中国碳排放权交易制度：历史、现状与展望

哈佛气候协议项目

由哈佛全球研究所支持

与清华大学能源环境经济研究所合作

Valerie J. Karplus
卡内基梅隆大学

2021年6月

中国碳排放权交易制度：历史、现状与展望

哈佛气候协议项目

由哈佛全球研究所支持

与清华大学能源环境经济研究所合作

Valerie J. Karplus
卡内基梅隆大学

2021年6月

致谢

本文是在哈佛全球研究所的支持下撰写的，是中国国家碳排放权交易体系大型研究项目的一部分。在这一倡议中，哈佛项目正与由张希良教授领导的清华大学能源环境经济研究所合作。哈佛项目得到了来自中国能源基金、Enel　基金会、哈佛大学气候变化解决方案基金、哈佛大学肯尼迪学院贝尔弗科学与国际事务研究中心以及哈佛大学环境中心的支持。

哈佛气候协议项目

哈佛气候协议项目是哈佛校级倡议，成立于2007年，旨在识别和推进应对全球气候变化的科学合理、经济合理和政治务实的公共政策选择。哈佛项目广纳天下之贤才，依托世界各地主要思想家，对国际和国内气候变化政策的政策架构、关键设计要素和制度层面进行研究。哈佛项目由哈佛大学肯尼迪学院　A.J. 迈耶（A.J. Meyer）能源与经济发展教授　Robert N. Stavins　领导。更多信息请访问哈佛项目网站：www.hks.harvard.edu/hpca。

引用信息

Karplus, Valerie J.　中国碳排放权交易制度：历史、现状与展望.　马塞诸塞州剑桥市：哈佛气候协议项目.　2021年6月.

中国碳排放权交易制度：历史、现状与展望

Valerie J. Karplus

卡内基梅隆大学

中国碳排放权交易体系（ETS）将于2021年年中正式投入运行。该体系旨在通过一个可交易的绩效标准来降低碳排放强度，并将率先在发电行业实施，预计未来将拓展到其他行业，且将由基于强度的碳交易体系向基于总量的体系过渡。本文梳理了碳交易体系的历史、设计及实施规则，并分析其未来十年的发展趋势。碳排放权交易体系将支撑“2030年前碳排放达峰”和“2060年前达成碳中和”这两个目标的实现。

1. 引言

在过去的十年里，碳排放权交易体系（ETS，下文简称“碳市场”）在中国逐渐发展起来。碳排放权交易是中国温室气体减排工作的基石。虽然目前只针对发电行业进行交易，但该系统将全面覆盖8个主要的能源密集型行业，预计到2025年将覆盖中国72%的碳排放（Zhang，2021）。如果发电行业如期在2021年开始交易，现行或计划实施的碳定价体系所覆盖的温室气体排放量将相比2020年增加约40%（世界银行，2020）。

碳市场将排放权分配给企业，并允许市场参与者以低于自身减排成本的价格购买排放权。经济学家认为，碳市场是一项成本最低的政策，因为从理论上讲，交易能够使各排放方的边际减排成本均等，以最低成本控制总排放量。

中国的政策制定者通过碳排放权交易来实现多个目标。首先，人们普遍认为，碳市场是一种以具有成本效益的方式控制来自电力和工业等主要排放源的碳排放量的工具，是中国为全球应对气候变化做出贡献的一种机制。不过，成本效益并不是唯一的目标。第二，碳市场建立了政府在碳排放监测、报告和核查（MRV）方面的能力，这对于衡量国家气候目标进展、加强参与者和观察员对该体系有效性的信任是必要的。第三，碳市场为中国的二氧化碳抵销市场注入了新的活力。此前，中国的碳抵销市场依赖于向欧盟排放权交易体系（EU　ETS）出售经认证的减排量。第四，或许也是最重要的一点，碳市场要求排放者对他们排放的二氧化碳负责。它提供了让管理者对二氧化碳和其他温室气体排放负责的基础，就像早期针对当地环境污染物的政策一样。可以说，中国的政策制定者可以实施许多有助于实现这些目标的替代政策设计，但它们都不具有行业覆盖面、当地熟悉度和支持度、国际地位，也与中国国内碳市场的改革议程不一致。虽然碳市场将有助于平衡企业间的碳边际减排成本，但这远远不是中国决策者判断该体系成功与否的唯一标准。

中国逐步发展碳市场反映了在此过程中的挑战和经验教训。2011年，中国首次宣布利用排放权交易管理二氧化碳排放的提议，并于2013年开始在七个省市进行试点。2017年底，有关部门正式宣布启动建立中国国家碳市场。经过数年的准备和延迟，首个覆盖发电行业的交易将于2021年6月启动。为目标行业建立监测、报告和核查制度（MRV）、2018年气候变化政策责任由国家发展改革委员会（NDRC，下文简称“国家发改委”）转至新成立的生态环境部（MEE）、最近爆发的CO-VID-19等相关挑战意味着中国的碳市场还有很长一段路要走。但是，这次延迟也为最终落实奠定了坚实的思想、法律和技术基础。

本章介绍了中国碳市场的现状。第2章将回顾其历史背景。第3章将阐述中国碳市场如何作为减排基于产出的可交易绩效标准（TPS）来实施。第4章将介绍碳市场的实施，包括其管理、覆盖范围、MRV及履约的相关规定。第5章将论述与现有政策的相互作用，包括现有区域试点与形成中的国家体系之间的关系。第6章将评估碳市场未来的发展方向。第七章将进行总结。

2. 历史背景

中国碳市场旨在支撑国家减缓气候变化目标的实施。当政策制定者在“十二五”规划（2011-2015年）中首次提出单位国内生产总值二氧化碳排放（下文简称“碳强度”）目标时，碳市场作为经济有效的替代命令与控制的应对气候变化方法而开始受到人们广泛关注。减少碳强度或减少与产出挂钩的碳排放总量的国家目标，与作为《联合国气候变化框架公约》（UNFCCC）进程一部分的减排承诺相对应。2009年，中国在哥本哈根首次承诺，到2020年全国碳强度将相比2005年下降40%~45%。2015年，在巴黎第21次缔约方大会（COP）召开之前，中国领导人宣布到2030年中国碳强度将相比2005年下降60%~65%，并最迟在2030年实现碳达峰。2020年秋天，习近平主席在联合国大会上宣布，中国将力争在2060年前实现碳中和。

中国碳市场建立在2013-2014年推出的七个碳排放权交易试点的经验基础上。此前在工业能效提升行动、《京都议定书》的清洁发展机制以及20世纪90年代末二氧化硫（SO_2）交易方面的经验也影响和塑造了中国碳市场的设计。

中国最初制定碳排放权交易机制是为了支撑国家和省级碳强度目标的实现，这与国家承诺和其他支撑政策相一致，如表1所示。在“十二五”规划中，碳强度目标与能源强度目标一同引入以支撑国内2009年哥本哈根承诺的落实。长期以来，中国五年规划中的能源强度目标仅从“十一五”规划（2006~2010年）开始才被视为具有约束力。尤其是“十一五”末为实现“强制性”能源强度下降目标而展开的一场代价高昂的争夺，凸显了目标不灵活的后果。官员们将国家目标分解到省级和省级以下行政部门，以实现公平分配的目标。总体而言，与较发达的东部省份相比，欠发达的西部省份面临的目标不那么严格。

表1. 国家气候承诺与国内主要碳减排政策间的对应关系

承诺年份	国家气候承诺—碳减排目标及时间表	关键实施政策
2009	与2005年相比，到2020年碳强度下降40%~45%	提出国家和省级二氧化碳排放目标、工业能效目标、碳市场
2014	与2005年相比，到2030年碳强度下降60%~65%；到2030年实现碳达峰	区域碳市场试点、国家碳市场（基于强度）、支持可再生能源电力的部署和并网
2020	2060年前实现碳中和	国家碳市场（基于总量）、可再生能源投资组合标准、对低碳能源的研发支持、技术标准（非二氧化碳温室气体）

应对气候变化和发展碳市场的职责最初属于国家发改委，该委员会是国家主要的经济规划部门。2018年，与气候变化相关的职能移交给了生态环境部，该部负责监督国内空气、水和土壤污染物的法规。这种职责转移授权生态环境部在企业层面监测温室气体和其他污染物的排放，监督国家碳市场的持续实施，并惩处违规行为。

中国碳市场发展的重要日期包括：

2011年 发布《碳排放权交易试点工作通知》

2013~2014年 7个国内碳排放权交易试点开始运行

2017年12月 启动全国碳市场、制定路线图并得到国务院批准

2018年 应对气候变化与发展碳市场职责从国家发改委转移到生态环境部

2020年12月 《碳排放权交易管理办法（试行）》发布（2021年2月1日起施行）

2021年3月 《碳排放权交易管理暂行条例（草案修改稿）》发布

3. 碳市场设计：可交易的绩效标准

3.1 配额分配

中国碳市场本质上是一种可交易的绩效标准（TPS）：其目标是降低经济活动的碳强度（基于强度的体系），而不是减少碳排放总量（基于总量的体系）（Pizer和Zhang，2018）。TPS的目标是减少碳市场所覆盖设施每单位产出的平均碳排放量。TPS要求碳市场所覆盖单位定期提供有关排放量和经济产出的信息。在履约期结束时，监管机构会核查设施实际产出以调整最终配额。

全国碳市场预计将全面覆盖电力（包括发电和热电联产）、建材、钢铁、有色、石化、化工、造纸和民航等八个行业的大型企业。以年度温室气体排放量达到约2.6万吨二氧化碳当量（相当于1万吨标准煤的能源消费量）为门槛，全国碳市场预计将覆盖约7500家企业，涵盖CO_2排放67亿吨，相当于中国2017年碳排放总量的72%（Zhang，2021）。中国火力发电机组基本都超过上述排放门槛，因此碳市场预计将全面覆盖该行业（该行业2017年碳排放总量达36亿吨CO_2）。

在率先实行碳排放权交易的发电行业中，初始配额将根据排放单位的技术碳排放率进行相应计算。该体系定义了四个基准类别：300兆瓦以下的常规燃煤电厂、300兆瓦以上的常规燃煤电厂、非常规燃煤电厂和天然气电厂。基准的部分目的是通过衡量较老、较脏电厂相对于同类电厂的最佳效率表现来限制其负担。由于这些工厂不成比例地分布在不太富裕的省份，通常是中西部省份，基准为解决地区公平问题提供了一种途径。早期碳市场所迭代的基准多达11个（Pizer和Zhang，2018），但为了提高系统整体效率，最终减少至如今的4个。

一个悬而未决的问题是，省级政府将如何处理由国家碳市场带来的省级减排义务的不确定性。目前，全国碳市场只覆盖各省的部分排放单位，包括所有发电企业和部分来自其他高能耗行业的企业（排放量占该行业的50%~100%）；特别是，一些较小的水泥公司没有被纳入全国碳市场。在能源密集型行业中，未达到碳市场门槛的企业通常是碳密集型企业。受减排目标约束的省级政府，需要确定该省不在碳市场覆盖范围内的企业应在多大程度上减少碳排放强度——但这是不确定的，因为在履约期结束前，难以确定被纳入碳市场的企业是通过内部减排还是通过购买配额抵销碳排放。这将给各省设计支撑碳强度目标实现的辅助措施带来困难，同时也将带来如何避免省内外抵销额度重复计算的挑战。

3.2 减排策略

可交易绩效标准的设计会影响被纳入单位的减排选择。考虑到它对电力企业的影响，电力公司有两种履约方法：一种是提高单台机组的效率，另一种是机组间的发电转换（例如，发电从效率较低、通常较旧和较小的机组转换到效率更高、通常较新较大的机组）。鉴于燃煤电厂和天然气电厂的基准不同，燃料转换的动力也受到限制。由煤转换为天然气是欧盟碳市场主要履约策略之一，其中将天然气纳入到单独的基准类别可以避免这些企业获得大量配额盈余。由于配额分配是根据实际产量进行调整的，因此只有当碳排放强度高于基准值时，排放单位才有动力通过减少产量来减少碳排放，而那些成本太高或难以融入碳市场的设施将面临越来越大的压力直至永久关闭。

碳市场不覆盖非化石能源发电（如核电、水电和其他可再生能源发电），相反地，可再生能源投资组合标准等政策将主要面向促进可再生能源发电量的增长。可再生能源的大规模发展可能会限制化石能源发电的发展，因此随着化石电力的减少，未来几十年碳市场在发电行业的减排贡献将不断下降。

4. 碳市场的实施

本章将根据2021年5月前发布的相关法律和指令描述中国碳市场的实施计划，并主要侧重于电力行业的设计。该计划将于2021年6月开始交易，将碳交易拓展到其他部门的工作仍在进行中。

4.1 机构结构与管理

生态环境部及其地方代表机构负责监督中国国家排放权交易系统的实施。自2021年2月1日起生效的《碳排放权交易管理办法（试行）》（下文简称《管理办法》）概述了交易实施细则。该文件首先阐述了碳市场发展的基本原则，具体包括：市场导向、循序渐进、公平公开和诚实守信的原则。开篇显示了中国政策指导的典型特征——旨在利益相关者间建立起对流程设计和结果的共同期望。

《管理办法》概述了两个国家机构在项目管理中的作用。首先，国家碳排放权注册登记机构将使用国家碳排放权注册登记系统记录碳排放配额的持有、变更、清缴、注销等信息，并提供结算服务。其次，全国碳排放权交易机构负责组织开展全国碳排放权集中统一交易。此前，尚不清楚是否有一个碳市场试点交易所将承担这一职能，但《管理办法》明确规定了对应的国家权力机构。以上两个机构应定期向生态环境部汇报进展。

生态环境部本身负责制定减排技术定义的规则，监督地方（如省、市）碳配额分配监管工作的表现，要求进行温室气体排放报告和核查，以及配合国务院有关部门做好碳排放交易体系协调工作。2018年之后，项目领导权从国家发改委移交给生态环境部，导致了实施的延迟。

根据《管理办法》有关规定，各级政府机构应当负责碳市场的具体实施。在生态环境部的监督下，省级生态环境主管部门负责在本行政区域内组织开展碳排放配额分配和清缴、温室气体排放报告的核查等相关活动，并进行监督管理。设区的市级生态环境主管部门负责配合省级生态环境主管部门落实相关具体工作，并根据有关规定实施监督管理。

作为国家应对气候变化努力的一部分，预计到2021年底，国务院法规将为碳排放权交易体系提供更强有力的法律依据。该法规在强度上等同于全国人民代表大会通过的法律。这将为该系统的未来发展奠定坚实基础，包括对违规行为处以更高的罚款。若2021年3月30日发布的《碳排放权交易管理暂行条例（草案修改稿）》（下文简称《暂行条例》，链接见参考文献）在今年晚些时候生效，则将取代《管理办法》。除非另有说明，以下关于碳市场的描述依赖于《管理办法》。

4.2 配额分配

碳排放权交易配额总量的设定与分配由生态环境部确定。全国碳市场的配额分配考虑了控制温室气体排放行动目标（国家与省级目标中提出的）、经济增长预期、经济结构调整（提高低能耗行业的比重）、能源结构优化（改用低碳燃料）和大气污染物排放控制等因素。尽管采用基准法核算配额量可以适应经济增长，但没有明确考虑其他标准。因而尽管人们一直对利用碳市场来加强空气污染控制目标感兴趣，但对于是否或如何将这些目标纳入方案设计尚未达成共识。

分配方案包括根据历史碳排放水平和产出向所覆盖的单位预分配碳配额，然后在履

约期末进行调整，即为与实际产出挂钩的排放量提供配额，其中配额所对应的排放量是根据各类别机组的碳排放基准值计算出来的。排放配额分配初期以免费分配为主，但《管理办法》与《暂行条例》表明，将适时引入有偿分配，并逐步扩大有偿分配比例。

中国发电行业碳市场初期的配额设置考虑了供电和供热，二者合计构成一个机组的总配额量。供电量或供热量将会乘以相应的排放基准值。而后的修正考虑了冷却方式（空冷还是水冷）、供热比重以及平均负载。特别是对于使用耗水量较少的空气冷却的电厂，其供电量的配额修正系数为1.05，而水冷为1。

4.3 覆盖范围

中国碳市场的第一阶段将包括2200家电力企业，包括热电联产和纯凝发电机组。该体系仅覆盖电力行业，每年将控制40亿吨二氧化碳排放量，占全中国碳总排放量的40%。将碳市场拓展到水泥和电解铝行业的提案正在制定中，这些行业的交易预计将于2022年开始。

除碳市场覆盖的单位外，生态环境部还负责监管所有“重点排放单位”的排放量，预计这些单位最终都将纳入全国碳市场。重点排放单位为全国碳市场将覆盖的八个行业内年度温室气体排放量达到2.6万吨二氧化碳当量及以上的企业或其他经济组织。该名称类似于大型排污单位；以前，特定污染物（例如二氧化硫或氮氧化物）的主要排放源清单定义了主要环境法规的范围和目标。连续两年温室气体年排放量未达到2.6万吨二氧化碳当量，或因停业、关闭或者其他原因不再从事生产经营活动的单位，将从重点排放单位名录中移出。

根据《管理办法》，碳市场以外的自愿减排量最多可抵销应清缴碳排放配额的5%，用于抵销的自愿减排量应来自可再生能源、碳汇、甲烷利用等领域减排项目。所有自愿减排量必须在国家自愿减排交易平台中进行登记。如何确保这些自愿减排量不会被碳市场和相关政策（例如省级可再生能源投资组合标准）重复计算，仍然是一个悬而未决的问题。

4.4 监测、报告与核查

只有当全国碳市场能准确计算其所覆盖的碳排放量，其作用才能有效发挥。MRV将确定排放单位的历史碳排放量和排放强度，并对其随时间变化的情况进行测算。在7个碳市场试点中，为支撑高质量MRV而实施的措施差异很大；可以说，MRV在北京发展得最为成熟。北京市政府要求对第三方碳排放核查机构的核查报告进行额外的随机审计。研究表明，在该制度下，企业自报的排放量与项目最初几年的实际排放量相差很大。这些偏差发生在两个方向上，表明企业没有故意歪曲其排放量（Zhang等，2019）。为了促进碳市场的发展，需要研究如何扩大MRV以支撑全国碳市场，特别是考虑到各省和部门在激励措施和机构能力方面的差异。现行行动方案明确规定，官员应使用“双随机、一公开”的方式进行检查和监督，这也是中国监管机构倡导的一种普遍做法，包括随机抽查核查

人员与被核查企业之间的匹配关系（“双随机”）并公布核查结果（“一公开”）。超过400名排放核查员已通过认证，可以为全国碳市场中的企业提供服务。申请纳入碳市场的单位必须先对其排放情况进行核查，然后由省生态环境厅批准。

4.5 执法和违规处罚

当前的执法机制，包括违规处罚，必须谨慎地权衡激励措施，以避免违规行为与市场参与者间的串谋。根据《管理办法》，虚报、瞒报排放的重点排放单位将处以1万元以上3万元以下的罚款，与大多数被覆盖企业的年利润相比，这是相对适度的。重点排放单位未按时足额清缴碳排放配额的，将处以2万元以上3万元以下的罚款。如果国务院发布《暂行条例》终稿，罚款金额预计将上升。根据《暂行条例》，虚报或瞒报排放将会被处以5万元以上20万元以下的罚款。未按时履行配额清缴义务的，将处以10万元以上50万元以下的罚款。然而相比各省可实施的其他政策工具（例如限制企业的融资渠道或其他形式的支持），财政处罚预计不会是违规行为的唯一威慑。如果排放核查机构与相关企业勾结或伪造数据，处罚将包括取消佣金、削弱其信用，严重情况下将禁止该组织运营三年。正在进行的讨论着重于如何在年度绩效评估中对不遵守碳市场规定的省级领导人和企业进行处罚。

5. 与相关政策的相互关系

从某种程度上说，中国气候政策格局采用了“双保险”的方法。全国碳市场是在7个试点碳市场以及一系列部门气候和产业政策的基础上发展起来的。因此，根据中国2060年前实现碳中和的承诺，清楚地了解这些政策将如何相互作用并最终影响二氧化碳总量的减少是很重要的。

5.1 碳排放权交易试点

国家碳市场的一个重要问题是它是否会取代在北京、天津、上海、广东、深圳、湖北和重庆建立的7个碳排放权交易试点。试点的部门覆盖范围各不相同，但一旦在8个覆盖的行业开始运行，就会与国家碳市场大体重叠。最新规则表明，试点将继续与国家碳市场并存，但这些系统不会重叠。具体来说，《管理办法》明确规定，某个单位一旦被纳入国家碳市场，就必须退出其所属的任何试点碳市场。但是，为支撑省级碳强度目标的实现，省级主管部门可以自由地将试点碳市场拓展到门槛以下的企业和处于未覆盖行业的企业。

5.2 可再生能源政策

各省制定的可再生能源投资组合标准已取代上网电价，成为中国推进可再生能源发展的主要政策工具。目前正在发电行业发展的碳市场仅涵盖化石能源电力（主要是煤炭和天然气发电），减排义务在机组级别确定。因此，可再生能源政策与碳市场在很大程度上没有重叠。对于纳入碳市场的发电企业，不能通过部署可再生能源来实现减排。唯一可能发生重叠的是用于抵销的国家核证自愿减排量，抵销比例最多可达到应清缴碳配额的5%。在这方面，用于抵销的自愿减

排量可来自可再生能源，从而增加了碳市场和可再生能源投资组合标准重复计算的可能性。这个问题有待于在未来系统的进一步设计中解决。

5.3 工业节能政策

针对大型企业的工业能效提升行动，包括2006~2010年的“千家企业节能行动”和2011~2015年的“万家企业节能低碳行动”，在许多方面都是多部门国家碳市场的先驱。尽管这些行动不包括贸易，但它们同样针对大型用能企业——鉴于煤炭在中国电力和工业中的直接使用比例很高，因此可以很好地替代碳排放强度。这些行动也为政策制定者强调了强有力的MRV的重要性，因为人们担心出于履约目的所提交的自我报告数据存在可靠性问题。

这些最新的工业能效提升行动与国家碳市场的预期范围非常接近。在最新版本中，一项拓展的工业能效提升行动引入了试点规模的节能配额交易。这种与碳市场的重叠是有问题的，因为必须在自身范围降低能源使用强度的公司参与交易的动机有限。此外，企业将需要跟踪与能源和二氧化碳密切相关的履约义务，这可能会使管理费用增加近一倍。由于这两个密切相关的计划由不同的政府部门牵头（国家发改委、工业和信息化部负责监督工业能效提升行动的实施），因此解决这一重叠问题具有较大挑战性，但对于扩大后的国家碳市场的有效运作至关重要。

6. 前景展望

6.1 将碳市场拓展到发电以外的行业

一个重要的问题是，以多快的速度、以什么样的顺序将碳市场的覆盖范围拓展到其他行业。碳市场设计师应关注以下几个标准。首先，对于所覆盖行业中的主要排放实体，MRV是否完整？这并不简单，因为MRV将在省级层面实施，而当地政府和所覆盖的排放单位都是首次进行MRV。因此，国家监督必须遵守并纠正错误的会计惯例。事实证明，在水泥和电解铝等产品相对同质的行业中开展MRV更为简单，这使得这些行业将成为下一个在全国碳市场进行交易的行业。

其次，由于私营企业可能对碳市场施加的成本更加敏感，因此碳市场在发电以外的国有程度较低的行业运行会提高其效率。但是，由于非国有企业缺少目标责任制等直接渠道，将缺乏对国家监督机构的责任，从而直接影响到高层领导者的激励。在中国的工业能效政策的背景下，规模较大的非国有企业更有可能报告违规行为（Karplus等，2020）。

6.2 从基于强度到基于总量的体系？

中国碳市场的设计者表示，它最终将从基于强度的体系转变为基于总量的体系。基于总量的体系将消除隐性的产出补贴，从而提高碳减排的成本效益。在基于总量的碳市场系下，可交易绩效标准的增量成本将随总排放量的减少而增加，因为电力输出的减少在CO_2减排总量中将占据更大的份额（Goulder等，2017年；2019年）。向基于总量的体

系过渡的主要缺点是，那些关注限制碳市场对覆盖企业和经济增长（更广泛地说）带来的负担的人强力支持基于强度的体系。

6.3 对正在进行的电力市场化改革的影响

中国正在进行的电力市场化改革与碳市场运行的第一阶段直接互动，该阶段只涉及发电机组。从1998年到2003年，第一轮电力改革将发电与输电分开，打破了国家对发电的垄断，目的是吸引新的投资以满足快速增长的电力需求并解决短缺问题（Davidson和Pérez-Arriaga，2020年）。自2016年以来，电力改革的重点转向批发和零售定价以及调度机制上，目标是（1）降低电价；（2）提供适当的激励措施来投资辅助服务，以确保系统持续运行；（3）改善可再生能源并网情况，包括跨省传输。

中国的固定电价体系已经发展成为一种混合体系，包括“计划内”（固定）电价和双边市场、多边市场以及现货市场交易。截至2020年底，已选定华南（广东）、蒙古西部、浙江、山西、山东、福建、四川和甘肃八个省份/地区进行现货市场试点。这些试点的现货价格起初很低，接近这些地区煤电机组的可变成本。改革导致电力销售份额在各省的差异，而电力销售份额又受到市场定价的影响。这对碳市场的统一实施提出了挑战，因为受“计划内”定价约束的公司无法转移碳市场履约成本，使其相对于向市场出售部分或全部发电产品的公司而言处于劣势地位。

6.4 国际气候政策与碳市场链接

随着越来越多的国家寻求到本世纪中叶实现气候中和，将气候政策与国际接轨将为各国政府提供了在组织能源密集型、贸易密集型产业搬迁的同时降低边际温室气体减排成本的机会。为了应对人们对碳泄漏的担忧，欧洲已经在开发碳边界调整机制（BCAs），并在美国最近的政策设计讨论中重新成为一个关键因素。BCAs可以为这种链接提供一个起点，因为它们需要评估出口市场与国内市场中气候政策的相对严格程度。随着越来越多的国家采用气候政策并探索BCAs的使用，该评估可能会成为确定链接收益的基础。

在许多方面，中国碳市场的设计者正在计划将其发展中的碳市场与全球其他国家碳市场相链接。首先，中国可以通过抵销建立链接方面的经验：在本世纪初期，在实施自己的国家气候政策之前，中国通过清洁发展机制为欧盟碳市场提供了二氧化碳抵销的主要来源。销售抵销额度的受益者主张继续和扩大获得减排碳信用的机会，包括国家碳市场和海外政策。其次，这种链接为中国提供了一个将其体系设计和技术标准投射到世界各地新开发的体系上的渠道，同时增强了中国作为全球减缓气候变化努力参与者的声誉。第三，随着中国碳市场的拓展和低成本减排机会的日益受限，碳市场设计者将有一种通过建立碳市场链接控制日益上涨的减排成本的经济动机。它还为中国企业提供了购买碳信用额度以覆盖其国内排放量的机会。

7. 结论

借鉴以往环境政策的经验，中国的政策制定者在逐步发展排放权交易制度的同时，也在逐步发展支持MRV和执法的制度。虽然更广泛的努力被称为碳排放交易制度，但深入研究可以发现，它的核心是一个过渡制度，将企业级目标、国家管控和产业政策等要素与市场机制结合起来。许多人认为，偏离市场机制对于获得并购、积累经验和解决股权问题是必要和重要的，尤其是在开始阶段。

随着电力市场改革的推进、可再生能源和其他先进能源技术的成本下降、以及MRV和执法能力更强大更具地域均衡性，系统成本有望下降且效率有望提高。因此，碳市场未来将成为管理所覆盖行业碳排放的强大工具。中国碳市场也可能为其他寻求以经济有效的途径来减轻自身对气候变化影响的发展中国家政府树立榜样。

全球气候减缓工作需要考虑到所有温室气体，而不仅仅是二氧化碳（约占中国温室气体总量的80%）。大家不得不面对这样一个事实：排放并非止于国界，而是全球供应链中多个参与者共同决定的结果。目前，中国的2060年碳中和目标并未提及其他温室气体。它也不承担在中国境外排放的温室气体的责任，即使这些排放通过供应链间接与中国公司或在华生产活动有关。中国全国碳市场的发展是对应对这些更广泛挑战的有针对性努力的补充，而不是替代。如何鼓励人们以不断提高的雄心发展碳市场是一个关键的问题。

参考文献

Administrative Measures for Carbon Emission Trading (Trial) 碳排放权交易管理办法（试行）published Dec. 30, 2020, effective Feb. 1, 2021. http://www.gov.cn/zhengce/zhengceku/2021-01/06/content_5577360.htm

Davidson, M. R. and Pérez-Arriaga, I., Avoiding Pitfalls in China's Electricity Sector Reforms. *Energy Journal*. 41 (2020). https://doi.org/10.5547/01956574.41.3.mdav

Goulder, L. H. and Long, X. and Lu, J. and Morgenstern, R. D., China's Unconventional Nationwide CO_2 Emissions Trading System: The Wide-Ranging Impacts of an Implicit Output Subsidy (2019). NBER Working Paper No. w26537. https://www.nber.org/papers/w26537

Goulder, L. H., Morgenstern, R. D., Munnings, C. and Schreifels, J. China's national carbon dioxide emission trading system: An introduction. *Economics of Energy and Environmental Policy*. 6, 1–18 (2017). https://doi.org/10.5547/2160-5890.6.2.lgou

Interim Regulation on the Management of Carbon Emissions Trading (Draft Revision). 碳排放权交易管理暂行条例（草案修改稿）published March 30, 2021. http://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/202103/W020210330371577301435.pdf

Karplus, V. J., Shen, X., and Zhang, D., Herding Cats: Firm Non-Compliance in China's Industrial Energy Efficiency Program. *Energy Journal*. 41 (2020). https://doi.org/10.5547/01956574.41.4.vkar

Pizer, W. A. and Zhang, X. China's New National Carbon Market. *AEA Papers & Proceedings*. 108, 463–467 (2018). https://doi.org/10.1257/pandp.20181029

World Bank. 2020. *State and Trends of Carbon Pricing 2020*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/33809

Zhang, D. *et al*., Integrity of firms' emissions reporting in China's early carbon markets. *Nature Climate Change* 9 (2019). https://doi.org/10.1038/s41558-018-0394-4

Zhang, X. (2021). *The Role of Carbon Market in Achieving China's New Climate Goals* (mimeo). Beijing, China: Tsinghua University Institute of Energy, Environment, and Economy.

哈佛气候协议项目

79 John F. Kennedy Street
Cambridge, Massachusetts 02138, USA

+1 617 496 8054
climate@harvard.edu
www.hks.harvard.edu/hpca

CHINA'S CO_2 EMISSIONS TRADING SYSTEM: HISTORY, STATUS, AND OUTLOOK

HARVARD PROJECT ON CLIMATE AGREEMENTS

Supported by the Harvard Global Institute

in collaboration with Tsinghua University, Institute of Energy, Environment and Economy

Valerie J. Karplus

Carnegie Mellon University

June 2021

China's CO_2 Emissions Trading System: History, Status, and Outlook

Harvard Project on Climate Agreements

Supported by the Harvard Global Institute

in collaboration with Tsinghua University, Institute of Energy, Environment and Economy

Valerie J. Karplus

Carnegie Mellon University

June 2021

ACKNOWLEDGEMENTS

This paper was written with the support of the Harvard Global Institute, as part of a larger project exploring China's national emissions trading system. The Harvard Project is collaborating closely with Tsinghua University's Institute of Energy, Environment and Economy, directed by Professor Zhang Xiliang, in this initiative. The Harvard Project receives support for other initiatives from Energy Foundation China, the Enel Foundation, Harvard University Climate Change Solutions Fund, the Belfer Center for Science and International Affairs at Harvard Kennedy School, and the Harvard University Center for the Environment.

THE HARVARD PROJECT ON CLIMATE AGREEMENTS

The Harvard Project on Climate Agreements is a Harvard-University-wide initiative established in 2007 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.

CITATION INFORMATION

Karplus, Valerie J. "China's CO_2 Emissions Trading System: History, Status, and Outlook." Cambridge, Mass.: Harvard Project on Climate Agreements, June 2021.

CHINA'S CO_2 EMISSIONS TRADING SYSTEM: HISTORY, STATUS, AND OUTLOOK[1]

Valerie J. Karplus
Carnegie Mellon University

China's emissions trading system (ETS) for carbon dioxide (CO_2) will become operational in mid-2021. The system targets reductions in carbon intensity via a tradeable performance standard, initially in the power sector, with expected expansion to other industries. Plans to convert from a rate-based to a mass-based system are underway. This paper describes the trading system's history, design, rules governing implementation, and anticipated developments over the next decade. The ETS is expected to support China's goals of reaching peak CO_2 emissions by 2030 and of achieving carbon neutrality by 2060.

1. INTRODUCTION

The past decade has seen the gradual development of an emissions trading system (ETS) for carbon dioxide (CO_2) in China. Emissions trading forms the cornerstone of China's greenhouse gas (GHG) emissions reduction efforts. While plans to begin trading currently exist only for the power sector, at full scale the system will cover eight major energy-intensive sectors. Ultimately, the system is expected to cover 72% of the country's CO_2 emissions by 2025 (Zhang, 2021). If the power sector begins trading as expected in 2021, global GHG emissions under existing or planned carbon pricing systems would increase by roughly 40%, relative to 2020 levels (World Bank, 2020).

An ETS allocates to enterprises rights to emit and allows market participants to purchase these rights when doing so is cheaper than undertaking reductions internally. Economists consider an ETS a least-cost policy because trading theoretically equalizes the cost of an additional unit of emissions reduction across emitters, staying below the total emissions limit at least cost.

China's policymakers have embraced emissions trading to advance multiple objectives. First, the ETS is widely viewed as a cost effective tool for controlling CO_2 emissions from its major sources in electric power and industry, providing a mechanism to implement China's contribution to global climate change mitigation. However, cost effectiveness is not the only goal. Second, an ETS builds *government capabilities* in monitoring, reporting, and verification (MRV) of CO_2 emissions, which is necessary to measure progress toward national climate goals and to strengthen trust in the system's efficacy among both participants and observers. Third, the ETS

1 The author is grateful to Marika Tatsutani for editing the paper and to Bryan Galcik for layout and design of the document.

gives new life to China's CO_2 offset market, which previously relied on selling certified emissions reductions to the European Union Emissions Trading System (EU ETS). Fourth, and perhaps most importantly, the system *holds emitters responsible* for the CO_2 they emit. It provides the basis for holding managers accountable for CO_2 and other GHG emissions, in the same way that earlier policies targeted local environmental pollutants. Arguably, China's policymakers could implement many alternative policy designs that could help to achieve these ends, but none shares the sectoral coverage, local familiarity and support, international stature, and alignment with China's domestic market reform agenda of an ETS. While the ETS will help to equalize the marginal cost of CO_2 abatement across firms, this is far from the sole criterion on which China's policymakers are judging the success of the system.

China's gradual approach to developing its ETS reflects challenges that have emerged and lessons learned along the way. The proposal to use emissions trading to manage CO_2 emissions in China was first announced in 2011 and piloted in seven provinces and cities starting in 2013. At the end of 2017, authorities officially announced the launch of efforts to build China's national ETS. After several years of preparation and delays, trading in the first covered sector, electric power, is expected to commence by June 2021. Challenges related to establishing monitoring, reporting, and verification (MRV) protocols for targeted industries, transitioning responsibility for climate change policy from the National Development and Reform Commission (NDRC) to the newly created Ministry of Ecology and Environment (MEE) in 2018, and, most recently, COVID-19 have meant a longer road for China's ETS. However, delays have also allowed time to lay a stronger ideological, legal, and technical foundation for its eventual launch.

This paper reviews the status of China's ETS. Section 2 provides historical context. Section 3 describes how China's ETS is currently implemented as a tradeable performance standard (TPS), with reduction obligations benchmarked to output. Section 4 describes the implementation of the ETS, elaborating its administration, coverage, and provisions for MRV and compliance. Section 5 addresses interactions with existing policies, including the relationship between preexisting regional pilots and the emerging national system. Section 6 assesses future directions for system development. Section 7 concludes.

2. HISTORICAL CONTEXT

China's ETS is designed to support the implementation of national climate change mitigation goals. When policymakers first introduced targets for CO_2 emissions intensity in the Twelfth Five-Year Plan (2011–2016), an ETS began to gain traction as a cost-effective alternative to command-and-control approaches for addressing climate change. National targets for reducing CO_2 emissions intensity, or CO_2 emissions indexed to output, correspond to mitigation commitments pledged as part of the United Nations Framework Convention on Climate Change (UNFCCC) process. The country's first pledge in Copenhagen in 2009 committed to reducing national CO_2 intensity by 40%–45% by 2020, relative to 2005 levels. Ahead of the 21st Conference of Parties (COP) in Paris in 2015, China's leaders announced intentions to reduce the CO_2 intensity of China's economy by 60%–65% below 2005 levels by 2030, and to reach peak CO_2

emissions at the latest by 2030. In the fall of 2020, President Xi Jinping announced before the UN General Assembly that the country would aim to achieve CO_2 neutrality by 2060.

China's ETS builds on experience with seven pilot emissions trading systems for CO_2 that launched in 2013–2014. Prior experience with industrial energy efficiency programs, the Clean Development Mechanism of the Kyoto Protocol, and early experiments with sulfur dioxide (SO_2) trading in the late 1990s have also informed and shaped the design of China's ETS.

Table 1. Correspondence between national climate pledges and key domestic CO_2 reduction policies.

Pledge Year	National Climate Pledge — CO_2 Reduction Target and Time Frame	Key Implementing Policies
2009	Reduce CO_2 intensity 40%–45% by 2020, relative to 2005	National and provincial CO_2 targets, industrial energy efficiency targets, ETS proposed
2014	Reduce CO_2 intensity 60%–65% by 2030, relative to 2005; reach peak CO_2 emissions by 2030	Regional ETS pilots, national ETS (rate-based), support for renewable electricity deployment and integration
2020	Achieve CO_2 neutrality by 2060	National ETS (mass-based), renewable portfolio standards, R&D support for low-carbon energy, technology standards (non-CO_2 GHGs)

China initially developed the ETS as a way to support the achievement of national and provincial targets for CO_2 intensity, in line with the national pledges and alongside other supporting policies, as described in Table 1. During the Twelfth Five-Year Plan, CO_2 intensity targets were introduced alongside energy intensity targets to support domestic implementation of the 2009 Copenhagen pledge. Energy intensity targets had long been included in the country's Five-Year Plans, but starting only with the Eleventh Five-Year Plan (2006–2010) were these targets considered binding. In particular, a costly scramble at the end of the Eleventh Five-Year Plan to achieve "mandatory" energy-intensity reduction targets highlighted the consequences of inflexible targets. Officials disaggregated the national target to subordinate administrative levels, with targets assigned at the provincial and lower levels to achieve distributional equity objectives. In general, less developed western provinces faced less stringent targets, compared to the more developed East.

Responsibility for climate change, and thus ETS development, initially belonged to China's National Development and Reform Commission (NDRC), the state's main economic planning body. In 2018, functions related to climate change were transferred to the Ministry of Ecology and Environment (MEE), which oversees the regulation of domestic air, water, and soil pollutants. This transfer of responsibility authorizes MEE to monitor GHGs alongside other pollutants at the enterprise level, oversee the ongoing implementation of the national ETS, and punish non-compliance.

Key dates in the development of China's national ETS include:

2011	Plans to develop trading systems for CO_2 emissions announced
2013–2014	Seven ETS pilots launched
Dec. 2017	National ETS development launched, roadmap outlined and endorsed by the State Council
2018	Responsibility for climate change and the ETS transferred from the NDRC to MEE
Dec. 2021	*Administrative Measures for Carbon Emission Trading* (Trial) published (effective February 1, 2021)
Feb. 2021	*Interim Regulation for the Management of Carbon Emissions Trading* (Draft) published

3. ETS DESIGN: A TRADABLE PERFORMANCE STANDARD

3.1 Permit Allocation

China's ETS is essentially a tradable performance standard (TPS): it targets reductions in the CO_2 intensity of economic activity (a rate-based system), rather than total CO_2 emissions (a mass-based system) (Pizer and Zhang, 2018). The TPS targets reductions in the average CO_2 emissions per unit of output of covered facilities. A TPS requires that covered entities regularly provide information on both covered emissions and economic output. At the end of the compliance period, regulators adjust final allowance allocations up or down based on the verified output of facilities.

Large firms in eight sectors — electricity (including power generation and power and heat cogeneration), buildings, iron and steel, non-ferrous metal processing, petroleum refining, chemicals, pulp and paper, and aviation — are slated for inclusion in China's national ETS when it reaches full scale. Applying a threshold of approximately 26,000 tons CO_2 emissions per year, corresponding to verified energy use of 10,000 tons of coal equivalent, at full scale the program is expected to cover approximately 7,500 enterprises representing 6.7 billion metric tons (bmt) of CO_2 or 72% of China's total CO_2 emissions in 2017 (Zhang, 2021). China's fossil power generating units are essentially all above this emissions threshold and therefore the ETS is expected to achieve comprehensive coverage of the sector, which emitted a total of 3.6 bmt of CO_2 in 2017.

In electric power, the first sector to implement the ETS, initial permit allocations differ according to the CO_2 emissions rate determined by a unit's technology. The system defines four benchmark categories: conventional coal plants below 300 megawatts (MW), conventional coal plants above 300 MW, unconventional coal, and natural gas. Benchmarks are intended in part to limit the

burden on older, dirtier plants by comparing their performance to the best-in-class efficiency of a comparable plant. As these plants are disproportionately located in less affluent, often central and western, provinces, the benchmarks provide a way to address regional equity concerns. Earlier iterations of the ETS included up to 11 benchmarks (Pizer and Zhang, 2018), but the number was ultimately reduced with the goal of raising the overall efficiency of the system.

An open question is how provincial governments will handle the uncertainty in provincial emissions reduction obligations created by a national trading system. The national ETS will cover only a subset of emitting firms in each province, including all electric power generators and firms representing between 50–100% of the emissions in other energy-intensive industries. In particular, a number of smaller emitting firms in the cement industry will not be covered by the national system. Within energy-intensive industries, firms below the threshold for inclusion in the ETS are often comparatively CO_2-intensive. Provincial governments subject to targets will need to determine how much CO_2 intensity reduction effort should come from installations in the province that are not covered by the ETS. This amount is uncertain because the CO_2 reductions by ETS firms, and the relative reliance of ETS installations on in-province reductions versus on allowance purchases and offsets, will not become known until the end of the compliance period. This will create difficulty for provinces when designing supplementary measures to support CO_2 intensity target achievement. It will also be a challenge to ensure that offsets generated in or outside the province are not double-counted toward provincial CO_2 intensity reduction goals.

3.2 Abatement Strategies

The tradeable performance standard design has implications for covered entities' abatement choices. Consider its implications for firms in the power sector, the first sector to be covered by the ETS. Firms essentially have two ways to comply: improve the efficiency of individual facilities and shift generation among units (e.g., from less efficient, often older and smaller, units to more efficient, typically newer and larger, units). Given that benchmarks are defined separately for coal and natural gas facilities, there is limited incentive for fuel switching. Coal to natural gas switching was one of the major compliance strategies observed in the EU ETS. Natural gas is included in a separate benchmark category to avoid an outcome in which these units receive large permit surpluses. Since allowance allocations adjust based on actual output, only units with emissions intensity above the benchmark will have incentives to reduce CO_2 emissions by curtailing output. Facilities that find it too costly or difficult to comply will face increased pressure to shut down permanently.

The ETS does not cover non-fossil electricity generators (e.g., nuclear, hydro, and renewables). Instead, policies such as renewable portfolio standards will separately target increases in renewable generation. Large-scale deployment of renewable energy is likely to limit the development of fossil generation, and thus the ETS will apply to a decreasing share of overall power sector output in the coming decades.

4. ETS IMPLEMENTATION

This section describes the planned implementation of China's ETS, based on relevant laws and directives released as of May 2021. The primary focus is on the design as it applies to the power sector, which is scheduled to begin trading by June 2021, recognizing that the extension of CO_2 trading to other sectors is still under development.

4.1 Institutional Structure and Administration

The Ministry of Ecology and Environment and its subnational representative offices oversee the implementation of China's national emissions trading system. Effective on February 1, 2021, the "*Administrative Measures for Carbon Emission Trading* (Trial)" (hereafter "*Administrative Measures*"; link provided in full references) published by MEE outlines the rules governing system implementation. The document begins by stating several principles to guide the development of the ETS, including adherence to: market orientation, gradual progress, fairness and openness, and honesty and trustworthiness. Opening keywords are a typical feature of policy guidance in China — they are designed to create a shared set of expectations among stakeholders on process design and outcomes.

The *Administrative Measures* outlines a role for two national agencies in program administration. First, the National Carbon Emissions Rights Registration Agency will record holdings, modifications, payments, and retirements of emission allowances using the national carbon emission rights registration system. It will also provide settlement services. Second, the National Carbon Emissions Trading Agency will oversee the centralized exchange of allowances among market participants. Previously, it was unclear whether one of the exchanges for the carbon market pilots would assume this function, but the *Administrative Measures* clearly establishes one national authority. Both agencies will regularly provide status updates to the MEE.

The MEE itself is in charge of outlining rules regarding the technical definition of emissions reduction, overseeing the performance of local (e.g., provincial and municipal) offices involved in supervision and management of the carbon emission quota allocation, requiring GHG emissions reporting and verification, and cooperating with the relevant departments of the State Council on ETS coordination. The transfer of program leadership from the NDRC to the MEE after 2018 contributed to delays in implementation.

Authorities at various levels of government are responsible for specific elements of ETS implementation, as spelled out in the *Administrative Measures*. Overseen by the national MEE, its provincial offices are responsible for allocating and collecting payments for purchased emissions allowances, verifying GHG emissions reported by firms, and carrying out supervision and management functions locally. Municipal EE authorities may be directed to carry out these functions by their provincial overseers.

By the end of 2021, a State Council Regulation is expected to provide a stronger legal basis for the emissions trading system as part of the country's effort to address climate change. Such a

regulation is equivalent in strength to a law passed by the National People's Congress. It would lay a foundation for future development of the system, including the introduction of higher penalties for non-compliance. The *Interim Regulation for the Management of Carbon Emissions Trading* (Draft Revision), published on March 30, 2021 and hereafter "*Interim Regulation*" (link provided in full references) would supersede the *Administrative Measures* if it goes into effect later this year. Unless otherwise stated, the ETS description below relies on the *Administrative Measures*.

4.2 Allowance Allocation

The MEE determines the total carbon emissions quota and plans for allocating allowances. Allowance allocation in China's national ETS considers national GHG emissions control requirements (set forth in the national and provincial targets), economic growth, economic structure adjustment (reduction of emissions by increasing the share of less energy intensive industries), energy structure optimization (reduction of emissions by switching to low carbon fuels), and coordinated control of air pollutant emissions. While the intensity basis of the allocation accommodates economic growth, other criteria are not considered explicitly. Despite ongoing interest in using the ETS to reinforce air pollution control objectives, there is no consensus yet on whether or how these objectives could be incorporated into program design.

The Allocation Plan involves granting covered units a pre-allocation of permits, based on historical CO_2 emissions levels and output, followed by *ex post* adjustments. *Ex post* adjustments grant allowances for emissions indexed to actual output, while allowable emissions are calculated based on the performance of each category's benchmark emissions control technology. In the initial phases of the program, allowances will be allocated free of charge. However, both the *Administrative Measures* and the *Interim Regulation* suggest that the system will increasingly shift from free to purchased allowances over time.

Quota setting in China's initial phase of the ETS in the power sector takes into account both power and heat generation, which sum together to form a unit's total emissions permit allocation. Quantities of power or heat produced are multiplied by the respective benchmark values for allowable emissions rates. Subsequent adjustments account for cooling mode (air cooling, water cooling), the relative share of heating, and the average load. In particular, plants that use air cooling, which is less water intensive, are entitled to an allowance multiplier on the electricity portion of their output of 1.05, compared to 1 for water cooling.

4.3 Scope and Coverage

The first phase of China's emissions trading system will include 2,200 companies in the power sector, including combined heat and power (CHP) and on-site generators. Covering the power sector only, the system will regulate 4 bmt of CO_2 emissions annually, 40% of China's total national CO_2 emissions. Proposals to expand the system to cement and aluminum are under development. Trading in these sectors is expected to begin sometime in 2022.

In addition to units covered by the ETS, the MEE is responsible for monitoring emissions from all "Key GHG Emitting Units" with the expectation that these units will eventually be covered under the national ETS. A Key GHG Emitting Unit is any unit that exceeds the threshold for inclusion in the ETS (26,000 tons of CO_2-equivalent emissions per year) and belongs to one of the eight ETS sectors. This designation is similar to that used to designate large emitters of local pollutants. Previously, lists of key emitters of specific pollutants — such as SO_2 or nitrogen oxides (NO_x) — defined the scope and targeting of major environmental regulations. Units for which annual GHG emissions have not reached 26,000 tons CO_2-equivalent for two consecutive years, or that have closed, shut down, or are no longer producing exit the ETS.

According to the *Administrative Measures*, up to 5% of the quota can be satisfied with voluntary emission reductions that are external to the trading system. Example sources of voluntary emission reductions include the development of domestic renewable energy, forest carbon sinks, methane utilization, and other domestic projects. All voluntary emission reductions must be registered in the national voluntary emission reduction transaction database. How to ensure that these voluntary reductions are not double counted toward the ETS and related policies, for instance provincial renewable portfolio standards, remains an open question.

4.4 Monitoring, Reporting, and Verification

The functionality of a national ETS is only as strong as its ability to account accurately for the CO_2 emissions of covered units. MRV establishes units' historical CO_2 emissions and emissions intensity. It also measures changes over time. In the seven ETS pilots, the measures implemented to support high-quality MRV varied widely. Arguably, MRV was most developed in Beijing among the seven ETS pilots. The Beijing government required additional random audits of emissions reports prepared by official third-party emissions verifiers. Research suggests that under this system, firms' self-reported emissions deviated widely from actual emissions in the initial years of the program. These deviations occurred in both directions, suggesting that firms did not deliberately misrepresent their emissions (Zhang *et al.*, 2019). The need to examine how MRV could be expanded to support the nationwide ETS, especially given provincial and sectoral variation in incentives and institutional capacity, contributed to the gradual pace of system development. The *Administrative Measures* directs officials to use the "double random, one public" approach to inspection and supervision, a general practice advocated by China's regulatory agencies that involves randomizing the match between verifiers and covered firms ("double random") and publishing the verification results ("one public"). More than 400 emissions verifiers are certified to serve firms in the national ETS. Units that apply for inclusion in the ETS must first have their emissions verified and then approved by the provincial EE authority.

4.5 Enforcement and Non-compliance Penalties

Current enforcement mechanisms, including non-compliance penalties, must carefully balance incentives to deter non-compliance with the need to maintain the cooperation of market participants. The *Administrative Measures* state that falsely reporting or concealing emissions results in

a fine of not less than 10,000 yuan but not more than 30,000 yuan, which is modest compared to the annual profit of most covered firms. If allowances are not surrendered on time and in full, local authorities may impose a fine of 20,000 to 30,000 yuan. The allowable fine is expected to rise if a final version of the State Council's *Interim Regulation* is issued. According to the *Interim Regulation*, falsely reporting or concealing emissions would result in a fine of not less than 50,000 yuan but not more than 200,000 yuan. Failing to surrender sufficient carbon emissions allowances owed at the end of the compliance period would carry a fine of 100,000 to 500,000 yuan. However, financial penalties are not expected to be the only deterrent for non-compliance, relative to other tools that provinces can use, such as restricting access to financing or other forms of assistance to firms. If emissions verification organizations collude with covered firms or falsify data, penalties include cancelling the commission, impairing its credit record, and in serious cases prohibiting the organization from operating for three years. Ongoing discussions focus on how provincial leaders and firms could be punished in annual performance reviews for failing to comply with ETS rules.

5. INTERACTIONS WITH RELATED POLICIES

To some extent, China's landscape of climate policies can be described as adopting a "belt-and-suspenders" approach. The ETS layers on top of the seven official pilot ETS programs as well as a range of sectoral climate and industrial policies. It is therefore important to have a clear understanding of how these policies will interact with and ultimately affect total CO_2 reductions in line with China's pledge to achieve carbon neutrality by 2060.

5.1 Pilot Trading Systems

An important question for the national ETS is whether it would supersede the seven official ETS pilots established in Beijing, Tianjin, Shanghai, Guangdong, Shenzhen, Hubei, and Chongqing. The pilots vary in sectoral coverage but would overlap substantially with the national ETS once it becomes operational in the eight covered sectors. The latest rules suggest that the pilots will continue to coexist alongside the national system but these systems will not overlap. Specifically, the *Administrative Measures* specifies that once a unit is included in the national system, it must exit any pilot system to which it belonged. However, provincial authorities are free to expand pilot systems to below-threshold firms and firms in uncovered sectors as a means of supporting the achievement of provincial CO_2 intensity targets.

5.2 Renewable energy policy

Renewable portfolio standards, set by province, have replaced feed-in tariffs as the primary policy instrument for promoting renewable energy within China's electricity mix. The ETS as it is currently developing in the power sector covers only fossil energy (mainly coal and natural gas generation), with emission reduction obligations defined at the unit level. As a result, renewable energy obligations and the ETS for the most part do not overlap. For power generators in the ETS, deploying renewable energy is not available as a strategy for reducing CO_2 emissions under

the system. The only potential overlap occurs in the category of offsets, which can cover up to 5% of a firm's reduction obligation. Here, renewable energy purchases can count towards allowable offsets, raising the possibility of double counting under the ETS and renewable portfolio standards. This issue remains to be clarified in future iterations of system design.

5.3 Industrial energy efficiency policy

Industrial energy efficiency programs targeting large firms, including the Top 1000 Enterprises Program (2006–2010) and Top 10,000 Enterprises Program (2011–2015), were in many respects precursors to a multisector national ETS. While these programs did not include trading, they similarly targeted large energy users — which, given China's high share of coal use in electricity and in direct industrial uses, is a close proxy for CO_2 emissions intensity. These programs also underscored for policymakers the importance of strong MRV, due to concerns that emerged about the reliability of self-reported data submitted for compliance purposes under these programs.

The latest iteration of these industrial energy efficiency programs overlaps very closely with the expected scope of the national ETS. In its latest iteration, an expanded energy efficiency program has introduced energy-saving allowance trading on a pilot scale. This overlap with the ETS is problematic because firms that must reduce energy use intensity within their own boundary will have limited incentives to engage in trading. Moreover, firms will need to keep track of closely related compliance obligations for energy and CO_2, which could nearly double overhead requirements. Since these two closely related programs are led by different government departments (the NDRC and the Ministry of Industry and Information Technology oversee implementation of the industrial energy efficiency programs), resolving this overlap will be challenging but ultimately important to the effective operation of an expanded national ETS.

6. LOOKING TO THE FUTURE

6.1 Scaling the system beyond electric power

An important question concerns how fast, and in what order, to expand the coverage of the ETS to other sectors. ETS architects have focused on several criteria. First, is MRV complete for the key emitting entities in the sector that would be included? This is not straightforward, given that MRV functions are implemented at the provincial level, and both local EE offices and covered units are conducting MRV for the first time. Therefore, national oversight must observe and correct for erroneous accounting practices. Carrying out MRV has proven more straightforward in sectors with relatively homogeneous products, such as cement and aluminum smelting, leading these sectors to become next in line to begin trading under the national ETS.

Second, a lesser extent of state ownership outside the electric power sector may improve the efficiency of system operation, as private firms may be more responsive to costs imposed by the ETS. However, these firms may be less accountable to state oversight bodies, as non-state firms

lack direct channels such as the target responsibility system, which shape the incentives for top leaders. In the context of China's industrial energy efficiency policies, larger, non-state firms were more likely to report non-compliance (Karplus *et al.*, 2020).

6.2 From a rate-based to a mass-based system?

The architects of China's ETS have indicated that it will eventually move from a rate-based system (TPS) to a mass-based system. A mass-based system would remove the implicit output subsidy, raising the cost-effectiveness of CO_2 reductions. The incremental cost of the TPS rises with the total emissions reduced as, under a mass-based ETS, reductions in electricity output contribute a greater share of total CO_2 abatement (Goulder *et al.*, 2017; 2019). The major drawback of transitioning to a mass-based system is that the rate-based system has strong support among those concerned about limiting the burden of the ETS on covered firms and, more broadly, economic growth.

6.3 Impact of ongoing power market reforms

China's ongoing electric power sector reforms directly interact with the first phase of ETS operation, which covers only power generating units. From 1998 to 2003, an initial round of reform separated generation and transmission, and broke up the state's monopoly over generation, with the goal of attracting new investment to meet rapidly growing demand and address shortages (Davidson and Pérez-Arriaga, 2020). Since 2016, the focus of reforms has shifted to the dispatch mechanism along with wholesale and retail pricing, with the goals of (1) reducing electricity prices, (2) providing appropriate incentives to invest in ancillary services to ensure continuous system operation, and (3) improving the grid integration of renewable energy, including via transfers across provincial boundaries.

China's system of fixed electricity pricing has evolved into a mixed system comprised of "within plan" (fixed) pricing and transactions that occur in bilateral markets, multi-sided markets, and spot markets. As of the end of 2020, eight provinces/regions had been selected for spot market pilots: Southern China (Guangdong), Western Mongolia, Zhejiang, Shanxi, Shandong, Fujian, Sichuan, and Gansu. Spot prices in these pilots were initially very low, closer to the variable cost of the coal units in these areas. These reforms have resulted in provincial variation in the share of electricity sold that is subject to market-based pricing. This presents a challenge for uniform implementation of the ETS, because firms subject to "within plan" pricing are unable to pass through ETS compliance costs, placing them at a disadvantage relative to those that sell part or all of their generation into markets.

6.4 International climate policy and ETS linkages

As more countries seek to achieve climate neutrality by mid-century, linking climate policies internationally will offer governments the opportunity to reduce marginal GHG abatement costs while discouraging the relocation of energy-intensive, trade-exposed industries. In response

to concerns over carbon leakage, border carbon adjustments (BCAs) are already under development in Europe, and have reemerged as a key element in recent discussions of policy design in the United States. BCAs can provide a starting point for linkage because they require an assessment of the relative stringency of climate policy in export versus domestic markets. As more nations adopt climate policies and explore the use of BCAs, this assessment could form the basis for determining the gains from linkage.

In many respects, the architects of China's ETS are positioning the country to link its emerging system to others globally. First, China can build on experience with linkages through offsetting: in the early 2000s, before implementing its own national climate policy, China was a major source of CO_2 offsets for the EU ETS via the Clean Development Mechanism. The beneficiaries of offset sales have continued to advocate for the continuation and expansion of opportunities to gain credit for reductions, including under the national ETS as well as policies overseas. Second, linkage provides a channel for China to project its system design and technical standards onto newly developing systems around the world, while at the same time reinforcing its reputation as an engaged participant in global climate change mitigation efforts. Third, as China's ETS expands and low-cost emission-reduction opportunities grow more limited, system architects will have an economic incentive to pursue linkages as a way to contain rising costs of abatement. It also would offer Chinese firms with an opportunity to purchase credits to cover their domestic emissions.

7. CONCLUSION

Learning from prior experiences with environmental policy, China's policy makers have pursued a gradual path to developing both the emissions trading system and, in parallel, supporting institutions for MRV and enforcement. While the broader effort is labeled an emissions trading system, an in-depth look reveals that it is, at its heart, a transitional system that combines elements of enterprise-level targets, state control, and industrial policy with a market mechanism. Many see deviations from the market mechanism as necessary and important to gain buy-in, build experience, and address equity concerns, especially at the outset.

Over time, parallel developments — in electricity market reform, reductions in the cost of renewable and other advanced energy technologies, and stronger, more geographically even MRV and enforcement capabilities — are likely to contribute to less costly, and more efficient, system operation. As such, future incarnations of the ETS have the potential to be a formidable tool for managing the CO_2 emissions of covered industries. China's ETS is also likely to serve as an example for other developing country governments that are seeking cost-effective paths to mitigate their own contributions to climate change.

Global climate mitigation efforts will need to consider all greenhouse gases, not just CO_2 (which accounts for approximately 80% of China's total GHGs). They will also have to grapple with the fact that emissions do not stop at national borders, but rather result from the combined decisions of multiple actors in global supply chains. Currently, China's 2060 carbon neutrality goal does not mention other GHGs. Nor does it assume responsibility for GHGs emitted outside

China's borders, even if these emissions are indirectly associated with Chinese companies or productive activities in China via their supply chains. The development of China's national ETS is a complement to, and not a substitute for, targeted efforts to address these broader challenges. A key question is how to evolve the ETS in a manner that encourages increasing levels of ambition over time.

REFERENCES

Administrative Measures for Carbon Emission Trading (Trial) 碳排放权交易管理办法（试行）published Dec. 30, 2020, effective Feb. 1, 2021. http://www.gov.cn/zhengce/zhengceku/2021-01/06/content_5577360.htm

Davidson, M. R. and Pérez-Arriaga, I., Avoiding Pitfalls in China's Electricity Sector Reforms. *Energy Journal*. 41 (2020). https://doi.org/10.5547/01956574.41.3.mdav

Goulder, L. H. and Long, X. and Lu, J. and Morgenstern, R. D., China's Unconventional Nationwide CO_2 Emissions Trading System: The Wide-Ranging Impacts of an Implicit Output Subsidy (2019). NBER Working Paper No. w26537. https://www.nber.org/papers/w26537

Goulder, L. H., Morgenstern, R. D., Munnings, C. and Schreifels, J. China's national carbon dioxide emission trading system: An introduction. *Economics of Energy and Environmental Policy*. 6, 1–18 (2017). https://doi.org/10.5547/2160-5890.6.2.lgou

Interim Regulation on the Management of Carbon Emissions Trading (Draft Revision). 碳排放权交易管理暂行条例（草案修改稿）published March 30, 2021. http://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/202103/W020210330371577301435.pdf

Karplus, V. J., Shen, X., and Zhang, D., Herding Cats: Firm Non-Compliance in China's Industrial Energy Efficiency Program. *Energy Journal*. 41 (2020). https://doi.org/10.5547/01956574.41.4.vkar

Pizer, W. A. and Zhang, X. China's New National Carbon Market. *AEA Papers & Proceedings*. 108, 463–467 (2018). https://doi.org/10.1257/pandp.20181029

World Bank. 2020. *State and Trends of Carbon Pricing 2020*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/33809

Zhang, D. *et al.*, Integrity of firms' emissions reporting in China's early carbon markets. *Nature Climate Change* 9 (2019). https://doi.org/10.1038/s41558-018-0394-4

Zhang, X. (2021). *The Role of Carbon Market in Achieving China's New Climate Goals* (mimeo). Beijing, China: Tsinghua University Institute of Energy, Environment, and Economy.

Harvard Project on Climate Agreements

79 John F. Kennedy Street
Cambridge, Massachusetts 02138, USA

+1 617 496 8054
climate@harvard.edu
www.hks.harvard.edu/hpca