to clear and specific provisions. On the other hand, having been so regulated, it operates relatively independently of government intervention. The Guangdong ETS also has several other distinct characteristics, including: considerable attention from the Guangdong provincial government, combining paid and free allowance-allocation methods in order to raise awareness of the paid use of natural resources, guiding covered enterprises to reduce their CO_2 emissions in a flexible and marketized way and gradually tightening the provincial emissions-reduction goal, and introducing auctioning as a means to actively explore market-based allocation methods. To sum up, the main reason for the system's success to date is its stable, well-ordered, and effective management and emissions-reduction mechanism, which has given both market participants and the provincial government solid confidence in the market's prospects.

Due to the Institutional Reform in China in 2018, the function of "tackling climate change" has been handed over from the Guangdong Development and Reform Commission (GDDRC) to the Department of Ecology and Environment of Guangdong (GDDEE). As a result of this transition, the Guangdong ETS has faced a series of challenges. For instance, carbon-market capacity building needs to be built up again for staff from GDDEE, so as to familiarize them with relevant work. In addition, it takes time to complete the integration of the carbon-trading mechanism into the administration system of GDDEE. In spite of all these challenges, GDDEE has speeded up capacity building and mechanism integration and ensured that compliance with the Guangdong ETS was completed on time, with a high compliance rate in 2019.

As a next step, Guangdong will continue to implement and improve its ETS before the central government terminates local ETSs and will fully cooperate with the central government in constructing a national ETS based on beneficial experience gathered from the Guangdong ETS.

EMISSIONS-TRADING SYSTEMS IN CHINA: SUBNATIONAL AND NATIONAL

—The Fate of the Pilot ETSs under a National Pricing System

Coexistence or Obsolescence? The Fate of China's Emissions-Trading Pilots Under a National System

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Key Points

- As China proceeds to establish a national emissions-trading system (ETS) for CO_2, the fate of the country's seven subnational pilot ETSs, which have been in operation since 2013, remains an open question.
- Going forward, the three main options are (1) coexistence, that is, maintaining separate subnational trading systems alongside the national system; (2) partial integration, which would mean allowing credits from one system to be used in other systems; and (3) full integration, which would involve subsuming the seven subnational pilots under a single national ETS.
- Each option presents tradeoffs. Full integration would probably be most economically efficient but there are several challenges: Local governments would have to relinquish control; in the near term, some local emissions sources would no longer be covered because the national ETS will initially be limited to the power sector; and full integration requires unified rules and a clear transition plan.
- In light of these challenges, attention should be directed toward strengthening and harmonizing guidelines for measurement, reporting, and verification (MRV) in all existing systems and to pursuing opportunities for greater mitigation ambition in the subnational systems, which can serve as a training ground for firms that will eventually be included in the national ETS.

China has piloted emissions trading for CO_2 at a subnational level since 2013. These systems, originally established in two provinces (Guangdong and Hubei) and five municipalities (Beijing, Chongqing, Shanghai, Shenzhen, and Tianjin), have outlasted their initial compliance horizons and in some cases have been expanded to include more firms. Together, the seven pilots account for around 3% of global CO_2 emissions and fully 20% of CO_2 emissions subject to pricing. Additional provincial systems were established by Fujian (in 2016) and Sichuan (in 2017).

Pilots are credited with educating firm managers on CO_2 accounting (Zhang *et al*. 2019) and incentivizing energy efficiency (Zhang and Karplus 2017), even as their effect on total CO_2 emissions remains debated (Chen and Xu 2018; Wang *et al*. 2019). With a national emissions trading system (ETS) on the horizon, the fate of the seven pilots remains an open question. This brief lays out the potential paths forward and associated tradeoffs, which largely involve weighing the relative economic efficiency of a single, unified system against the practical challenges of evolving existing, especially local, institutions.

The seven pilots

The diversity of the seven ETS pilots presents challenges for their integration into a single national system. Local governments were deliberately granted the flexibility to customize pilot designs to unique circumstances and needs. One goal of setting up pilots in diverse settings across China was to learn about how different designs worked and to gain lessons for establishing a national system. The main features of the original seven pilots are summarized in Table 1. The pilots differ in the number of firms and sectors each covers, with implications for total emissions coverage. The composition of firms included in each pilot reflects local economic structure. For instance, the Hubei pilot includes fewer larger, more energy-intensive firms that use primary energy directly, while the Beijing and Shenzhen pilots have a much larger share of smaller, service-sector enterprises that primarily use electricity. Within each jurisdiction, the legal basis; cutoff for program inclusion; stringency of measurement, reporting, and verification (MRV) requirements; and penalties for non-compliance differ widely (Zhang *et al*. 2014).

Table 1. Design features of the original seven subnational pilot emissions trading systems in China

City or province	Launch year	Share of local GHG emissions	CO_2 price (Euro/ton CO_2)	Number of companies	CO_2 emissions cap (mt/yr)
Beijing	2013	40%	7	490	70
Chongqing	2014	40%	3	242	100
Guangdong	2013	60%	2	202	350
Hubei	2014	35%	2	138	120
Shanghai	2013	57%	3	191	510
Shenzhen	2013	40%	4	635	30
Tianjin	2013	55%	2	114	150

Source: CarbonBrief (2018) and Chen and Xu (2018). Prices are mean values between March 2016 and March 2017.

There is very limited information, and even more limited consensus, on the impact that the ETS pilots have had on CO_2 emissions (Chen and Xu 2018; Wang *et al*. 2019). Part of the difficulty has been the large number of overlapping policies, for instance, to control air pollution, subsidize renewable energy, promote energy efficiency, and accelerate urbanization, which have affected energy production and use in ways that may have made compliance with overall ETS targets much easier.

Challenges in integrating the seven pilots into a single national system

In principle, subsuming the seven pilots under a single national system incentivizes cost-effective emission reductions while keeping administrative redundancy and associated costs to a minimum. In practice, however, integration poses several challenges. First, local governments have hesitated to relinquish control or cancel their programs. Prevailing norms of central-local interaction grant localities substantial autonomy to advance initiatives that are consistent with central government targets and goals, which include local CO_2 intensity targets. These targets are disaggregated at the industry and even firm level, and do not yet account for reductions achieved through trading.

Second, overlap between the emerging national system and existing provincial systems will initially be limited, thus substituting the former for the latter would reduce coverage in some industries. The national system is expected to launch with coverage of the electricity sector only and expand to include cement and aluminum smelting and eventually other energy-intensive industries subsequently. The time frame for expansion is not yet clear. Provincial systems include firms in a greater variety of industries, which would no longer be covered if provincial systems are cancelled.

Third, an integrated system will still need to rely on the local cadre evaluation system to incentivize implementation. Local officials and firms are evaluated based on targets, including environmental targets, which measure achievements within their administrative boundary. The additional complexity of accounting for purchased and sold CO_2 market credits, potentially according to a new set of MRV guidelines, may lead to the mistaken impression that a firm or locality has not complied. Moreover, even once the CO_2 market is unified, there will be local policies and targets that directly or indirectly affect CO_2 emissions, which may distort market operation and undermine gains in cost effectiveness.

Possible paths forward for the pilot systems

There are essentially three paths forward: one of separate, coexisting systems; one of partial integration; and one of full integration. Coexistence has two downsides. Marginal abatement costs will differ across systems, leading to different CO_2 prices. While to some extent these differences may be mitigated via integrated downstream markets in some industries, for other industries there will be excess emissions reductions in high-abatement-cost industries while some low-cost opportunities are foregone. Over time, some firms may transition between systems, which will require clarifying the process for transitioning.

Partial integration is perhaps the least attractive of the three options. "Hot air" (that is, allowances allocated in excess of likely actual emissions) generated in provincial systems could "leak" into the national system if MRV standards are weak or uneven in the former. Meanwhile, partial integration introduces a coordination problem when moving to more stringent targets, analogous to that of overlapping state and federal fuel economy policies in the United States For instance, a national system could undermine provincial ambition by ensuring that additional reductions can be offset by buyers in provinces bound by only the less-stringent national system.

Full integration is perhaps the most economically attractive, as discussed above, but requires resolve at the national level to establish unified rules and a trading architecture. It is unlikely that this fusion can be accomplished for multiple sectors simultaneously, especially in the near term. While it may be most feasible to move electricity producers from a local system to the national

ETS without undermining firms in other industries that are participating in local systems, this will be more difficult as more industries are included in the national ETS. A clear transition plan will be needed. The reallocation of responsibility for managing CO_2 from the National Development and Reform Commission to the Ministry of Economy and Environment in 2018 has generated some uncertainty about the timing and leadership of national ETS development. One downside of national integration is that it leaves provinces without a mechanism for expanding coverage and mitigation ambition within their own borders, which will always be beneficial given that the national ETS is expected to cover only the largest emitters.

Given the challenges of overlapping policies and administrative costs, the gains from moving from existing subnational pilots to a single national system will likely be hard to measure empirically. They are also likely to be relatively modest at the outset, when only electricity is part of the national system. Therefore, attention should be directed toward strengthening and harmonizing guidelines for MRV for all existing systems in operation, and to pursuing opportunities for greater ambition – in terms of both coverage and emissions reductions – when feasible. Subnational systems would thus serve as a training ground for firms that will be included in an expanded national system in the long run.

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EMISSIONS-TRADING SYSTEMS IN CHINA: SUBNATIONAL AND NATIONAL

—Designing and Implementing China's National ETS

Challenges for China's National ETS

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Key Points

- China's national emissions-trading system (ETS) is likely to face significant challenges, due to its complexity, large scale, and China's socioeconomic and political realities.
- The national ETS needs to be able cope with increasing market volatility, as China's economy undergoes a structural transition from manufacturing to services.
- Market-oriented reforms in energy sectors and state-owned enterprises are needed to create a supportive institutional environment for the ETS.

China's national carbon emissions-trading system (ETS) is expected to become the world's largest carbon market and is critical for achieving China's domestic climate-change mitigation goals. But China's program is likely to face significant challenges, due to its complexity and large scale. While some of these challenges – such as emissions accounting, allowance allocation, and market volatility – are common to ETSs around the world, others are unique to China, due to its particular socioeconomic and political realities. Therefore, some researchers have argued that China's ETS needs to incorporate features that differ from other major ETSs around the world, such as those in the European Union and California, in order to cope with the country's specific conditions. We identify three issues that we regard as the most critical challenges and provide corresponding policy recommendations.

First, an ETS is a highly complex, government-created market for carbon emissions that requires reliable emissions data, clearly defined market rules, and strict enforcement, all of which demand advanced institutional capacity. In particular, accurate facility-level emissions data is a prerequisite for allowance transactions and compliance. But the accuracy and credibility of China's emissions data have been widely criticized. There are significant inconsistencies between national and provincial emissions inventories, and the facility-level data are even less reliable.

Important reasons for this weak data foundation are inadequate institutional capacity and lack of legal support. Current ETS pilot programs are managed by relatively lower-ranked government agencies, which lack sufficient authority and are understaffed for market design and management. Most of the pilots are not backed by legislation passed in the national or provincial People's Congress, but by ad-hoc government guidelines. As a result, program managers have found it difficult to mandate that firms report their actual emissions, and firms have found the

1 This policy brief is adapted from Pu Wang, *et al*. 2019. "Key Challenges for China's Carbon Emissions Trading Program." *Wiley Interdisciplinary Reviews: Climate Change*. June 7. https://onlinelibrary.wiley.com/doi/full/10.1002/wcc.599.

cost of violation is usually lower than the cost of compliance. Therefore, to make the national program work, institutional capacity related to the carbon market needs to be significantly enhanced at all levels, from the central government to the local level.

Second, compared to ETSs in other parts of the world, China's program is likely to face greater market volatility, due to structural changes in the economy, which is transitioning from manufacturing to services. International experience has shown that changes in market conditions can cause significant volatility in carbon markets. In California, the northeastern United States, and the European Union, heavy industry accounts for a small portion of the economy, while emissions from residential, commercial, and transportation sectors are relatively stable. Even so, after the 2009 financial crisis, carbon prices in these regions' respective ETSs (California ETS, Regional Greenhouse Gas Initiative, and EU-ETS) fell sharply, and markets almost collapsed.

China's steel, cement, and other high-emissions industries have been significantly affected by economic fluctuations in recent years, so demand for allowances will likely be very volatile. In addition, in the context of economic restructuring, some heavy industries could receive too many allowances as they decline, which could turn the ETS into a form of subsidy to these industries and obstruct China's low-carbon transition. Thus, drastic and uncertain changes in China's economy will significantly complicate the design and management of the program.

Third, emissions trading is a market-based policy tool, which is most effective when there are well-functioning market mechanisms. But China has a market economy with many remaining features of a central-planning system. In particular, state-owned enterprises (SOEs), many of which evolved from former central-government agencies, have near-monopolistic control over energy supply and a strong influence on national policy making. Since the SOEs do not act as conventional profit-maximizing entities, their behavior could undermine the efficiency of the ETS.

China's electricity market, in particular, is highly regulated, with generation quotas and prices that are determined by the government. Thus, the electricity sector, the largest emissions source, is unlikely to respond in a timely way to changing carbon prices. In fact, the "test run" of the national ETS, which covers only the electricity sector, will largely amount to a tradable-performance-standard system.

One of the distinctive features of China's ETS pilots is that they cover both direct emissions, such as emissions from power plants, and indirect emissions, such as emissions embodied in the consumption of heat and electricity, in order to address the issue of fixed electricity prices. But this method results in double counting for some emission sources and could distort the price signal. There is hope that market-oriented reforms will be introduced in the power sector so that the national ETS no longer needs to cover indirect emissions, but the likelihood of this occurring is small in the near future. To ensure the effectiveness of the ETS, China will need to deepen its market-oriented reforms for SOEs, particularly in the energy and electricity sectors.

To tackle the above challenges, we offer several policy recommendations. First, institutional capacity needs to be significantly enhanced from the central government to the local level. The national ETS needs to be managed and coordinated in high-level government agencies and be backed by national legislation. In contrast to an ordinary environmental regulation that affects only a small fraction of the economy, an ETS will have significant economy-wide effects. Therefore, the State Council needs to give carbon market managers enough authority to coordinate multiple ministries and provinces and develop a high-level regulatory system. Current ad-hoc government guidelines are not sufficient to ensure implementation and enforcement of the program, so formal climate-change laws need to be passed by the National People's Congress to provide firm legal support. Financial and human resources should be provided to establish facility-level emissions databases; reliable methodologies for measuring, reporting, and verification (MRV); and training programs for large numbers of professional practitioners in supervision, trade, and third-party verification.

Second, profound structural change in China's economy creates significant uncertainties regarding carbon emissions from various industrial sectors, which means the ETS has to be robust enough to cope with changing economic realities. In this context, the choice of methods for allocating emissions allowances becomes critical. Studies have shown that auctioning is the best way to distribute allowances to the firms that need them most and to set the right economic incentives for emissions reduction. But auctions impose high initial costs on emitters and could encounter significant political resistance. Therefore, in practice, ETSs usually auction just 5%–10% of allowances initially and give out most allowances free of charge. If China distributes free allowances to firms based on their historical emissions, heavy industries with declining output will get an excessive allocation of allowances that they can sell for a profit. Thus, to the extent possible, technology-based benchmarking, or a frequently-updated output-based method, should be used as the basis for allocation so that the process reflects changing economic conditions. A high degree of uncertainty also means that certain price-containment mechanisms need to be put into place to maintain stability in carbon markets. A price ceiling, at which the government releases more allowances, and a price floor, at which the government buys back allowances, should be considered in China's program.

And last, deep reforms are needed in China's energy sectors and SOEs to create a favorable market environment. Otherwise, non-market factors in the Chinese economy, particularly generation quotas and fixed prices in the electricity sector, and the market power of SOEs, could greatly undermine the effectiveness of the ETS. Currently, both the ETS itself and electricity-market reform are highlights of a national effort to "deepen comprehensive reforms" and "let the market play a fundamental role in resource allocation." It is important that the two initiatives are pushed forward simultaneously. Electricity generation quotas need to be replaced by a competitive wholesale market, and electricity prices need to be determined by the market, so that carbon prices can be reflected in a timely manner in electricity prices. The management of SOEs also needs to change to create a fair competitive market for both SOEs and privately-owned enterprises.

Assessing Regional Implementation Pathways Toward a Nationwide Emissions-Trading System in China

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Key Points

- The seven pilot emissions-trading systems (ETSs) launched in China in preparation for a nationwide ETS have not produced significant changes in industrial structure or emissions intensity, perhaps because they were designed with loose caps to ensure market stability and focus on gaining experience.
- Modeling studies find that different ETS designs have different impacts in terms of the "pollution-haven" effect (i.e., companies' incentive to relocate to areas with less stringent environmental regulation) and in terms of emissions reductions, economic losses, and welfare effects.
- To inform the design of an efficient nationwide ETS for China, the author uses a computable general equilibrium (CGE) model to study regional impacts under different trading scenarios. The results show that allowance trading significantly reduces economic and welfare losses from a carbon constraint.
- Further, an emissions-based allowance allocation produces fewer economic losses and distortions than an output-based allocation, which effectively functions as a production subsidy. A welfare-based allocation produces the largest income transfers between regions. Emissions trading with allowance auctioning minimizes the pollution haven effect.

Before establishing a nationwide emissions-trading system (ETS) for carbon dioxide (CO_2) emissions, China launched pilot ETSs in seven cities and provinces beginning in 2013. Intuitively, one would expect ETS implementation to cause significant declines in CO_2 intensity and share of national CO_2 emissions in the seven pilot areas. However, there have been no significant changes in industrial structure or differences in energy intensity between the pilot and non-pilot areas. Considering the loose emission-allowance budgets for these pilots, policymakers may have been more concerned with ensuring market stability and gaining relevant experience with ETS operation than they were with the exact impact on emissions in the pilot cities.

To research the effects of emissions trading, many scholars adopt a "difference-in-difference" approach to evaluate ETS treatment effects. Zhang *et al*. (2017) and Wang *et al*. (2019) find that the ETS pilots effectively reduced carbon emissions, while Fan *et al*. (2017) find support for the "weak Porter hypothesis" – i.e., that stricter environmental regulation stimulates innovation. Specifically, Fan *et al*. find that the ETSs did not improve the total factor productivity of pilot areas, but they did significantly improve technology.

Scholars have also simulated the impact of emissions trading, most commonly using computable general equilibrium (CGE) methods. Tang *et al*. (2016) build an inter-regional dynamic CGE (IRD-CGE) model to simulate the impact of an ETS. Their results show that an ETS can mitigate the "pollution-haven" effect – that is, companies choosing to relocate to areas with less stringent environmental regulation to reduce their costs. The pollution-haven effect can be further mitigated by using an auction mechanism to allocate emissions allowances. Qian *et al*. (2018) simulate the impact of the ETS under different sector-coverage scenarios and show that the emissions-intensity scenario can achieve the largest emissions reductions, while the policy-equivalence scenario is best in terms of economic and welfare effects. All scenarios analyzed by Qian *et al*. (2018) show that partial coverage will not lead to significant inter-sectoral carbon leakage in the current construction of the national ETS.

To construct an efficient nationwide ETS, we used a CGE model to assess regional impacts under different trading scenarios. The model includes 30 regions, 42 industries, and two agents: households and regional governments. Households provide capital and labor; a third factor, the "carbon emission permit," is owned by the government. The model is calibrated using regional input-output data for the 2007 base year, and is solved recursively to 2020. It treats China as a "small economy" in international trade and as a "large economy" in domestic trade.

We model two scenarios: a "NULL" scenario, in which climate and energy policies are not being implemented yet, and a "business-as-usual" (BAU) scenario. In the BAU scenario, the emissions-reduction target changes over time: from 2005 to 2010, the target is set according to the Notice on the Completion of the 11th Fifth-Year Plan's Regional Energy Conservation Targets; from 2010 to 2015, the target is set based on the government's proposed work program for controlling greenhouse-gas emissions in the 12th Fifth-Year Plan; and from 2015 to 2020, the target is set according to China's Copenhagen commitment.

Using the model, we assess economic costs, regional effects, and industrial effects. Our results show a 0.28% reduction in yearly average GDP growth in the BAU scenario compared with the NULL scenario. They also show a nonlinear correlation between economic costs and emissions vs. emissions-*intensity* reduction targets. From a regional perspective, the more energy-intensive and industrialized regions of China (the "mid/northern" regions) are most affected; less energy-intensive regions (the eastern coastal and southern regions) are less sensitive. In addition, structural changes are not significant because emissions-intensity constraints allow manufacturers to achieve policy targets by expanding production – in effect, the intensity-based approach actually provides a production subsidy.

As shown in table 1, we define six different policy scenarios based on emissions-reduction targets under the BAU scenario: S3, S4, S5, S6, S7, S8.

Table 1: Policy Scenarios

	CODE	TARGETS	ALLOCATION	FLEXIBILITY
S3	EM_NT	Total Emission Constraint (Set According to BAU)	Regional Emissions in Base-year	Non-tradable
S4	EM_T			Tradable
S5	OPT_NT		Regional Output in Base-year	Non-tradable
S6	OPT_T			Tradable
S7	WLF_NT		Regional Welfare in Base-year	Non-tradable
S8	WLF_T			Tradable

Our simulation results show that if emissions allowances are not tradeable, then there is no guarantee that an allocation exists that satisfies both efficiency and equity objectives. Compared with the NULL scenario, we find a GDP loss of 3.85% in the WLF_NT (welfare-based allocation, no trading) scenario in 2020, and 2.78% loss in the EM_NT (emissions-based allocation, no trading scenario) scenario. Social welfare losses in these two scenarios (WLF_NT and EM_NT) are 4.17% and 2.99%, respectively. However, these losses decline in any allocation system if allowances are tradable. Because the trading mechanism decouples the economic efficiency of the emissions-reduction policy from other factors, the government can adjust regional welfare levels by adjusting the initial distribution of emissions rights and promote regional equity without seriously impacting overall economic output levels, thereby avoiding additional economic and welfare losses.

With respect to welfare reallocation effects, an emissions-based allowance allocation produces the least distortion and lowest economic losses in a non-trading scenario: in this case, income would transfer from industrialized to industrializing areas. An output-based allocation produces the opposite effect: income transfers from industrializing to industrialized areas. The welfare-based allocation produces the highest distortion in non-trading scenarios, with income transfer from southern to mid- and northern areas. We also find that without any policy intervention, the pollution haven effect in western-northern China will be intensified under a stringent emissions-reduction policy. Emissions-intensity targets can further strengthen the pollution haven effect in this region, whereas emissions trading using auction-based allowance allocation can reduce the relocation of energy-intensive sectors to other regions.

A number of remaining issues should also be considered in ETS implementation. First and foremost is the issue of co-benefits, which could create uncertainties about the factors incentivizing the national ETS. Since environmental pollution control can bring about obvious health benefits and less externalities of welfare gain, regional government may prefer to prioritize tackling environmental pollution by emphasizing its co-benefits of carbon-emissions reduction. Concerning income disparity across regions and the consumption mode of energy service, and the different choice of firm and government, there would be regional disparity of co-benefits of climate policies. In addition, mandatory standards, direct subsidies to specific sectors, and other relevant policies that might interact with a national ETS are also important issues to consider, given uncertainties about the effects of ETS implementation.

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Accelerating the Establishment of China's National ETS

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Key Points

- Emissions trading has been an important part of China's efforts to address climate change since 2011, when seven cities and provinces were selected to host pilot-emissions-trading systems.
- This brief offers ten recommendations for next steps to build an effective national carbon market in China.
- It is suggested that China needs to advance international cooperation on carbon-pricing mechanisms, to be consistent with the "Green Belt and Road" initiative as well as to promote low-carbon transitions in other countries.

Emissions trading has been an important part of China's efforts to address climate change. As early as 2011, seven provinces and cities, including Beijing, Shanghai, Tianjin, Guangdong, Shenzhen, Hubei, and Chongqing were selected to launch pilot carbon-emission-trading systems (ETSs) aimed at gaining experience to support the establishment of a national carbon market. In December 2017, the Chinese government released its "National Carbon Emission Trading Market Establishment Working Plan (Power Sector)," marking the launch of a national ETS.

In 2018, the Climate Change Department was moved from the National Development and Reform Commission to the Ministry of Ecology and Environment (MEE) as part of a government reform effort. MEE's traditional enforcement functions will provide a more solid foundation for the national ETS, and work accelerated in 2019, not only to develop a legal framework but also to construct the infrastructure for ETS implementation.

To build an effective carbon market in China, this brief offers ten recommendations for next steps:

1. Establish a well-functioning legal system for China's national ETS

In March 2019, MEE solicited public opinions on its "Interim Regulations on the Management of Carbon Emissions Trading (Draft for Comment)[1]," which provide the legal basis for China's national ETS. The interim regulations should be improved and promulgated as soon as possible. Meanwhile, other necessary management measures that should be promulgated include "Management Measures for Reporting Greenhouse Gas (GHG) Emissions of Key Emitting Entities," "Management Measures for Market Transactions," and "Management Measures for Verification Agencies."

1 http://fgs.mee.gov.cn/yfxzyfzzfjs/201904/t20190403_698483.shtml

2. Enhance the top-level design of China's national ETS

At the policy making level, cap setting and allowance-allocation mechanisms should be further revised and improved, technical guidelines for allowance allocation should be developed, and, on that basis, the "National Plan for Carbon Emissions Trading Cap Setting and Allowance Allocation"[2] should be made public at the earliest opportunity. Moreover, at the administrative level, roles should be clarified for central- and local-level competent authorities, and other relevant government agencies – with regard to designing and establishing a collaborative working platform for China's national ETS.

3. Ensure and elevate the quality of emissions data

More efforts should be made to ensure the authenticity, completeness, continuity, and comparability of GHG-emissions data reported by enterprises. The monitoring of GHG emissions should be further improved so as to align monitoring plans with local conditions and make them easy to implement. Experience and lessons with respect to the monitoring and reporting of data should be regularly summarized to provide guidelines for revising and improving related standards and technical norms.

4. Perfect the carbon-accounting system

A clear system for carbon accounting is conducive to improving the efficiency of market-based mitigation policies. It is also conducive to discovering the intrinsic value of emissions allowances and the financial attributes of carbon assets, and to improving the liquidity and integrity of carbon markets. Thus, competent authorities could choose to issue management measures for carbon accounting, formulate operational standards for carbon-accounting verification and calculation, establish an information disclosure mechanism, and build an information disclosure platform accordingly.

5. Accelerate the construction of infrastructure for China's national ETS

First, the operation of the registration system and trading system needs to be tested, prior to opening accounts for key emitting enterprises, as part of conducting technical research to further improve the stability and security of both systems. Second, it is suggested that the registration system for China's national ETS be connected with China's business-registration system to prevent the opening of any illegal accounts. Third, the registration system and the trading system are suggested to be linked to the clearing (or closing) system, and inter-system management and supervision mechanisms need to be further improved.

6. Continue to support the development of regional (or pilot) ETSs.

Experience gained and lessons learned from pilot ETSs should be summarized to inform the design of China's national ETS. After the national ETS is established, the regional (or pilot)

2 The Chinese government published, in early December 2019, two allocation plans, which are being tested in provincial-level capacity building workshops. See: http://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/201909/t20190930_736483_wap.shtml. However, as of December 9, 2019, the government had not published the final version of the National Plan.

ETSs should continue to play a role. Their sectoral coverage should be gradually expanded, and efforts should be made in advance to collect emissions data and enhance capacity for relevant industries. This will prepare key sectors other than the power sector to be incorporated into the national ETS.

7. Diversify trading products in China's national ETS

Chinese certified emissions reductions (CCERs) should be incorporated in the national ETS as soon as possible. On the one hand, CCERs can enrich the variety of trading products and provide key emitting enterprises with more options for compliance. Proceeds from the sale of CCERs can also be utilized to fund low-carbon projects, which is conducive to developing climate investment and financing. In addition to CCERs, financial derivatives (such as forward trades and futures) that are based on carbon allowances and other carbon credit products can also be rolled out promptly.

8. Explore effective measures for coordinating the management of GHG and other pollutant emissions

The carbon market can be used not only to promote carbon abatement, but also to synergistically reduce emissions of conventional air pollutants. Research on the coordinated management of GHG and other pollutant emissions needs to be conducted, with input from various stakeholders, to strengthen the top-level design. Markets for trading energy-use quotas and pollution rights should also be correlated with the national ETS, to keep air-pollution prevention measures in line with climate-change-mitigation actions.

9. Strengthen the supervision of China's national ETS

The scale of China's national ETS will increase as more sectors are covered and as more stakeholders are involved. The fluctuation of carbon prices and the greater uncertainties caused by this expansion are likely to expose the carbon market to greater market and operational risks. Thus, competent authorities should establish risk identification, risk assessment, and early warning mechanisms at the national, local, and trading-platform level. Competent authorities should also clarify the rights and responsibilities of different market participants, assist stakeholders in improving their risk management awareness and capacity, and build a "top-down" market supervision system.

10. Advance international cooperation on carbon-pricing mechanisms

Linking China's national ETS with foreign ETSs and constructing regional carbon markets may promote low-carbon transitions over a larger area; moreover, international cooperation between different ETSs is also consistent with China's initiative to build a "Green Belt and Road." In the future, China can strengthen the exchange of experience with ETS practices with other "Belt and Road" countries (e.g. the ASEAN countries), provide other developing countries with carbon-market capacity-building activities, establish regional information-sharing platforms, and so on.

China's National ETS: Impacts on Costs in the Power Sector

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Key Points

- The interaction between China's national emissions-trading system (ETS) and electricity-market reform will affect how the ETS develops in the future.
- The ETS will impose costs on power generators in the short term; these costs could amount to 5%–12% of fossil generators' profits.
- This brief proposes three options for compensation arrangements to offset cost impacts.

China is building its electricity and carbon markets, which presents both a challenge and an opportunity. The carbon market interacts with the electricity market in various ways, but in the short term mainly affects dispatch. The benchmark for carbon reductions set by the government has an impact on the scale and distribution of additional costs for generation units in China. Based on current proposals, the introduction of a national ETS could add costs of 1 to 2.5 billion yuan, which would account for 5%–12% of the profit of fossil-fuel power plants in China. Thus a compensation arrangement should be designed to manage these reductions in profit before the electricity market is fully functional. Both a carbon levy on end-use electricity prices and an enhanced market for tradable generation rights can play a role in compensating generators for their losses. Enhanced trading in generation rights might be the preferable option due to its side benefits in terms of incentivizing efficiency improvements and emissions reductions.

The Chinese government is still not considering additional carbon costs in a formal manner, for several reasons. First, targeted reductions will not be too strict at the beginning of the national ETS. Thus, generation companies are still largely unaware of future cost impacts. Second, existing consultations with stakeholders are focused on large generation companies, whose power plants operate more efficiently and at higher capacity. Third, most generation companies in China are state-owned, and therefore are not purely driven by profit considerations. But additional carbon costs will be a concern once the national ETS is operating and the emissions benchmark becomes more stringent over time. Without a cost pass-through mechanism, pushback from companies will be felt sooner or later.

The first option is to provide no compensation for additional carbon costs and expect companies to absorb these costs by themselves. This could be an option at the beginning of the national ETS, especially if benchmark emissions targets are technology-specific and not very stringent. However, if the benchmark target is more aggregated and more stringent, costs will be larger, and the distribution of these costs will be more uneven. The problem will be more severe in the context of declining coal plant profits. In 2015, operators of thermal power plants realized a combined profit of only 20.7 billion yuan, a decrease of 83.3% over the previous year. As a result, the profits of power generation enterprises fell by 32.4%. As previously noted, we estimate that the ETS could result in 0.9–2.5 billion yuan in additional costs, or about 5%–12% of overall profit. It is difficult to believe that no compensation is an option given the already low profitability of fossil-fuel power plants.

The second option is to establish an adjustment mechanism to transfer costs to downstream consumers. Similar to the adjustment mechanism that exists to pass through coal prices, an adjustment mechanism can be established to pass through carbon prices. The additional cost of carbon would be calculated regularly and collected as a levy on the existing retail price. Levies collected from end consumers can be put into a pool to compensate generation companies. The advantage of this type of arrangement is that it is based on existing experience and is therefore familiar to local governments, grid companies, and generation companies. But this option also has significant disadvantages since it simply shifts costs from generation companies to downstream end users, without providing any incentives for generation companies to explore mitigation opportunities. The result could be to neglect impacts on emission performance on the generation side. This disadvantage could be partly offset by a burden-sharing arrangement between generation companies and end users. For example, only 80% of the additional cost could be compensated through the adjustment mechanism, leaving generation companies with an incentive to minimize the remaining 20% of cost, perhaps by improving efficiency.

A third option could involve targeting opportunities to optimize the generation mix within the existing context. Although generation plans are largely determined through bilateral negotiations between the government and generating companies, there is still room for improvement if generators are allowed to trade their "right" to generate. Large-scale generators are generally more technically efficient and better equipped with pollution-control devices; these larger generators can buy generation rights from smaller-scale operators. Small-scale power plants can also benefit from such transfers, creating win–win opportunities. Trading in generation quotas can be done as a transaction between units within the same generation company or on a transparent matchmaking platform. Such trading can help achieve overall energy conservation and emissions-reduction goals, while also reducing the overall cost of carbon abatement and resolving the uneven distribution of abatement costs.

Trading in generation rights is not a new concept in China – in fact it was proposed ten years ago, but trading to date has been limited in both scale and scope. The main reason is that the difference in feed-in tariffs between large and small power plants has not been sufficient to fully compensate for the cost of operating pollution-control equipment. Thus, it has been more profitable for small-scale power plants to use their quotas rather than sell them to larger units.

The introduction of an ETS for carbon emissions could be a game changer, for several reasons: First, the cost of emissions allowances will create additional incentives for small generators to sell their generation quotas. With a reasonable carbon price and benchmark setting, small-scale generators can avoid incurring allowance costs by selling their quota to larger units. Second, larger and more efficient units will also be incentivized to buy generation rights at a higher price because they can generate more credits if they generate more electricity (since the emissions intensity of larger units will be lower than the benchmark in all cases). These additional incentives, on both sides, can prompt increased trading.

COMPARATIVE PERSPECTIVES ON SUBNATIONAL POLICY

India and Subnational Climate Change: An Emerging Discourse

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Key Points

- Indian climate policy began at the national level and has been rapidly diffusing to states and cities over the last few years, resulting in the gradual mainstreaming of climate-change policy into the subnational level.
- The starting point for subnational climate action in India is the linkage between local development objectives and climate change.
- Effective subnational climate action in India requires capacity and strategic understanding to negotiate the institutional complexities that arise from the country's multilevel and federal governance arrangements.

As one of the three largest emerging economies in the world, India's future trajectory carries important implications for global climate-change outcomes. The country ranks third, globally, in primary energy consumption, electricity consumption, and CO_2 emissions (BP 2019). At the same time, India is starting at a low base of development, and its future growth, which will improve quality of life for millions of its people, cannot be assured without increasing levels of energy use and associated greenhouse-gas emissions. This duality – that is, being a large overall contributor to current and future greenhouse-gas emissions while also being a minor contributor on a per-capita basis and with regard to past emissions – creates a complex set of circumstances for India to navigate as it seeks to integrate climate considerations into its development plans.

India's approach started with an initial emphasis on climate change as a diplomatic problem, especially before 2007. It was in the years prior to the Copenhagen Conference of the Parties, in 2009, that the focus of India's climate actions shifted out of the realm of foreign policy to take the domestic context into account (Dubash *et al*. 2018). The largest stimulus to national climate policy, the National Action Plan on Climate Change (NAPCC), was released in 2008. It comprises eight national missions across the spectrum of India's development efforts, ranging from solar energy and energy efficiency to urban habitats and water management. In this way, the NAPCC engaged a wide range of sectoral ministries on climate issues, many for the first time (PMCCC 2012).

Importantly, the NAPCC made concrete the principle of co-benefits, which has subsequently guided India's national and subnational actions. The principle of co-benefits meant prioritizing measures that achieved national development objectives but that also helped tackle climate change. In the following years, leading up to India's Paris pledge in 2015 and beyond, a growing evidence base of climate-change impacts, along with India's changing role in global geopolitics, has led to a proliferation of domestic climate policy actions and changes. These domestic efforts are frequently motivated by new scientific assessments and international pressures, ideas, and networks, and are leading to a new set of governance arrangements. Moreover, while policy changes began at the national scale, they are rapidly diffusing to states and cities, thereby marking the gradual internalization of climate change into policy making at the subnational level (Atteridge *et al*. 2012).

The starting point for subnational climate actions is the linkage between local development objectives and climate change. States were mandated to develop climate action plans as early as 2009, following a nudge from the national government and its NAPCC. The types of actions included in the state plans usually advanced the eight national missions within the NAPCC, but with a local flavor. For instance, many states emphasized energy efficiency and renewable energy, with a push for coal-fired power in Odisha and desertification in Rajasthan.4 In another example, state planning in Delhi was driven by an effort to leverage perceived climate funding opportunities to address short-term development agendas (Aggarwal 2013). In most cases, however, action at the state level is guided by a strong top-down approach that takes its cues from the central government, with occasional, yet limited space for state-level experimentation with alternative policies (Jorgensen *et al*. 2015). Moreover, delving into the development-climate linkage remained thin in these plans, in part because of limited scientific input (Dubash and Jogesh 2014).

By contrast, Indian cities have no mandate and little institutional incentive to create climate plans (Khosla and Bhardwaj 2019). Importantly, India's federal structure places responsibility for planning the delivery of urban services at the central and state levels, which means that local authorities have little control beyond implementing climate plans. As a result, subnational climate action by Indian cities is still nascent, though growing numbers of city initiatives are being launched around the country. While these actions initially focused on adaptation, climate vulnerabilities, and risks, cities' climate plans have broadened over time to include mitigation.

National-level policies and schemes, which are conceptualized at higher levels of government, are also prompting cities to adopt climate-friendly programs, such as the National Mission on Sustainable Habitat, the Smart Cities Mission, the Solar City Program, and the Green Urban Transport Mission, which collectively enable rooftop solar, energy efficiency, public transport, sidewalks and bike lanes, and building energy codes. It is worth noting that, in spite of a strong, centrally-driven, multilevel governance architecture for climate policy, Indian cities are finding different, locally-feasible avenues to pursue mitigation actions within the limited institutional spaces available to them.

An overarching characteristic of these subnational actions is the use of local development priorities as an entry point to climate actions, especially as city bureaucrats in India have little choice but to focus on pressing and immediate gaps in the provision of housing, sanitation, safety, and other important services. By comparison, climate change remains a relatively low, though increasingly salient political priority.

A second characteristic of city-based climate efforts in India is the important role of non-state actors, such as international donors, consultants, researchers, industrial lobbies, and NGOs. These non-state actors play a crucial role in bridging gaps in state capacity, data, and finances, and their involvement is leading to a shifting balance of power across coalitions of state and non-state actors. A third characteristic of current subnational climate actions is a proclivity for discrete, project-based activities that are aimed at implementing projects defined by the central government or by states. This proclivity stems from a lack of institutional spaces to develop programmatic, long-term, and strategic responses to climate change at the city level.

Clearly, subnational climate action in India requires negotiating the institutional complexities that arise from the multilevel and federal nature of the country's governance. To do so well will require a commensurate increase in the depth of capacity at different levels of governance. The cumulative benefit from such effective institutionalization will also demand a larger strategic understanding of the interaction, synergies, and trade-offs between climate and development priorities. This strategic understanding is needed across policies and at the national, state, and city government levels – and it has yet to be developed.

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Subnational Carbon-Pricing Policy in the United States

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Key Points

- Given the global commons nature of climate change, international cooperation is essential, and policy actions by the highest level of geographic jurisdiction (typically nations) are likely to be the most effective environmentally, as well as the most cost-effective.
- But subnational climate change policies may – in some cases – be desirable when national policies appear to be insufficient.
- However, the interactions between a subnational system and a national policy in which it is nested can be problematic, benign, or positive, depending on the relative scope and stringency of the policies and the specific policy instruments employed.
- These various types of interactions are exemplified by the history of conventional air pollution regulation, as well as by more recent climate-change policies.

Introduction

Greenhouse gases (GHG) mix in the atmosphere, so the location of emissions has no effect on either the location or even the aggregate magnitude of impacts. In economic terms, climate change is a global commons problem. Any jurisdiction taking action incurs the costs of its actions, but the climate benefits are distributed globally. Therefore, for virtually any jurisdiction, the direct climate benefits it reaps from its actions will be less than the costs it incurs (despite the fact that the global benefits may be greater – possibly much greater – than the global costs). This presents a classic free-rider problem, which is why international, if not fully global, cooperation is essential, and it is also why the highest level of effective governance – typically nations – must ultimately be responsible for policy action. Furthermore, the larger the jurisdiction taking action, the less, in general, will be the economic and emissions leakage.

Why then even think about subnational climate change policies? There are two possible answers. One is that some national government has not taken action. The other is that the actions taken by a national government are judged to be insufficient.

The Case of the United States

The current U.S. administration under President Donald Trump has rolled back – or at least has tried to roll back – federal climate-change and related energy policies across the board. But it is not trivial to change federal laws and regulations, and state (and local) climate-change policies remain in place, with some being strengthened as a result. Renewable energy mandates affecting electricity generation exist in more than half of U.S. states. Also at the state level, there are motor vehicle GHG-emissions standards, zero-emission vehicle (ZEV) rules, appliance efficiency standards, building codes, zoning laws, subsidies, and many other types of climate and energy policies.

Most significant – or, at least, most interesting – are a handful of subnational carbon-pricing initiatives. California's AB-32 and AB-398 include an economy-wide cap-and-trade system. In the Northeast and Middle Atlantic regions, the Regional Greenhouse Gas Initiative (RGGI) is a linked system of carbon dioxide (CO_2) cap-and-trade systems regulating the electricity sector in ten states. Oregon and Washington may enact their own cap-and-trade systems in 2020. On the other hand, Washington State has twice defeated carbon tax referenda.

Regional Greenhouse Gas Initiative (RGGI)

This is a downstream CO_2 cap-and-trade system regulating the electricity sector in ten states. Each state is required to auction 25% of its allowances, but all have trended toward auctioning 100%. There is no true safety-valve on prices, but when and if a trigger price is reached, increased use of offsets from outside of the system is allowed.

The system initially limited emissions to the average of 2002–2004 emissions during the period 2009–2014. But these modest targets were non-binding, due to low natural gas prices, recession, and energy conservation. In response, the cap was lowered by 45% in 2015, then by 2.5%/year, for an eventual 10% cut by 2019 (13% below 1990, 35% below business-as-usual or BAU). With the non-binding cap, there was no direct emissions impact while the allowance price remained close to the auction reservation price of \$2.00/ton CO_2, but it now exceeds \$5.00/ton. In any event, the auctions have raised considerable revenue for the states, greater than \$2 billion, so the system remains popular with state governments.

California's Global Warming Solutions Act of 2006

Assembly Bill 32 is a broad and ambitious policy to cut GHG emissions to 1990 levels by 2020. Its successor, AB 398, provides for emissions to be cut to 40% below the 1990 level by 2030. This pair of policies includes: a cap-and-trade system; energy efficiency standards for vehicles, buildings, and appliances; renewable portfolio standards; and a low-carbon fuel standard.

The cap-and-trade system is very broad in scope, covering about 85% of the economy's emissions. There has been increasing use of auctions over time, with a price collar post-2020, and an output-based updating allocation is used to protect trade-sensitive industries. A declining share of reductions can be from offsets, starting at 49% and going down to 5%. Finally, the system is tightly linked with a virtually identical system in Quebec, and other linkages are pending.

Reflecting on Subnational Climate-Change Policies

The U.S. experience provides an opportunity to reflect on the merits and the limits of subnational climate-change policies. Two questions stand out. First, in the presence of a national (federal) policy, will subnational efforts achieve their objectives? And second, will subnational efforts be cost-effective? The answer to both questions is that the interactions between a subnational system and a national policy in which it is nested can be problematic, benign, or positive, depending on the relative scope and stringency and the specific policy instruments employed.

Problematic Interactions

If a national policy limits emissions quantities or uses nationwide averaging of performance, then any additional emissions reductions accomplished by the "green state" (more stringent policy than the national or federal policy) will reduce pressure on other states, thereby encouraging emissions increases in those other states (such as through a lower national allowance price). The result is 100% leakage and loss of cost-effectiveness nationally.

Potential examples depend upon the details of regulations, but would include: California policies and a federal cap-and-trade system (as with HR 2454, the so-called "Waxman-Markey Bill"); state limits on GHGs/mile and federal Corporate Average Fuel Economy (CAFE) standards; state renewable fuels standards (RFS) and the federal RFS; and state renewable portfolio standards (RPS) and a federal RPS. A partial solution would be a carve-out for the relevant states from the federal policy, which eliminates the 100% leakage, but the result will not be cost-effective.

Benign Interactions

There are two important situations in which the interactions between a nested subnational policy and a national carbon-pricing regime are benign, where benign means that the policies are additive in their impacts. The first case is trivial, namely where the subnational policy is less stringent than the federal policy. The result is that the subnational policy becomes non-binding and is largely irrelevant.

The other key situation is where a national carbon-pricing policy sets price, not quantity. For example, with a carbon tax or a binding price collar in a cap-and-trade system, more stringent actions in green states do not lead to offsetting emissions in other states induced by a changing carbon price, because the carbon price is simply unaffected. However, there will still be different marginal abatement costs across states, and so aggregate reductions will not be achieved cost-effectively. The same national target could be achieved at lower aggregate cost by simply increasing the level of the carbon tax and abandoning the binding state policies.

Positive Interactions

By positive interactions, I mean that the effects of the national policy combined with those of the subnational policy can be greater than the sum of their parts. Three possible routes for such positive interactions have been posited. First, subnational jurisdictions can – in principle – address market failures not addressed by a national carbon-pricing policy. One prominent example is the well-known principal-agent problem that plagues energy-efficiency investments in renter-occupied properties. Here, that sector might be more effectively addressed through state or local building codes.

Second, it is frequently suggested that subnational jurisdictions can be "laboratories" for policy design by providing useful information for the development of an effective national policy. An important question, however, is whether subnational authorities will allow their "laboratory" to be closed after the experiment has been completed and the information delivered. Third and finally, subnational governments can create pressure for more stringent national policies. The thirty-year history of regulations under the U.S. Clean Air Act illustrate such phenomena. Most recently, California's standards led to subsequent change in the federal CAFE standards. Such linkage is desirable if the previous national policy was insufficiently stringent, which is an empirical question.

Conclusions

Subnational climate-change policies often appear highly desirable in the light of insufficient national policies. Indeed, such policies can be helpful, even highly valuable. But it is important to keep in mind that, given the global commons nature of the climate-change problem, the highest level of geographic jurisdiction (typically nations) is likely to be the most effective environmentally, and the most cost-effective. That said, national and subnational circumstances matter.

Under some conditions, national and subnational policies can be mutually reinforcing, resulting in positive interactions. In other circumstances, the interactions are at least benign. But under certain conditions, perverse interactions can occur when one policy is nested within another, resulting in no incremental emissions reduction (100% emissions leakage), greater aggregate costs, and suppressed allowance prices, and hence diminished incentives for technological change. In other words, the devil is in the details!

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The Evolution of Carbon Pricing Across Canada: Lessons for Subnational Climate-Change Policy in China

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Key Points

- The Canadian experience with innovative provincial climate and carbon-pricing policy spans more than a decade. This once highly fragmented subnational activity helped form the foundation for the country's new pan-Canadian carbon-pricing program.
- The flexible nature of the pan-Canadian approach not only accommodates existing subnational carbon-pricing actions and infrastructure but has been – and continues to be – deeply reliant on cross-federal, provincial, and territorial governance and greenhouse-gas policy coordination efforts.
- Canada's multi-level, collaborative experience is a prime model to inform more cohesive carbon-pricing activities in other regions, including China.
- Examples of areas where comparative lessons can be gleaned from Canada include: joint development of a framework for greenhouse-gas offsets; consistent greenhouse-gas quantification, inventories, and guidance; coordinated actions on supplementary measures to complement carbon pricing; and coordinated strategy to harness international market opportunities under Article 6 of the Paris Agreement.

Canadian Policy Context

Canada's 2016 *Pan-Canadian Framework on Clean Growth and Climate Change (PCF)*[1] represents the country's overarching national strategy to reach its nationally determined contribution (NDC) of a 30% absolute reduction in greenhouse-gas (GHG) emissions below 2005 levels by 2030. Navigating the multi-dimensional, multi-level path toward PCF implementation is a complex journey – one that requires hyper-policy coordination, coherence, and innovations across Canada's disparate landscapes.

Putting politics aside, Canada's diverse economic, geographic, energy, and GHG emissions profiles across its ten provinces and three territories – combined with remarkably staggered levels of mature versus non-existent provincial climate actions – makes the country's climate-policy "laboratory" one to carefully watch and, in some areas, potentially replicate. The purpose of this brief is not to analyze Canada's recent spate of climate-related political shifts and constitutional

1 www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html

legal challenges, though these have been significant. Rather, we aim to elucidate some priority technical and governance learnings from the still-evolving Canadian experiment, showcasing insights and lessons to potentially inform other national and subnational jurisdictions, with particular attention to supporting the development of China's carbon-pricing landscape.

Canada as a Microcosm – Carbon-Pricing Fragmentation

For over a decade, Canada has solidified its reputation as a microcosm of the global carbon-pricing landscape. A selection of highlights from the Canadian experience with subnational carbon pricing is summarized below:

- North America's first compliance GHG emissions-trading system (ETS), launched in 2007, covers large power generators and heavy industry in the Canadian province of **Alberta**.[2] This provincially-administered large emitters' GHG program has evolved over the years, with the latest iteration – labeled the Technology Innovation and Emissions Reduction (TIER) program[3] – launched by the new Alberta Government in October 2019.[4]

- In 2008, **British Columbia** introduced North America's first revenue-neutral carbon tax.[5] The tax applied to the purchase or use of fuel in the province; until 2019, all revenue generated from the tax was recycled in the form of personal and business tax cuts and a tax credit for low-income British Columbians. The same year, 2008, also saw the province enact its Carbon Neutral Government Regulation,[6] which spurred significant private investment and offset protocol development across the province.[7]

- In 2013, after nearly a decade of close cross-jurisdictional, GHG-market-design collaboration and hundreds of stakeholder consultations under the Western Climate Initiative (WCI), **Quebec** established its carbon cap-and-trade program. In 2014, Quebec linked its program with California's as part of the WCI, creating the largest carbon market in North America and the "first to be designed and managed by sub-national governments in different countries."[8]

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2 www.edf.org/sites/default/files/alberta-case-study-may2015.pdf

3 www.alberta.ca/technology-innovation-and-emissions-reduction-engagement.aspx

4 www.alberta.ca/carbon-competitiveness-incentive-regulation.aspx

5 https://www2.gov.bc.ca/gov/content/taxes/sales-taxes/motor-fuel-carbon-tax

6 https://www2.gov.bc.ca/gov/content/environment/climate-change/planning-and-action/legislation#ccaa

7 https://www2.gov.bc.ca/gov/content/environment/climate-change/public-sector/offset-portfolio

8 www.environnement.gouv.qc.ca/changementsclimatiques/marche-carbone_en.asp

- In 2019, after regular guidance from Quebec and California regulators, **Nova Scotia** launched its stand-alone provincial cap-and-trade program,[9] which secured its ability to administer its new carbon market at the provincial level while avoiding federal government intervention.

Canada's Pan-Canadian Framework on Clean Growth and Climate Change, signed by the federal government and nearly all Canadian subnational leaders in 2016, identifies "pricing carbon pollution" as a core component to achieving its goals. The Framework triggered legislative and regulatory actions to ensure that *all Canadian provinces and territories* have an economy-wide compliance carbon-pricing system in place by 2019. For any subnational jurisdiction that fails to impose an equivalent carbon-pricing system – according to the published federal carbon-pollution-pricing "benchmark"[10] – Canada's federal "backstop" program now applies through 2022 (and potentially thereafter).

Federal Carbon-Pricing Advances in Canada

As of 2019, Canada's new federally legislated and administered compliance carbon-pricing backstop program has created a new overlay on the above-described provincial carbon-pricing activities. This carbon-pricing hybrid regime, enabled through the federal *2018 Greenhouse Gas Pollution Pricing Act (GGPPA)*[11] with regulations introduced in 2019, includes a carbon levy (tax) on fossil fuels and an ETS Output-Based Pricing System (OBPS) that covers large power and industrial emitters facing trade exposure. Notable details for these core design features are summarized below.

- **Federal Carbon Levy:** On April 1, 2019, the federal carbon levy was imposed on several provinces that had failed to implement their own equivalent pollution-pricing programs (i.e., Saskatchewan, Ontario, New Brunswick, and Manitoba). Starting at CA$20 per ton carbon dioxide equivalent (tCO_2e) in 2019, this levy will increase by CA$10/$tCO_2e$ per year until it reaches CA$50/$tCO_2e$ in 2022, at which point the federal government will conduct a full program review.[12] The levy is currently defined as "revenue neutral," meaning that revenue from the federal mechanism will be returned to Canadians in the province or territory where the carbon levy applies.

9 https://climatechange.novascotia.ca/nova-scotias-cap-trade-program

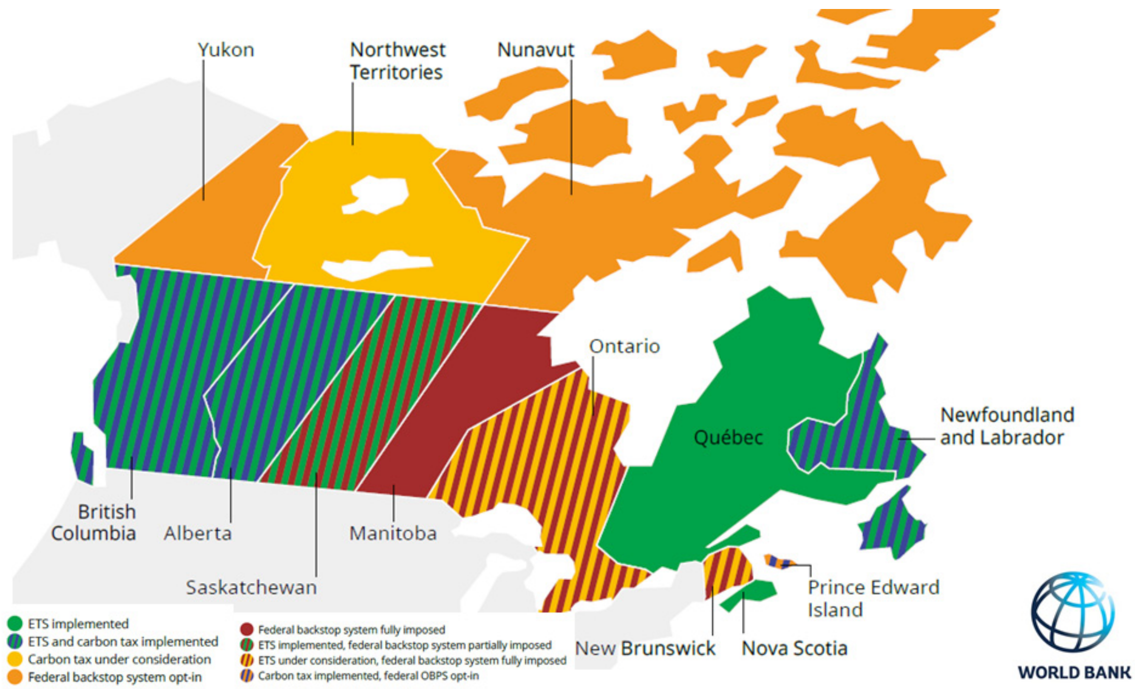
10 www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/guidance-carbon-pollution-pricing-benchmark.html

11 https://laws-lois.justice.gc.ca/eng/acts/G-11.55/page-1.html

12 www.canada.ca/en/environment-climate-change/news/2017/05/pricing_carbon_pollutionincanadahowitwillwork.html

- **Federal Output-Based Pricing (Carbon Market) System:** Through the flexible OBPS market system, covered entities can pay into a federal fund or use tradable units (i.e., surplus credits or offset credits) to meet annual compliance obligations. Although elements of the OBPS program (such as offsets, use of direct proceeds, market registry) are still under development, the compliance ETS came into force on January 1, 2019 and final regulations were published in June 2019 (with retroactive application).[13] Similar to the carbon levy, revenue accruing to the federal government for compliance where the federal OBPS applies will be recycled into jurisdictions of origin to support affected industries or sectors.

Canada's Carbon-Pricing Landscape – Application of Federal Backstop Across Sub-Nationals



Pan-Canadian Framework – Enhanced Coordination & Governance[14]

Key ingredients for achieving subnational support for the pan-Canadian cooperative approach on climate policy and carbon pricing included the launch of new multi-level governance structures and priority action-oriented work areas. Many of these activities were administered through the Canadian Council of Ministers of the Environment (CCME), the country's "primary minis-

13 www.canada.ca/en/services/environment/weather/climatechange/climate-action/pricing-carbon-pollution/output-based-pricing-system-technical-backgrounder.html

14 World Bank Group. 2019. *State and Trends of Carbon Pricing 2019*; p. 31. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/191801559846379845/State-and-Trends-of-Carbon-Pricing-2019

ter-led intergovernmental forum for collective action on environmental issues of national and international concern."[15]

A selection of CCME-driven activities, where all subnational and federal authorities are coordinating to drive climate-policy consistency and alignment, can be summarized as follows:

- **Pan-Canadian GHG Offsets Framework**[16]—common roles and objectives, offset eligibility and fungibility (cross-system, provincial-federal unit acceptability), infrastructure (shared registries, tracking systems), structure and authority, and offset project core design elements.
- **GHG Quantification and Inventories**[17]—common GHG measurement and reporting standards, consistent or aligned approaches to GHG inventories, progress monitoring to support international NDC reporting obligations, and alignment on GHG forecasts and modeled assumptions, with consistent guidance for use by all levels of governments.
- **Pollution Pricing and Complementary Actions**[18]—coordinated review of other non-pricing targeted climate and energy-policy actions and comprehensive evaluation of interactions with supplementary measures (e.g., energy-efficiency standards, land-use incentives, coal phase-out regulations).
- **Internationally Transferable Mitigation Outcomes (ITMOs)**[19]—launch of federal-subnational "International Mitigation Project Team" to assess opportunities and risks for cooperative approaches and the acquisition of international units (per Article 6 of the Paris Agreement).

Alignment of these activities – and guidance from an intergovernmental body such as the CCME – will help create cohesive climate governance across provinces and at the federal level in Canada. It is likely that as multi-level climate-change policy evolves in Canada, it will yield lessons for China's implementation of its national carbon-pricing system, in the face of existing pilot programs at the provincial and municipal levels.

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15 www.ccme.ca/en/about/index.html

16 www.ccme.ca/en/current_priorities/climate-change/climatechange/ghg_offsets_framework.html

17 www.canada.ca/en/environment-climate-change/services/climate-change/pan-canadian-framework-reports/first-annual-report/reporting-oversight.html

18 www.canada.ca/en/environment-climate-change/services/climate-change/pan-canadian-framework-reports/second-annual-report/section-4.html

19 www.canada.ca/en/environment-climate-change/services/climate-change/pan-canadian-framework-reports/first-annual-report/annex-1.html

AUTHOR BIOGRAPHIES

Michael R. DAVIDSON is Assistant Professor in the School of Global Policy and Strategy and the Department of Mechanical and Aerospace Engineering at the University of California San Diego. His research and teaching center on the engineering implications and institutional conflicts inherent in deploying low-carbon energy at scale, with a particular interest in China, India, and the United States. He is an expert in renewable energy resource assessments, electric power systems, and the political economy of low-carbon infrastructure innovation and markets. He is an associate and former post-doctoral research fellow in the Environment and Natural Resources Program at the Belfer Center for Science and International Affairs, Harvard Kennedy School. He holds a Ph.D. in engineering systems from the MIT Institute for Data, Systems, and Society, an M.S. in technology and policy from MIT, and a B.S. in mathematics and physics and B.A. in Japanese studies from Case Western Reserve University.

Gørild HEGGELUND, Ph.D., is a Senior Research Fellow at the Fridtjof Nansen Institute (FNI) and was FNI China representative from 2014–2017. She has carried out research on China's environmental, energy and climate change policy for three decades, including the Arctic. From 2009–2014 she was Senior Climate Change Advisor at UNDP China. Heggelund was Country Director, China and Head of Energy and Climate Policy, INTASAVE Asia-Pacific (2014–2016). Heggelund has experience from evaluation projects in China and is currently China Programme Focal Point for the meta evaluation commissioned by Children's Investment Fund Foundation (CIFF) for the China Renewables Programme as part of China's Energy System Revolution. She was Senior Evaluator in an international evaluation team to provide evaluation services of energy-related coal cap strategies in China (2017–2018) commissioned by CIFF, Hewlett Foundation, and ClimateWorks Foundation. Heggelund is international advisor to the ongoing Special Policy Study (SPS) on "Global Climate Governance and China's Role" under the China Council for International Cooperation on Environment and Development (CCICED); she was international expert in the CCICED SPS on Good City Models under the Concept of Ecological Civilization. Prior to this, she took part as international expert and international coordinator in the Task Force on Environmental Protection and Social Development in 2013 as well as in the Task Force for China Environment and Development Outlook. Heggelund has lived and worked in China for more than 16 years and is fluent in Chinese, having studied at Peking University.

Valerie J. KARPLUS is Assistant Professor of Global Economics and Management at the MIT Sloan School of Management. Karplus studies resource and environmental management in firms operating in diverse national and industry contexts, with a focus on the role of institutions and management practices in explaining performance. She is an expert on China's energy system, including technology- and business-model innovation, energy-system governance, and the management of air pollution and climate change. She studies the determinants of clean-energy transitions in emerging markets, with projects in China, India, and Sub-Saharan Africa. From 2011–2015, she directed the MIT-Tsinghua China Energy and Climate Project, a five-year research effort focused on analyzing the design of energy and climate-change policy in China and its domestic and global impacts. She holds a B.S. in biochemistry and political science from Yale University and a Ph.D. in engineering systems from MIT.

Radhika KHOSLA is the Research Director of the Oxford India Centre for Sustainable Development at Somerville College and a Senior Researcher at the Smith School of Enterprise and Environment, School of Geography and the Environment, at the University of Oxford. She is the Principal Investigator of the Oxford Martin School's interdisciplinary and multi-country programme on the Future of Cooling. She is also a contributing author to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Radhika works on examining the productive tensions between urban transitions, energy services consumption, and climate change, with a focus on developing country cities. Radhika's other academic affiliations are at the University of Pennsylvania (USA), and the Centre for Policy Research (India). Previously, she has been at the Massachusetts Institute of Technology, Fellow at the Centre for Policy Research in New Delhi, and Staff Scientist at the Natural Resources Defense Council in New York. Radhika serves on government policy committees, and boards of journals and book presses. She holds a Ph.D. in the Geophysical Sciences from the University of Chicago and an undergraduate and master's degrees in Physics from the University of Oxford.

Ellen LOURIE is the North America Policy Associate at the International Emissions Trading Association (IETA). On behalf of IETA's global multi-sector business membership, Ellen supports efforts to inform climate-change policy and carbon-market design with government and non-government partners across Canada and the Americas. Before starting with IETA, Ellen completed her M.Sc. in Climate Change, Development and Policy at the University of Sussex, UK. In between studies, Ellen was Social Impact Advisor at ecobee, one of the world's largest smart thermostat companies and worked on energy-efficiency and mercury-reduction programs for Summerhill Group, an environmental consultancy.

QI Shaozhou is a Professor and Doctoral Supervisor in the Economics and Management School, Wuhan University. He currently serves as Dean of the Low Carbon Economics School of Hubei University of Economics and Director of the Climate Change and Energy Economics Study Center (CCEE) and the Center for European Studies, Wuhan University. He was awarded the New Century Excellent Researcher by the Education Ministry of China and Jean-Monnet Chair Professor by the European Union. His research interests include carbon market (ETS), climate change, and energy economics. He has published more than 60 research papers in international and domestic journals as well as several books in related fields. Professor Qi has presided over major research projects in philosophy and social sciences for the Education Ministry of China, 973 Science -Technology Programs, the "11th Five-Year plan," the Science-Technology Support Program for the "12th Five-Year plan," and the Science and Technology Ministry of China, as well as a number of national-level major projects related to carbon markets, climate change, energy economics and policies. He has submitted more than 20 advisory reports and policy plans for the Development and Reform Commission, the Science and Technology Ministry, the Ministry of Commerce, the government of Hubei province, and Wuhan city. He is a Reviewer of IPCC AR5 and the major author of the China Evaluation Report on Climate Change in the "13th Five-Year plan."

QI Ye is a leading expert on China's environmental policy and is a Senior Fellow and Director of the Brookings-Tsinghua Center for Public Policy (BTC) in Beijing. His research focuses on China's policies on climate change, environment, energy, natural resources, and urbanization. His recent work examines low carbon development in China, including an annual report analyzing how China is balancing its economic growth and environmental challenges. Qi also headed up the design of China's first low-carbon development plan, for the city of Baoding in Hebei Province. Along with his duties as BTC director, Qi serves as the Cheung Kong Professor of Environmental Policy and Management at Tsinghua University's School of Public Policy and Management. From 1996–2003, he taught ecosystem management and climate-change science at the University of California, Berkeley's Department of Environmental Science, Policy and Management. Prior to joining the BTC, he was Director for the Climate Policy Initiative in Beijing and Director of the Climate Policy Institute at Tsinghua University. Qi received his doctorate in environmental science in 1994 from State University of New York College of Environmental Science and Forestry and from Syracuse University in New York. Qi also received the NOAA Postdoctoral Fellowship Award (1994) and National Science Foundation Fellowship (1995). Qi studied agriculture, ecology, and economics at Hebei Agricultural University, the Chinese Academy of Agricultural Sciences, and the Chinese Academy of Sciences. Qi publishes extensively on and serves as a reviewer for a number of international journals including *Science*, *Nature*, and *Proceedings of National Academy of Sciences*, has published *Environmental Governance in China* in 2008, and co-authored the book, *The Governance of Climate Relations between Europe and Asia* (2013). He is principal investigator and Chief Editor of the *Annual Review of Low Carbon Development in China*, which has been published in both English and Chinese since 2010.

Robert N. STAVINS is the A. J. Meyer Professor of Energy & Economic Development at the Harvard Kennedy School, Director of the Harvard Environmental Economics Program, Director of Graduate Studies for the Doctoral Programs in Public Policy and Political Economy & Government, Co-Chair of the Harvard Business School-Kennedy School Joint Degree Programs, and Director of the Harvard Project on International Climate Agreements. He is a University Fellow of Resources for the Future, a Research Associate of the National Bureau of Economic Research, Co-Editor of the *Review of Environmental Economics and Policy* and the *Journal of Wine Economics*, and a member of the Board of Directors of Resources for the Future and the Scientific Advisory Board of the Fondazione Eni Enrico Mattei. He is an elected Fellow of the Association of Environmental and Resource Economists. He was formerly Chairman of the Environmental Economics Advisory Committee of the U.S. Environmental Protection Agency's Science Advisory Board. He has been a Lead Author of the Second, Third, and Fifth Assessment Reports of the Intergovernmental Panel on Climate Change. His research has focused on diverse areas of environmental economics and policy and has appeared in leading economics, law, and policy journals, as well as a dozen books. He has been a consultant to several administrations, Members of Congress, environmental advocacy groups, the World Bank, the United Nations, state and national governments, and private foundations and firms. He holds a B.A. in philosophy from Northwestern University, an M.S. in agricultural economics from Cornell, and a Ph.D. in economics from Harvard.

Robert C. STOWE is Executive Director of the Harvard Environmental Economics Program (HEEP) and Co-Director of the Harvard Project on Climate Agreements, both Harvard-University-wide initiatives based in the Harvard Kennedy School (HKS). He teaches courses on climate-change policy at HKS and, with the HEEP team, designs the curriculum for an HKS executive-education program on climate-change and energy policy. Dr. Stowe has participated, through the Harvard Project, in the annual Conferences of the Parties of the U.N. Framework Convention on Climate Change since 2007. He was a Contributing Author to a chapter on international cooperation in the Intergovernmental Panel on Climate Change's Fifth Assessment Report and has participated regularly in biannual meetings of the Climate Change Expert Group, hosted by the Organisation for Economic Co-operation and Development, in Paris. With the HEEP and Harvard Project team, Dr. Stowe has designed agendas for fifteen research workshops and policy roundtables since 2011. Topics include China's national carbon-pricing system, the elaboration and implementation of the Paris Agreement, sub-national climate-change policy in North America, and the governance of solar geoengineering. Workshops and roundtables have been held at HKS and in Beijing, Shanghai, Toronto, Mexico City, Berlin, and New York. Dr. Stowe has co-edited, with Robert Stavins (HKS, five volumes of expert briefs (short papers) based on research workshops – including the present volume. Dr. Stowe holds a Ph.D. in political science from the Massachusetts Institute of Technology and an A.B. in physics from Harvard College.

Katie SULLIVAN serves as Managing Director of IETA, the premier global multi-sector business voice for the intersection of markets and climate change. For two decades, IETA's mission has been to support durable climate policies and financial structures that attract private-sector engagement and capital at scale. On behalf of IETA's 150+ corporate members, Katie leads efforts to inform market solutions to address environmental challenges across the Americas and globally. She also manages IETA's growing climate finance, aviation, and digital innovation sustainability initiatives. Katie currently sits on the University of Toronto's Environmental Finance Committee, the newly-launched Canadian Institute for Climate Change Advisory Panel, the International Carbon Capture & Storage (CCS) Knowledge Centre Board, Ivey Foundation's Climate Advisory Group, the Global Steering Committee for the Carbon Pricing Leadership Coalition (CPLC), and Blockchain for Climate's Advisory Panel. Prior to IETA, Katie worked as a Senior Consultant at ICF International. In 2019, Katie was recognized as a Clean16 and Clean50 award recipient for contributing to Clean Capitalism Leadership in Canada.

TAN Xianchun, Ph.D., is Professor and Deputy Director of the Institute for Sustainable Development Strategy in the Institute of Science and Development, Chinese Academy of Sciences. She is also a lead author of IPCC 6th assessment reports in WG III. She was also a visiting scholar at the Harvard Kennedy School from 2015–2016. Prof. Tan's research areas include climate economics, climate-change strategy and planning, including adaptation and mitigation strategies for climate change and relative capacity building of government officials, national and regional low-carbon development strategies, and planning to implement China's (I)NDC, address climate change through South-South Cooperation. She has been carrying out valuable theoretical exploration in the modeling and prediction of energy-economy carbon-emission systems, emission-reduction potential and cost-benefit analysis of greenhouse-gas reduction policy, regional low-carbon development planning, and low-carbon roadmaps. Prof. Tan has led more than 30 research projects, published more than 50 academic papers, and has received three research awards and three patents.

Fei TENG is Associate Professor and Deputy Director of the Institute of Energy, Environment and Economy in Tsinghua University. He is also a lead author of IPCC 5th and 6th assessment reports in WG III. He is the lead author of the China's second and third National Assessment Reports on Climate Change, member of the drafting team for several key national documents, including the National Plan on Climate Change and White Paper on Climate Change. He served as an advisory expert for China's negotiation team on mitigation and transparency under the UNFCCC for many years. In 2014, he was selected as the chair of the consultative group of experts (CGE) to non–Annex I countries national communication. He has also been a member of the BASIC expert group since 2011. He was the chief scientist of the National Basic Research Program of China on Comparability and MRV in mitigation actions. His research interests include: climate policy, international climate regime, consumer behavior in energy consumption, and energy modeling.

TIAN Qi works in the Department of Ecological Environment of Hubei Province dealing with climate change. Tian Qi has been engaged in climate change and carbon-market construction for many years and has pursued in-depth study on low-carbon development and carbon-market construction.

WANG Pu is an associate professor at the Institutes of Sciences and Development, Chinese Academy of Sciences. His research involves climate and energy policies and sustainable development. More specifically, his current research projects focus on China's carbon-emissions-trading program and co-benefits of policies in addressing climate change and conventional environmental issues. Pu received his Ph.D. degree from Cornell University in 2014 in the field of environment and natural resources. He was a postdoctoral fellow at the Belfer Center for Science and International Affairs, Harvard Kennedy School in 2015–2017, where he conducted research on cap-and-trade systems in China and on Chinese-U.S. cooperation in climate-change policies.

Christine WONG is Professor of Chinese Studies and Director of the Centre for Contemporary Chinese Studies at the University of Melbourne. She was Professor of Chinese Public Finance and Director of Chinese Studies at the University of Oxford from 2007–2013 and the Henry M. Jackson Professor of International Studies at the University of Washington from 2000–2007. She has also taught economics at the University of California, Santa Cruz and Berkeley campuses, and Mount Holyoke College. Outside of academia, Professor Wong has held senior staff positions in the World Bank and the Asian Development Bank and worked with many other international agencies including the IMF, OECD, and UNDP. She is a member of the OECD Advisory Panel on Budgeting and Public Expenditures. Professor Wong has published widely on China's public finance, intergovernmental fiscal relations and their implications for governance, and economic development and welfare.

WU Libo is Professor of Economics and Professor of Applied Statistics, Director of the Department of Development and Planning, Deputy Director of the Institute for Big Data, and Director of the Center for Energy Economics and Strategies – all at Fudan University. She was the 2016 Youth Yangtze Scholar nominated by the Ministry of Education of the People's Republic of China. She primarily studies energy-consumption behavior and emissions-reduction mechanisms of micro-market entities, assessing their environmental willingness and driving factors, simulating the economic and technological impacts of low-carbon energy policies, emissions-reduction effects, and exploring their industrial, regional, and individual heterogeneity. She has published more than 50 papers in *PNAS*, *Nature Climate Change*, *Energy Economics*, *Social Sciences in China*, *Economic Research Journal* and other SSCI, SCI, and domestic authoritative journals. She has undertaken national major projects such as the National Social Science Fund Major Project and the National 863 Project. Wu has received several awards for theoretical research achievements, having won second prize of the Excellent Research Achievements of the Humanities and Social Sciences of the Ministry of Education, third prize of the Outstanding Achievements of Shanghai Philosophy and Social Science Research, and second prize of the Shanghai Excellent Teaching Achievement. She has abundant consulting experiences for government policy making and successively won four policy decision-making consultation awards, such as the second prize of the National Energy Administration's outstanding achievements in soft science research. Several research achievements were adopted by the Development and Reform Commission of the Economic and Information Commission of the Shanghai Municipal Government.

ZENG Xuelan, Ph.D., is Director of the Guangdong Research Centre for Climate Change of Sun Yat-sen University (Mainland China). She is mainly engaged in the research and application in the field of carbon trading, low-carbon policy and planning, and renewable energy. She is one of the major experts supporting the design, construction, and operation of the Guangdong ETS (once served as the leader of Guangdong ETS management working team established by Guangdong Development and Reform Commission). She also participated in the design of the China National ETS (served as deputy director of the China National ETS allowance allocation working team established by Department of Climate Change, National Development and Reform Commission). She has received grants from the Ministry of Science and Technology, National Development and Reform Commission, and Guangdong Province, among others, to undertake many projects on low-carbon development, carbon trading, and renewable energy. She has published many papers in journals such as *Climate Policy* and *Applied Energy*. She has been awarded the first prize of environmental-protection science and technology of Guangdong Province and the third prize of science and technology of Guangdong Province.

ZHANG Jianyu helped found the China program of Environmental Defense Fund (EDF), a leading U.S. environmental NGO. Since 1999, he has been responsible for the establishment and overall management of the EDF China program. Being an expert on environmental and public policies, with a focus on the application of Market-Based Instruments (MBIs) in solving environmental problems, Zhang is known for his leadership and contribution to the establishment of China's Carbon Trading System, the largest of its kind in the world. Zhang has authored many peer-reviewed articles, columns, and book chapters and is a frequent commentator on environmental issues in China with public media. Zhang serves on many advisory boards, including the Chinese Research Academy of Environmental Sciences (CRAES), the China-ASEAN Environmental Cooperation Center, and is a special advisor for the China Council for International Cooperation on Environment and Development (CCICED). Zhang is a Visiting Fellow with the School of Public Policy and Management of Tsinghua University, as well as a Visiting Professor with the School of Environment and Energy, Peking University. Zhang received his advanced degrees from Tsinghua University (Bachelor), Stanford University (Master), and Carnegie Mellon University (Ph.D.). He recently completed his Ph.D. studies in Finance from the Chinese Academy of Social Science.

ZHANG Xiliang is Professor and Director of the Institute of Energy, Environment, and Economy, Tsinghua University. Zhang is also Director of the Tsinghua-MIT China Energy and Climate Project and Deputy Director of the Low Carbon Energy Laboratory, Tsinghua University. His current research interests include low-carbon energy economy transformation, integrated assessment of energy and climate policies, renewable energy, and automotive energy. Since 2015, he has been heading the expert group on China's national carbon market design under the Department of Climate Change and Ministry of Ecology and Environment. He is also leading a major research initiative "Green and Low Carbon Economy Transformation" for the National Natural Science Foundation of China. He co-led the expert group for drafting the "China Renewable Energy Law" in 2004–2005 under the Environment and Resource Committee of the People's Congress. Zhang has been a lead author of the 4th and 5th IPCC Climate Change Assessment Report. He is Chair of the Energy Systems Engineering Committee of the China Energy Research Society and Vice President of the China Renewable Energy Industry Association. Zhang holds a Ph.D. in Systems Engineering from Tsinghua University.

ZHAO Xiaofan is a post-doctoral researcher at the School of Public Policy and Management, Tsinghua University. She holds a B.S. in environmental engineering (with honors and distinction) and an M.S. in management science and engineering, both from Stanford University, and a Ph.D. in public administration from Tsinghua University. She has particular research interests in energy conservation and climate-change policies with a geographical focus on China and global comparative environmental governance. Her publications have appeared in peer-reviewed journals including *World Development*, *Energy Policy*, *Journal of Cleaner Production*, *Energy Research & Social Science*, and *Energy*. Before starting her doctoral study at Tsinghua University, Xiaofan worked two years as a policy analyst for the Climate Policy Initiative at Tsinghua. She has also worked as a part-time consultant for World Resources Institute.

ZHOU Li is Associate Professor at the Institute of Energy, Environment and Economy at Tsinghua University and Deputy Director of the China Carbon Market Center (CCMC). She is an expert in the field of key technologies and national policies related to climate change and energy issues. She has published more than 30 papers. She has obtained the support of Beijing's first youth talent program for outstanding young teachers under the age of 35 and was selected by an exchange program for new scientists supported by the Chinese Ministry of Science and Technology. She hosted or participated in several important projects that had been sponsored by scientific and technological support research of the 11th Five-Year Plan, National 973 Program, National Natural Science Foundation of China, UNDP, Rockefeller Foundation, World Bank, and others. Her research results are recognized by other experts, and she was invited to be an author for the Global Energy Assessment (GEA) report, National Assessment Report of Climate Change, and China's third national assessment report on climate change. Some of the results were adopted as important technical support for national policy making, like provincial carbon-emissions-intensity control targets and national carbon-market design. She has been invited as an expert to participate in the "Annual Obligation Trial Assessment and Evaluation Work of Controlling Greenhouse Gas Emission Targets" since 2013, which is organized by national departments.

中国地方应对气候变化政策
哈佛气候协议项目研讨会

SUBNATIONAL CLIMATE CHANGE POLICY IN CHINA

A Research Workshop of the

Harvard Project on Climate Agreements

主办方：清华大学能源环境经济研究所
协办方：哈佛全球研究所

In Collaboration with and hosted by the

Institute of Energy, Environment, and Economy

Tsinghua University

With Support from the Harvard Global Institute

Harvard Global Institute

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

Harvard Project on Climate Agreements

中国地方应对气候变化政策

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主办方：清华大学能源环境经济研究所

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2019年7月18日至19日 周四-周五
清华大学
中国北京

议程

中国地方应对气候变化政策

背景和动机

气候变化是全球共同面临的问题，要充分应对气候变化，就需要在最高管辖层进行合作，即开展各国政府间的国际合作。然而，国家及地方政府的独立行动也能一定程度减缓气候变化。目前，世界各省市都采取了减少温室气体排放的措施，有时还进行跨国合作，其中包括排放量最大的国家—中国、美国和印度—以及欧盟的司法管辖区。

本次研讨会将探讨中国地方应对气候变化的政策。主题包括中国各省市如何与中央政府合作以落实相关政策，以及这种合作所面临的挑战。与会者将重点关注中国国家碳定价体系的实施，包括如何将试点省市纳入国家体系，如何更广泛地发挥各省在国家碳定价体系中的作用。与会者还将讨论减少温室气体排放的其他地方政策方法。

本研讨会隶属哈佛气候协议项目，该项目旨在研究中国和印度应对气候变化的地方政策，并在可行范围内进行比较。值得一提的是，本次研讨会将对中国与印度、美国和加拿大的政策进行比较。

哈佛气候协议项目衷心地感谢清华大学能源环境经济所张希良教授共同发起并主办此次研讨会，同时还感谢哈佛全球研究所(HGI)对本项目的支持。HGI支持旨在深化哈佛国际参与度的科研项目并为其提供经费支持，以应对气候变化、移民和国际关系等紧迫全球挑战。HGI一直重点关注中国问题，并在近期开始重点研究印度问题。

哈佛气候协议项目成立于2007年，旨在探明并推进科学、经济及政治可行的应对全球气候变化的公共政策。借助世界各地的领先思想家，哈佛项目基于国际、国家和地方等层面，开展了关于气候变化政策的政策架构、关键设计元素及制度的研究。

中国地方应对气候变化政策

哈佛气候协议项目研讨会

主办方：清华大学能源环境经济研究所
协办方：哈佛全球研究所
2019年7月18日至19日 周四至周五
清华大学
中国北京

议程

研讨会地点：

文津大酒店四楼寿山厅，
北京市海淀区成府路清华科技园，毗邻清华

7月18日（星期四）

上午

10：30 – 11：10 **欢迎致辞**

蒋兆理
生态与环境部气候变化司副司长

Robert STAVINS
哈佛气候协议项目主任

何建坤
国家气候变化专家委员会副主任

11：10 – 11：50 **中国气候变化政策现状研究**

全国碳定价体系
张希良

泛气候变化政策及相关环境能源政策
齐晔

11：50 – 12：10 **提问/回应**

蒋兆理
张建宇

12：10 – 12：45 **讨论**

中午

12：45 – 13：45 **午餐**

下午

13：45 – 14：45 **中国应对气候变化的地方政策及相关环境能源政策展望**

Michael DAVIDSON
齐绍洲
谭显春
Christine WONG

14：45 - 15：15 **讨论**

15：15 - 15：45 **休息**

15：45 - 16：30	**比较背景下应对气候变化的地方政策**
	印度：Radhika KHOSLA
	加拿大：Katie SULLIVAN
	美国：Robert STAVINS
16：30 - 16：50	**提问/回应**
	柴麒敏
	滕飞
16：50 - 17：30	**讨论**
晚上	
18：30 - 20：30	**接待晚宴**
	环境保护基金中国项目主办 1911 Restaurant 2d floor, Sohu.com internet plaza Walking directions and map will be provided at the workshop

7月19日（星期五）

上午	
中国国家碳定价体系中的中央-省级关系	
9：00 - 9：30	**国家碳定价体系与试点省市的整合**
	Valerie KARPLUS
	MEI Dewen
9：30 - 10：00	**国家碳定价体系的地方实施路径：挑战和机遇**
	Gørild HEGGELUND
	WU Libo
10：00 – 10:20	**提问/回应**
	TIAN Qi
	ZENG Xuelan
10：20 – 10：50	**休息**
10：50 – 11：45	**讨论**
11：45 – 12：00	**内部讨论及后续研究安排**
	Robert STAVINS
	张希良
中午	
12：00 – 14：00	**午餐（可选）**

SUBNATIONAL CLIMATE CHANGE POLICY IN CHINA

A Research Workshop of the Harvard Project on Climate Agreements

In Collaboration with and hosted by the
Institute of Energy, Environment, and Economy, Tsinghua University

With Support from the Harvard Global Institute

Thursday - Friday, July 18 – 19, 2019
Tsinghua University, Beijing, China

Agenda

SUBNATIONAL CLIMATE CHANGE POLICY IN CHINA

BACKGROUND AND MOTIVATION

Climate change is a global commons problem and, as such, requires cooperation at the highest jurisdictional level – that is, international cooperation among national governments – if it is to be adequately addressed. However, national governments acting independently, as well as subnational governments, can also significantly advance efforts to mitigate climate change. Provinces and municipalities around the world have undertaken initiatives – sometimes working together across national boundaries – to reduce greenhouse-gas emissions. This includes jurisdictions in the largest-emitting countries – China, the United States, and India – as well as in the European Union.

This workshop will examine subnational climate-change policy in China. For the purpose of these discussions, the topic includes how Chinese provinces and municipalities work with the central government to implement policy – and challenges to such cooperation. Participants will focus to a considerable degree on the implementation of China's national carbon-pricing system, including approaches to integrating the pilot programs into the national system and the role of provinces in implementation more generally. Participants will also address subnational dimensions of other policy approaches to reducing greenhouse-gas emissions.

This workshop is part of larger initiative of the Harvard Project on Climate Agreements examining – and, to the extent feasible, comparing – subnational climate-change policy in China and India. Indeed, there will be one session in this workshop comparing China with India, as well as with the United States and Canada.

The Harvard Project on Climate Agreements is grateful to Tsinghua University's Institute of Energy, Environment, and Economy, directed by Professor Zhang Xiliang, for co-sponsoring and hosting this workshop. The Harvard Project is also grateful to the Harvard Global Institute (HGI) for support for the broader initiative. HGI supports research initiatives that deepen Harvard's international engagement and promote scholarship to address pressing global challenges, such as climate change, migration, and transnational relations. HGI's geographical focus has been on China and, more recently, India.

The Harvard Project on Climate Agreements, established in 2007, seeks to identify and advance scientifically sound, economically sensible, and politically pragmatic public policy options for addressing global climate change. Drawing upon leading thinkers from around the world, the Harvard Project conducts research on policy architecture, key design elements, and institutional dimensions of international, national, and subnational climate-change policy.

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With Support from the Harvard Global Institute

Thursday - Friday, July 18 – 19, 2019
Tsinghua University, Beijing, China

AGENDA

Location of all workshop sessions:

Wenjin Hotel, Fourth Floor, Shoushan Room,
Tsinghua Science Park, Chengfu Road, Haidian District, Beijing
Adjacent to the South Gate of Tsinghua University

Thursday, July 18

10:30 – 11:10 am **Welcome, framing, and self-introductions**

JIANG Zhaoli
Deputy Director General, Climate Change Department,
Ministry of Ecology and Environment

Robert STAVINS
Director, Harvard Project on Climate Agreements

HE Jiankun
Deputy Director, National Experts Committee on Climate Change

11:10 – 11:50 am **Status update on climate-change policy in China**

National carbon pricing system:

ZHANG Xiliang

Broader climate-change policy – and related environmental and energy policy:

QI Ye

11:50 am – 12:10 pm **Responses**

JIANG Zhaoli

ZHANG Jianyu

12:10 – 12:45 pm **Discussion**

12:45 – 1:45 pm **Lunch**

1:45 – 2:45 pm	**Perspectives on subnational climate-change policy – and related environmental and energy policy – in China**
	Michael DAVIDSON
	QI Shaozhou
	TAN Xianchun
	Christine WONG
2:45 – 3:15 pm	**Discussion**
3:15 – 3:45 pm	**Break**
3:45 – 4:30 pm	**Subnational climate change policy in comparative context**
	India: Radhika KHOSLA
	Canada: Katie SULLIVAN
	United States: Robert STAVINS
4:30 – 4:50 PM	**Responses**
	CHAI Qimin
	TENG Fei
4:50 – 5:30 pm	**Discussion**
6:30 – 8:30 pm	**Reception and dinner**
	Hosted by the Environmental Defense Fund China Program
	1911 Restaurant 2d floor, Sohu.com internet plaza Walking directions and map will be provided at the workshop

Friday, July 19
Tsinghua University

Central-provincial relations in China's national carbon-pricing system

9:00 – 9:30 am **Integration of national system with provincial/municipal pilots**

Valerie KARPLUS

MEI Dewen

9:30 – 10:00 am **Subnational implementation pathways for the national pricing system: Challenges and opportunities**

Gørild HEGGELUND

WU Libo

10:00 – 10:20 am **Responses**

TIAN Qi

ZENG Xuelan

10:20 – 10:50 am **Break**

10:50 – 11:45 am **Discussion**

11:45 am – 12:00 pm **Closing observations, discussion, and next steps**

Robert STAVINS

ZHANG Xiliang

12:00 – 14:00 pm **Optional Lunch**

SUBNATIONAL CLIMATE CHANGE POLICY IN CHINA

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