EMISSIONS TRADING IN CALIFORNIA: LESSONS FOR CHINA

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ABOUT THIS REPORT

The Emmett Institute on Climate Change and the Environment is simultaneously preparing multiple reports comparing the approaches to emissions trading systems in California and China. Some of this report draws on material in a second report, entitled *Key Governance Issues in California's Carbon Cap-and-Trade Program* (2022), focusing on governance of California's cap-and-trade program.

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ACRONYNMS	
BAAQMD	Bay Area Air Quality Management District
CAFE	Corporate Average Fuel Economy
CARB	California Air Resources Board
CalEPA	California Environmental Protection Agency
CCER	China Certified Emission Reduction
CCUS	Carbon capture, utilization, and storage
CNOOC	China National Offshore Oil Corporation
CO_2	Carbon dioxide
COOP	Electrical cooperative
EDU	Electrical distribution utility
EPA	US Environmental Protection Agency
ETS	Emissions trading system
GHG	Greenhouse gas
GJ	Gigajoule
IOU	Investor-owned utility
Ktons	Kilotons
MEE	People's Republic of China Ministry of Ecology & Environment
MMR	Mandatory Greenhouse Gas Reporting Regulation
$MMTCO_2e$	Million metric tons of carbon dioxide equivalent
MRV	Monitoring, reporting, and verification
$MTCO_2e$	Metric tons of carbon dioxide equivalent
NGS	Natural-gas supplier
NO_x	Nitrogen oxides
$PM_{2.5}$	Fine particulate matter
POU	Publicly owned utility
RECLAIM	Regional Clean Air Incentives Market
RTC	RECLAIM trading credit
RGGI	Regional Greenhouse Gas Initiative
SCAQMD	South Coast Air Quality Management District
SO_2	Sulfur dioxide
tpd	Tons per day

PREFACE

This report evaluates California's two major emissions trading systems (ETS): (i) the Regional Clean Air Incentives Market (RECLAIM) program for conventional air pollutants in southern California, begun in 1993 and now being retired; and (ii) the economy-wide greenhouse gas cap-and-trade program commenced in 2013 and authorized through 2030. We consider these systems in the context of broader critiques about emissions trading systems and take seriously problems of environmental ambition, integrity, and justice. We also explore ways in which emissions trading systems can affect the political economy of climate policy for better or worse.

This report was written with an audience of Chinese regulators and researchers in mind, as China has recently commenced the world's largest ETS by volume of emissions covered. The material on California is meant to support the design and reform of this system. We have also included a chapter summarizing the current structure of China's national ETS and offered a series of reform recommendations, drawing on lessons from California.

We hope that a frank assessment of the benefits and shortcomings of emissions trading will allow China and other jurisdictions to avoid the mistakes of existing ETS and to find an appropriate balance among emissions trading and a broader portfolio of climate measures.

CHAPTER ONE
INTRODUCTION

As of 2022, the countries of the world and subnational jurisdictions have begun to orient their climate change policies toward mid-century carbon neutrality goals coupled with near-term emissions reduction goals.[1] China has begun to implement its so-called 30/60 goals to achieve (i) peak carbon emissions by 2030 and (ii) carbon neutrality by 2060. The European Union (EU) is pursuing a 2050 carbon neutrality goal with an interim goal to reach 55% emissions reduction by 2030, compared to 1990 levels.[2] The Biden administration has announced a goal for the US to reduce overall greenhouse gas (GHG) emissions by 50-52% in 2030 from 2005 levels as a first step to "put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050."[3] Subnational jurisdictions have established carbon neutrality goals as well. The state of California, for example, has set a goal to achieve carbon neutrality by 2045.[4] These commitments come at a time when the physical impacts of climate change – historic temperature highs, drought, wildfires, extreme storms, flooding, among other things – are more evident than ever.[5]

The central question now is how to realize these goals in practice.[6] Market measures are, many hope, poised to play a significant role in the effort. Emissions trading systems (ETS) are in place in key jurisdictions, including the EU, parts of the United States (California, the northeastern states' Regional Greenhouse Gas Initiative (RGGI), Washington), the Canadian provinces of Quebec and Nova Scotia, South Korea, New Zealand, and Mexico.[7] China launched a national tradable performance standard-based ETS in 2021. As of 2021, 30 ETS were in force globally, covering 16-17% of global GHG emissions.[8] The finalization in 2021 of the Paris Agreement rulebook for international cooperation through carbon markets has cleared the way for a substantial expansion of emissions trading and carbon pricing worldwide.[9]

Much of the scholarly debate over carbon pricing mechanisms has been in the realm of instrument choice theory. Proponents argue that emissions trading programs can achieve pollution abatement

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1 These targets are meant to be consistent with the findings of the Intergovernmental Panel on Climate Change (IPCC) report on pathways for achieving climate goals under the UN Framework Convention on Climate Change (UNFCCC). IPCC, Global Warming of 1.5°C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context Of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty (2018), https://www.ipcc.ch/sr15/.

2 *European Climate Law*, Eur. Comm'n (last visited Apr. 10, 2022), https://ec.europa.eu/clima/eu-action/european-green-deal/european-climate-law_en.

3 *Executive Order on Tackling the Climate Crisis at Home and Abroad*, White House (Jan. 27, 2021); The United States' Nationally Determined Contribution: Reducing Greenhouse Gases in the United States: A 2030 Emissions Target 15, 23 (Apr. 15, 2021), https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20States%20of%20America%20First/United%20States%20NDC%20April%2021%202021%20Final.pdf.

4 *See* Cal. Exec. Order B-55-18 to Achieve Carbon Neutrality (2018), https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf.

5 *See* IPCC, *supra* note 1.

6 Here, we are primarily referring to the governance and regulatory tools and policies that will pave the way to goal achievement. This will also include, however, debates over how to define and measure achievement of carbon neutrality – topics beyond the scope of this report. *See, e.g.*, NewClimate Inst. & Data-Driven EnviroLab, Navigating the Nuances of Net-Zero Targets (Oct. 2020), https://newclimate.org/2020/10/22/navigating-the-nuances-of-net-zero-targets/.

7 This report will refer to emissions trading systems (ETS) generally to include cap-and-trade systems (such as are found in the EU and California) and tradeable performance standards (such as in China's national system). Other market measures, such as environmental taxes, are not the focus of this report.

8 *See Carbon Pricing Dashboard*, World Bank (last visited Apr. 6, 2022), https://carbonpricingdashboard.worldbank.org/map_data ("In 2021, these initiatives would cover 8.73 $GtCO_2e$, representing 16.1% of global GHG emissions."); *see also* Int'l Carbon Action P'ship (ICAP), Emissions Trading Worldwide: Status Report 2022, at 36–37, https://icapcarbonaction.com/system/files/document/220330_icap_report_rz_web.pdf.

9 These are rules under Article 6 of the Paris Agreement agreed upon at COP26 in Glasgow. Simon Evans et al., *COP26: Key Outcomes Agreed at the UN Climate Talks in Glasgow*, Carbon Brief (Nov. 15, 2021), https://www.carbonbrief.org/cop26-key-outcomes-agreed-at-the-un-climate-talks-in-glasgow.

at significantly lower cost than command-and-control measures.[10] Emissions trading creates an incentive for firms with lower marginal abatement costs to mitigate more, whereas less efficient firms can purchase allowances on the market. In this way, aggregate emissions reductions can be achieved at lower total cost. Emissions trading can also generate revenue through allowance auctions that can be used to fund environmental projects, mitigate the economic or distributional impacts of climate policy, and generate political support for environmental regulation in general. In comparison to environmental taxation (another carbon pricing measure), emissions trading can also provide certainty about emissions quantity by imposing an emissions cap.

Can emissions trading achieve these benefits in practice? In recent years, a growing critical literature has highlighted the ways in which emissions trading has fallen short of its theoretical potential.[11] Although emissions trading promises dramatic cost savings in theory, political economy dynamics often lead to regulatory design choices that limit environmental ambition. The complexity of emissions trading systems can mask these problems and create a false sense of progress towards environmental goals. At worst, trading systems can create perverse incentives that subsidize pollution sources and delay environmental action. Trading has also generated sharp conflicts over environmental justice – concerns that poorer communities or communities of color are exposed to more pollution under trading regimes as compared to other forms of regulation.[12] So far, emissions trading systems have been too incremental in their effect to play the central role in climate policy some supporters have contemplated. Given the urgent need to decarbonize in just the next few decades, market measures have not yet proven themselves up to the task. Indeed, polluting firms have supported emissions trading over carbon taxes or command-and-control regulation, seeing it as a form of regulation less likely to demand major changes in firm behavior.[13]

This report seeks to introduce California's experience in emissions trading to Chinese regulators and researchers in the context of these broader debates over emissions trading. In introducing California's experience with two emissions trading systems – a statewide carbon ETS and the Los Angeles-area regional emissions trading system for SO_2 and NO_x known as the Regional Clean Air Incentives Market (RECLAIM) – we seek to move the discussion away from theoretical debates over instrument choice and toward practical questions of how to ensure that market measures can help, not hinder, achievement of climate goals. Furthermore, much of the Chinese-language literature on emissions trading has focused on comparisons to the EU ETS.[14] This report will provide more information for Chinese regulatory design from another major ETS jurisdiction.

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10 *See, e.g.*, Alexander Eden et al., *Benefits of Emissions Trading: Taking Stock of the Impacts of Emissions Trading Systems Worldwide*, ICAP (Aug. 2018), https://icapcarbonaction.com/en/publications/benefits-emissions-trading-taking-stock-impacts-ets-worldwide (surveying the literature on environmental efficacy, cost-effectiveness, and policy co-benefits from emissions trading); *see also* High-Level Comm'n on Carbon Prices, Report of the High-Level Commission on Carbon Prices (2017), https://www.carbonpricingleadership.org/report-of-the-heghlevel-commission-on-carbon-prices.

11 *See, e.g.*, Jessica F. Green, *Does Carbon Pricing Reduce Emissions? A Review of Ex-Post Analyses*, 16 Env't. Rsch. Letters (2021); William Boyd, *The Poverty of Theory: Public Problems, Instrument Choice, and the Climate Emergency*, 46 Colum. J. Env't L. 399 (2021); Danny Cullenward & David Victor, Making Climate Policy Work (2020); Matto Mildenberger, Carbon Captured: How Business and Labor Control Climate Politics (2020); Barry Rabe, Can We Price Carbon? (2018); Jesse Jenkins, *Political Economy Constraints on Carbon Pricing Policies: What are the Implications for Economic Efficiency, Environmental Efficacy, and Climate Policy Design?*, 69 Energy Pol'y 467 (June 2014).

12 As we note at c.2, §§ III.D.4, IV.D.7 *infra*, the research is mixed as to whether such distributional effects exist.

13 Jonas Meckling, Carbon Coalitions: Business, Climate Politics, and the Rise of Emissions Trading (2011).

14 *See, e.g.*, Min Jin et al., *Analysis of the Current Status and Problems of the Carbon Emission Trading Pilots in China*, 42:3 Env't Prot. Sci. 134, 138–40 (2016); Jiahua Pan, *Construction, Challenges and Market Expansion of Emission Trading System*, 26:8 Chinese J. Population, Res. & Env't 1 (2016); Caixia Wu, *Links in International ETS Markets and Lessons for China*, 38:5 Dong Yue Trib. 111 (2017); Xuezhi Liu et al., *Study on EU ETS MRV System and the Enlightenments for China* (2018) 8 F. Sci. & Tech. in China 164.

Our analysis of California's experience with emissions trading is guided by a focus on principles of environmental ambition, integrity, and opportunity.[15] That is, to what extent have the trading systems advanced environmental ambition (significant emissions reductions) with integrity (done in a transparent, reliable, and durable way), while expanding opportunities for environmental protection (generating revenue, building political support for climate action, or strengthening administrative capacity)?

Based on this analysis, we offer three top-line takeaways, followed by specific recommendations for reform of China's national ETS.

Engage in Continuous Improvement

First and foremost, market measures have not yet achieved the emissions reductions necessary to decarbonize the economy. Therefore, the design of emissions trading systems must be assessed and improved on a continual basis. We recommend that regulators treat ETS design elements as *presumptively inadequate* and build in continuous cycles of evaluation and reform. There are risks to such an approach, to be sure. Each opportunity for positive environmental reform is also a chance for opponents of climate action to weaken regulation. Nonetheless, our hope is that clear-eyed recognition of the ways in which political economy dynamics tend to weaken emissions trading design will create a stronger foundation for positive environmental reforms.

In California, critics have raised concerns about excessive allowances, the environmental integrity of offsets, the appropriateness of anti-leakage measures, and environmental justice. China's national ETS must also consider a variety of design reforms that would improve environmental ambition, integrity, and opportunity – instituting a cap and a schedule for cap reduction, introducing auctioning and limiting free allowance allocations, using auction revenues to promote environmental and justice aims, incorporating non-fossil sources into the trading scheme, setting schedules for tightening benchmarks or eliminating multiple performance benchmark categories, and instituting market reforms to grid dispatch rules and improving regional integration of the grid.

Do No Harm

Second, policymakers must ensure that emissions trading measures do not make it more difficult to achieve climate objectives – whether by creating perverse incentives that delay decarbonization, obscuring insufficient regulatory ambition, or blocking other forms of climate regulation. In California, as part of the compromise to extend the carbon cap-and-trade program to 2030, for example, local regulators were prohibited by law (preempted) from regulating GHG emissions from facilities within the ETS.[16] The Greater Los Angeles-area RECLAIM emissions trading program was the subject of

15 In selecting this set of values, we are purposely emphasizing environmental aims, which we consider appropriate given the urgency of climate objectives. We also believe that a focus on environmental objectives will help to highlight areas in which trade-offs are commonly made in support of competing policy objectives or vested interests. We note that California's environmental regulators frame policy assessment in terms of *environmental integrity* (progress in achieving environmental goals), *economy* (impact on jobs, specific sectors, and economic growth in general), and *justice* (distribution of environmental and economic impacts, particularly along racial and income lines) factors. Other metrics – such as *cost-effectiveness, environmental co-benefits*, *administrability/enforceability*, and *legality* – will necessarily be part of any policy evaluation, but our emphasis in this report is on environmental outcomes.

16 Such a compromise arguably would not have been needed for garden-variety command-and-control legislation, as legislators sought to achieve a super-majority of support for the cap-and-trade program to avoid any constitutional questions over whether the cap-and-trade program constituted a "tax" that would have required a two-thirds supermajority in the legislature.

intense political lobbying that resulted in the approval of a delayed emissions reduction schedule contrary to regulatory staff recommendations. China's national carbon ETS provides an implicit output subsidy to more efficient coal-fired power plants at two separate benchmark levels of carbon intensity, potentially reducing the incentive to switch to non-fossil sources of electricity production. This comes at a time when China is phasing out subsidies for renewable energy.[17] These examples illustrate that, far from being a panacea, emissions trading measures must be carefully crafted to avoid counterproductive results.

Take a Portfolio Approach

Third, we emphasize the importance of a portfolio approach to climate regulation. This is a regulatory approach that combines command-and-control, market, information-based, participatory, and other forms of regulation to improve the chances of emissions reduction.[18] This approach is widely accepted in regulatory circles in California and elsewhere. Nonetheless, discussions of market measures still commonly take the view that carbon pricing can and should dominate climate regulation (primarily due to theoretical cost-efficiency benefits) and that command-and-control tools should be minimized to the extent possible.[19]

In our view, the evidence to date simply does not support such a central role for emissions trading, and traditional command-and-control measures seem to have played the central role in emissions reductions to date. This does not mean, however, that emissions trading should play no role as, some of the strongest opponents of carbon pricing have suggested. Rather, emissions trading should be seen as one component of a portfolio that includes all types of regulatory measures.

California regulators have taken this portfolio approach since the inception of the Global Warming Solutions Act of 2006 (AB 32). Even within this portfolio approach, the specific role of any individual measure (like cap-and-trade) depends on the requirements of the other measures, and that role may change over time, Chinese regulators have typically relied much more heavily on "administrative measures" (行政手段) – *i.e.*, non-market approaches – and it is more likely that market measures like emissions trading will play a role in adding some market incentives to a predominantly command-and-control system. Nonetheless, we believe this point still deserves emphasis. A diversified portfolio of measures is more likely to generate greater environmental ambition, integrity, and opportunity.

The above-described dynamics, of course, require frank discussion of the appropriate role of emissions trading within the mix of regulatory measures in any jurisdiction.

17 *See, e.g.*, Yujie Xue, *China to Remain Renewable Energy Leader with Strong Capacity Growth in 2022, Despite Subsidies Phase-Out*, S. China Morning Post (Jan. 2, 2022), https://www.scmp.com/business/china-business/article/3161732/china-remain-renewable-energy-leader-strong-capacity-growth.

18 These include renewable portfolio standards, feed-in tariffs, electric vehicle mandates, government procurement rules, standards for energy efficiency and emissions, transparency rules, and provisions addressing distributional concerns (related to environmental justice, just worker transition, or stranded assets).

19 In this way, strong-form arguments in favor of carbon pricing have mirrored the view in broader economic debates that the "market" should be the ultimate arbiter of economic activity with government intervention playing a minimal role.

I | REPORT OVERVIEW

Chapter Two of this report provides a critical overview of the two major emissions trading regimes in California. In 1994, California's regional regulators in the Greater Los Angeles area, home to some of the most serious ozone and fine particulate matter ($PM_{2.5}$) pollution in the United States, instituted the RECLAIM program as a market-based approach to reducing NO_x and SO_2 emissions in the region. In 2012, California commenced a carbon emissions trading system that now covers approximately 80% of the state's GHG emissions. How have these systems fared? What lessons (positive or negative) can China take from the California experience?

Both California examples highlight the challenges of maintaining environmental ambition and integrity in emissions trading systems, while also considering economic and justice concerns. Put more bluntly, these systems appear to have had only a modest impact on emissions reduction to date. With RECLAIM, local regulators have noted that more than half of local facilities did not comply with the relevant command-and-control standards.[20] What's more, litigation over whether RECLAIM was the equivalent of those command-and-control standards ultimately contributed to the cancellation of the program. California's carbon cap-and-trade program, for its part, has faced significant surpluses of allowances, concerns about the environmental integrity of offsets, and increased free allowances for energy-intensive, trade-exposed industries due to competitiveness and leakage concerns. Moreover, emissions reductions at facilities covered under the ETS are thought to have come primarily from other policies. That said, the cap-and-trade program has generated a price signal for GHG emissions, produced substantial revenue that has been used for environmental purposes, and established a sophisticated system for monitoring, reporting, and verifying GHG emissions.

Both of California's emissions trading systems are also case studies in the difficulties of reform once a system has commenced. With RECLAIM, fierce industry opposition led to adoption of a schedule for tightening the emissions cap that was substantially less stringent than recommended by agency technical staff. As for the carbon ETS, the 2017 law to extend the ETS to 2030 (AB 398) instituted a variety of improvements, but also contained compromises (such as the limit on additional rules by local regulators that would apply to covered facilities within the cap-and-trade program).

Chapter Three offers a basic description of China's national carbon ETS with preliminary recommendations that draw on our evaluation of California's trading systems. In 2021, China launched the largest carbon market in the world in terms of tons of GHGs covered. This came on the heels of provincial and municipality-level pilot carbon trading regimes commenced between 2013 and 2016.[21] Chinese regulators also piloted SO_2 trading systems in the 1990s and early 2000s.[22] How effective is the current design of China's national emissions trading system? How can it be strengthened? The tradeable performance standard structure, free allocations without auctioning, and other elements of the current design (and the need for broader reforms, for example, in the electricity sector) substantially limit the environmental impact of the national ETS and reflect the primacy of economic, energy security, and other policy aims over environmental objectives.

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20 *See infra* c.2, § III.D.3.

21 Beijing (2013), Chongqing (2014), Fujian (2016), Guangdong (2013), Hubei (2014), Shanghai (2013), Shenzhen (2013), Tianjin (2013). *See* ICAP, Emissions Trading Worldwide: Status Report (2021), https://icapcarbonaction.com/en/publications/emissions-trading-worldwide-icap-status-report-2021.

22 In Jiangsu Province, the city of Taiyuan, and other locations. Jintian Yang & Jeremy Schreifels, Implementing SO_2 Emissions Trading in China (2003), https://www.oecd.org/env/cc/2957744.pdf.

II | ANALYSIS OF CHINA'S NATIONAL CARBON ETS

The Chinese ETS is a massive regulatory endeavor, initially covering 2,200 companies in the power sector that account for more than four billion tons of CO_2 emissions.[23] It is slated to add additional sectors in coming years. China's national ETS comes to life at a critical juncture as policymakers begin to devise ways to achieve China's 2030 carbon peaking and 2060 carbon neutrality target. In several respects, the current design of China's carbon ETS reflects concessions to competing economic, social, and parochial interests that weaken environmental ambition. It is difficult to see the Chinese ETS, in its present form, playing a significant role in reducing carbon emissions at the level and speed necessary for China to reach carbon neutrality by 2060. What's more, the present design of the ETS contains perverse incentives (output subsidies for more efficient power plants) that could set back the cause of GHG mitigation. In a period of increasing climate urgency, such setbacks could be devastating to global climate efforts. Fortunately, China's roll-out of the so-called "1+N" documents (a series of planning documents for achieving the 30/60 goals) and other regulatory and planning efforts suggests an appetite for continual reform and improvement. Indeed, many of the recommendations we list below are already under consideration for near-term adoption. These include tightening of benchmarks, introduction of auctioning and reduction of free allowances, and expansion of ETS coverage to additional sectors.

Our analysis of the Chinese carbon ETS leads us to several general conclusions.

The current design of China's national ETS will not likely generate adequate emissions reductions. According to Tsinghua University and International Energy Agency (IEA) analysis, carbon emissions from coal-fired power plants will be higher in 2035 than emissions today.[24] While the system creates an incentive to shift toward more efficient coal-fired power production, it creates little incentive for fuel switching away from coal to renewable energy. China's ETS will also generate windfalls for more efficient coal-fired power plants (an implicit output subsidy), creating an incentive to sustain coal-fired electricity production and build new coal-fired coal capacity. Without substantial reforms, these design features will very likely hinder China's efforts to achieve carbon peaking and carbon neutrality.

Chinese researchers and regulators are aware of these shortcomings of current ETS design and are already proposing reforms. These include, among other things, tightening of benchmarks, moving to an absolute emissions cap (*i.e.*, from a rate-based to a mass-based system), reducing free allocations of allowances, and using revenues from auctions to support the green development transition. The existing design reflects the current carbon intensity-focused orientation of China's national climate policy and an intention to build experience with emissions trading gradually, while minimizing negative economic and energy security impacts. California's emissions trading systems were likewise commenced with relatively less stringent compliance obligations to gain political buy-in and to avoid unexpected negative economic impacts. But the moment to accelerate the environmental ambition of China's emissions trading system is now and significant reforms are needed as soon as possible.

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23 Assuming global annual emissions GHG emissions of 51 billion tons, China's national ETS covers about 8% of global emissions. In comparison, the European Union ETS caps emissions at 1.6 billion tons. California's carbon cap-and-trade program caps emissions at 320.8 million tons. The Regional Greenhouse Gas Initiative (RGGI) in the northeastern US has a cap of 108.9 million tons. All figures are in terms of CO_2 equivalent (CO_2e).

24 Int'l Energy Agency (IEA) & Tsinghua Univ., The Role of China's ETS in Power Sector Decarbonisation 10 (2021), https://www.iea.org/reports/the-role-of-chinas-ets-in-power-sector-decarbonisation.

Experience from California suggests that sufficiently ambitious reform will not be easy to achieve. The opponents of a rapid green transition are many and considerations of economic, security, and social impacts will continue to generate inertia and create pressure to move slowly on climate action. The California experience can help to highlight some of the areas in which robust regulatory reform will be most difficult.

At the same time, California has, at this point, many years of governance experience in operating an economy-wide carbon emissions trading system and can help Chinese regulators to move more quickly on basic design choices. Cap-setting, ETS governance and MRV, auctioning and use of auction proceeds, and offset integrity are areas where California could offer useful lessons for China.

China should make every effort to build in opportunities for continual reform, weed out design features that hinder climate progress, and commit to a portfolio approach to climate policy. A well-designed carbon trading system still has the potential to improve the overall cost-effectiveness of climate regulation, serve as a "backstop" to mitigate emissions in harder-to-reach corners of the economy, and generate revenue that can be used for environmental purposes. In the Chinese context, the national ETS can temper the problems of so-called "one-sized fits all" (一刀切) regulatory approaches and improve monitoring and tracking of carbon emissions as well.

Chinese leaders have already spoken clearly about the need to bring an all-of-society approach that uses the strengths of government, markets, and public involvement to make progress on climate policy. This is the sort of portfolio approach that California is taking as well, and the jurisdictions can work together on the difficult task of coordinating a range of policy instruments and approaches.

III | SUMMARY OF RECOMMENDATIONS

As for specific reforms, Chinese policymakers will need to consider, among other things: a cap on emissions, elimination of multiple categories of performance benchmarks, and auctioning of allowance allocations to strengthen the environmental effects of the ETS. A regular process for reviewing climate ambition – including through the Scoping Plan process (California's periodic climate change planning process) or an independent advisory commission like California's Independent Emissions Market Advisory Committee – can help to ensure that weaknesses in design do not persist.

An assessment of China's national ETS also highlights the need for reform in other parts of China's regulatory system. For example, China must limit the continued approval and development of coal-fired power plants, and carry out electricity sector reforms regarding grid dispatch and cross-provincial grid integration.

ETS Reforms

- Tighten benchmarks;
- Move from tradeable performance standard (rate-based) to absolute cap (mass-based) with declining limits over time;
- Add auctioning, reduce free allocations;
- Introduce incentives for fuel switching (to non-fossil fuels);
- Create an environmental and/or social fund for auction proceeds (for environmental projects, economic and jobs transition);
- Strengthen protocols for offset integrity;
- Optimize allowance banking policies (to reduce negative impact on ambition);
- Establish a continually updating/increasing price floor;
- Improve monitoring, reporting, and verification, including transparency aimed at accountability and improved performance, process-specific emissions formulas, etc.;
- Carefully expand market coverage to maintain ambition and integrity;
- Advance research on role of derivatives and financial instruments in carbon markets;
- Be cautious about adverse policy compromises.

Other Reforms

- Prohibit new coal power plants;
- Introduce grid reforms – to improve dispatch, regional integration, resource flexibility;
- Use ETS to provide subsidy for non-fossil energy development.

CHAPTER TWO
CALIFORNIA EMISSIONS TRADING EXPERIENCE

I | OVERVIEW

This Chapter introduces California's two main emissions trading schemes: the Los Angeles-area RECLAIM program and the statewide carbon emissions trading system established under AB 32. It will offer an overall assessment of these systems in the context of debates over the efficacy of emissions trading systems, and provide a description of design elements, drawing on official documents, scholarly analysis, and policy and media reports.

The US Congress created the world's first large-scale cap-and-trade program as part of the 1990 amendments to the US Clean Air Act. Commenced in 1995, the Acid Rain Program, as it was called, aimed to reduce emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), the primary precursors of acid rain, from the power sector. The European Union created the world's first greenhouse gas cap-and-trade market in 2005.

At the time of writing this report, there are 30 carbon emissions trading markets globally, including the RGGI states in the northeastern US, California, and most recently, China, covering 16-17% of global GHG emissions.[25] The completion of the Paris Agreement Article 6 rulebook at COP26 in late 2021 sets the stage for further expansion of market measures in global climate policy.

A | California's emissions trading programs

1 | RECLAIM

The RECLAIM program was California's first emissions large scale cap-and-trade program.[26] It was adopted by the South Coast Air Quality Management District (SCAQMD) in 1993 and went into effect in 1994. The program was designed as a market-based alternative to command-and-control regulations for restricting NO_x and SO_2 emissions from large polluting facilities in the South Coast Air Basin, an area covering Los Angeles, Orange County, and several surrounding urban areas, which had (and still has) some of the worst ozone pollution in the country.[27] The program initially covered 394 facilities.[28] RECLAIM's primary focus was NO_x [29] and the use of emissions trading was permitted to the extent such market measures reduced emissions to levels achievable through traditional technology-based standards.[30]

25 *See supra* note 8.

26 *See generally REgional Clean Air Incentives Market* (*RECLAIM*), SCAQMD (last visited Apr. 10, 2022), http://www.aqmd.gov/home/programs/business/about-reclaim.

27 *See California Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants*, US Envtl. Prot. Agency (EPA) (Data as of Mar. 31, 2022), https://www3.epa.gov/airquality/green book/anayo_ca.html (South Coast Air Basin has been in "extreme nonattainment," the highest category of ozone pollution, since 1992).

28 As of 2019, the program covered 246 facilities. *See* SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 2 (2021), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2019-reclaim-report.pdf?sfvrsn=6.

29 As mentioned above, RECLAIM also covered sulfur dioxide, but the SO_2 market was much smaller: only 41 sources participated, and all but 2 of those were also NO_x sources. Robert C. Anderson & Richard D. Morgenstern, *Marginal Abatement Cost Estimates for Non-CO_2 Greenhouse Gases: Lessons from RECLAIM*, 9 Climate Pol'y 40, 48 (2009).

30 These air emissions limits are known as Best Available Retrofit Control Technology (BARCT) standards. BARCT standards apply to existing stationary sources and are set at the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or

RECLAIM has not reduced pollution to the extent achievable through command-and-control regulations.

While RECLAIM initially appeared to provide pollution reductions at the same level as – or even greater than – the command-and-control regulations implemented in other areas of California, by the 2010s it became clear that the system was not generating adequate emissions reductions.[31] An expansion in credit availability in the early 2000s led to low credit prices and appears to have slowed emissions reductions. Industry hampered SCAQMD's effort to tighten the availability of credits in 2015-2016, resulting in less stringent reductions requirements than even SCAQMD's own staff had supported. In 2018, SCAQMD determined that most of the equipment at facilities covered by RECLAIM did not have key emissions-reducing technology.[32] Ultimately, SCAQMD determined that RECLAIM was not meeting the requirements of California state law and decided to phase out the program and replace it with the command-and-control requirements.

B | California's Greenhouse Gas Cap-and-Trade Program

California's GHG ETS is part of a suite of climate programs authorized by the state's Global Warming Solutions Act of 2006 (also known as AB 32), and primarily implemented by the California Air Resources Board (CARB).[33] Since 2015, the ETS has covered a large majority of California's carbon emissions – between 75% and 85%[34] – including from power generation, industrial manufacturing, oil and gas production, and transportation fuels. It has also linked with the Québec emissions-trading market (since 2014), and briefly with Ontario's. CARB first adopted cap-and-trade regulations on October 20, 2011 via Board Resolution 11-32 (final regulation order Dec. 21, 2011).[35] The regulation has been amended eight times since then. California's state legislature passed AB 398 in 2017, extending the cap-and-trade program and mandating certain design features through 2030. Based on the extension, CARB amended the program regulation on December 12, 2018 via Board Resolution 18-51, addressing issues including offset limits, leakage assistance factors, allowance allocation, compliance, and delinking with Ontario.[36]

The GHG ETS, envisioned as a backstop to California's other climate policies, has taken on more prominence in recent years, particularly as AB 398 narrowed the scope for local regulators to enact their own climate regulation. At the same time, it has attracted criticism that the ETS has failed to generate sufficient emissions reductions and allowed distributional inequities in pollution reductions.

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category of source. Cal. Health & Safety Code § 40406 (West).

31 *See, e.g.*, SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 3-4 (2021) (chart showing dramatic slowdown in emissions reductions after 2002).

32 SCAQMD, RECLAIM Transition Plan Version 1.0, at vi, 13 (Mar. 2018), http://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/regxx/draft-transition-plan-version1-final.pdf?sfvrsn=6.

33 *See generally AB 32 Global Warming Solutions Act of 2006*, CARB (Sept. 28. 2018), https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006.

34 CARB's materials generally estimate that the cap-and-trade program covers about 85% of the state's GHG emissions. *See, e.g.*, CARB, Overview of ARB Emissions Trading Program 1 (2015), https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/guidance/cap_trade_overview.pdf. However, more recent estimates place the current coverage at about 75% of statewide emissions. *See, e.g.*, Indep. Emissions Market Advisory Comm., 2021 Annual Report of the Independent Emissions Market Advisory Committee 3 (2022), https://calepa.ca.gov/wp-content/uploads/sites/6/2022/01/2021-IEMAC-Annual-Report.a.pdf [hereinafter Indep. Emissions Market Advisory Comm. 2021 Report].

35 *Cap and Trade 2010*, CARB (last visited Dec. 22, 2011), https://ww3.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm.

36 *California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation*, CARB (last visited Mar. 29, 2019), https://ww2.arb.ca.gov/rulemaking/2018/california-cap-greenhouse-gas-emissions-and-market-based-compliance-mechanisms.

California's GHG cap-and-trade program has produced modest emissions reductions; it has also generated substantial revenue for environmental objectives and established a strong market governance system.

California's GHG cap-and-trade program remains an important component of California's overall climate policy. However, the system has received criticism, primarily over questions of environmental ambition, integrity, and justice. One analysis (from the state Legislative Analyst's Office) has concluded that the program could hinder California's ability to meet its goals for emissions totals in 2030, mostly because of banked credits from earlier in the program's history.[37] Surpluses have generally caused allowance prices to be low with correspondingly small incentives for facilities to reduce GHG emissions (although the last few auctions have shown a different trend). The bulk of reductions from sectors covered under the GHG ETS have come from the power sector, which are likely driven by other policies such as the renewable portfolio standard. Critics have also raised questions about the integrity of emissions reductions obtained through offsets.

On the other hand, the carbon ETS has been an important source of revenue for environmental programs and funding to underserved communities, although the volatility of the auction revenues means that this funding is not reliable. In addition, California has developed a robust monitoring, reporting, and verification (MRV) system to ensure that emissions and production data are rigorous and understood, implemented effective market controls to prevent manipulation of the allowance market, and established enforcement mechanisms to deter rule breaking.

37 *See infra* note 290.

II | CURRENT DEBATES OVER EMISSIONS TRADING

We conduct our assessment of these two California emissions trading schemes keeping in mind recent debates over the advantages and disadvantages of emissions trading systems. We highlight the ways in which political economy dynamics can render emissions trading relatively low in environmental ambition, whether due to competing policy priorities or vested interest intervention.

A | Advantages

Emissions trading arose as a response to shortcomings of traditional command-and-control regulation. The main argument in favor of emissions trading is the potential to achieve environmental objectives at least cost. Traditional command-and-control regulation offered little flexibility to companies in how and where to reduce emissions and failed to take advantage of the fact that some polluters can reduce emissions more cheaply than others. In a cap-and-trade structure, firms meet their compliance obligations by reducing emissions *or* purchasing allowances under the constraint of a fixed cap on emissions. In this way, firms can determine for themselves the lowest-cost approach to compliance, while the cap ensures a maximum limit on emissions. In a properly structured market, trading gives firms with lower marginal abatement costs an incentive to reduce emissions "beyond compliance" and to sell unused allowances on the market to firms for whom allowance purchases would be the most cost-effective means of compliance. Through such a system, environmental goals can be achieved at a lower aggregate cost of compliance.

An early example of the efficiency gains achievable through trading in the US was the inter-refinery averaging of lead in gasoline, which helped transition mid-sized refineries with relatively high de-leading costs.[38] The program was only in effect for a few years, however. A larger, more sustained emissions trading program – the US SO_2 emissions trading program (authorized by the Clean Air Act Amendments of 1990) – also demonstrated cost reductions.[39] One-third of such cost savings could, however, be attributed to fuel switching to low-sulfur coal that had begun to happen prior to the cap-and-trade program, as the result of regulatory changes that lowered the cost of shipping low-sulfur coal.[40]

Proponents of emissions trading also argue that such systems are administratively less burdensome to operate and enforce. As such, emissions trading systems should be more easily expanded to cover diverse sources of emissions.

38 *See generally* Richard G. Newell & Kristian Rogers, *The US Experience with the Phasedown of Lead in Gasoline*, Res. for Future (2003), https://web.mit.edu/ckolstad/www/Newell.pdf; Suzi Kerr & Richard G. Newell, *Policy-Induced Technology Adoption: Evidence from the US Lead Phasedown*, *in* Controlling Automobile Air Pollution 193–219 (Virginia McConnell ed., 2018); Hugh S. Gorman & Barry D. Solomon, *The Origins and Practice of Emissions Trading*, 14 J. Pol'y Hist. 293, 303–08 (2002).

39 *See* Curtis Carlson et al., *Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?*, 108 J. Pol. Econ. 1292 (2000) (projecting expected savings of about 43% by 2010, versus the least-cost alternative command-and-control approach); Nathaniel O. Keohane, *What Did the Market Buy? Cost Savings under the US Tradeable Permits Program for Sulfur Dioxide*, Yale Ct. for Env't. L. & Pol'y Working Paper (Oct. 15, 2003), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=465320 (estimating that the trading system created savings between 16 and 25% between 1995 and 1999, compared to the least-cost alternative command-and-control approach).

40 *See* Richard Schmalensee & Robert N. Stavins, *The SO_2 Allowance Trading System: The Ironic History of a Grand Policy Experiment*, 27 J. Econ. Persp. 103, 110–12 (2013).

B | Disadvantages

In recent years, emissions trading has come under sustained criticism that the systems have not lived up to their theoretical promise.[41] In the climate context, the most salient concern is that emissions trading's effects on decarbonization have simply been too incremental and that such modest environmental impacts are inadequate given the demands for rapid decarbonization reflected in Paris Agreement goals and domestic carbon neutrality targets.

These critiques have focused on the role of political economy factors in weakening the environmental ambition of emissions trading systems. Such systems have generally been established with relatively modest targets and assumptions about growth and technology change.[42] Concerns about economic impact and political buy-in have contributed to relatively soft design elements, such as overallocation of allowances, free allocations of allowances that constrain price impact, and limits on sectoral coverage. What's more, it has been difficult as time goes on to make emissions trading systems more environmentally stringent.

The application of emissions trading systems across multiple sectors and the focus on a highly visible carbon price has generated sustained industry opposition and public concern about the costs of regulation that result in conservative design choices. Fossil fuel industries have been particularly active in seeking to weaken the ambition of trading systems.[43] Concerns about impact on electricity and fuel costs to consumers have also limited the environmental ambition of trading systems.[44] Considerations of excessive cost to industry are sometimes framed in terms of a policy interest in protecting "energy intensive, trade exposed" industries and avoiding "leakage" of emissions (*i.e.*, increasing regulatory costs to a point that drives firms to shift production and associated GHG emissions outside of the regulated jurisdiction). In limited instances where prices have risen to "excessive" levels, regulators have stepped in to mitigate price impacts.

These dynamics have meant that allowance prices in carbon emissions trading systems have been low. This was true most notably in the first to third phases of the EU ETS, although prices have been rising as the EU takes measures to meet new carbon neutrality targets.[45] In recent years, industry opponents have taken to supporting carbon pricing initiatives *because* of their relatively light regulatory impact, the ability to negotiate industry-favorable compromises such as preemption of other regulations, and the reputational benefits for industry of supporting *some* form of regulation as support for climate action has grown.[46] The effects of such dynamics can be seen in the design, for example, of the EU ETS, California carbon ETS, and the provisions of the failed Waxman-Markey bill, which would have established a nationwide emissions trading system in the United States in 2010.[47]

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41 *See* Green, *supra* note 11; Boyd, *supra* note 11; Cullenward & Victor, *supra* note 11.

42 Jesse D. Jenkins & Valerie J. Karplus, *Carbon Pricing under Binding Political Constraints* 6 (U.N. Univ., Working Paper, Apr. 2016), https://www.wider.unu.edu/sites/default/files/wp2016-44.pdf.

43 *See, e.g.*, Michael E. Mann, The New Climate War: The Fight to Take Back Our Planet (2021).

44 Such concerns are, of course, present more broadly across environmental regulatory instruments.

45 Nina Chestney, *EU Carbon Price Hits Record High above 45 Euros a Tonne*, Reuters (Apr. 20, 2021), https://www.reuters.com/business/energy/eu-carbon-price-hits-record-high-above-45-euros-tonne-2021-04-20/.

46 *See* Meckling, *supra* note 13; Jennifer A. Dlouhy & Leslie Kaufman, *How the Oil Lobby Learned to Love Carbon Taxes*, Bloomberg Green (Mar. 4, 2021), https://www.bloomberg.com/news/articles/2021-03-04/how-the-oil-lobby-learned-to-love-carbon-taxes.

47 Even if it had passed, the Waxman-Markey Bill nonetheless contained provisions to keep costs low and provide large amounts of free allocations to energy-intensive heavy industry and natural gas and electricity distribution companies to reduce impacts on energy consumers, weakening the plan's emission cutting ambitions in the energy sector. *See* Jenkins & Karplus, *supra* note 42, at 7.

The theoretical administrative simplicity of emissions trading systems also may not carry over to all regulatory systems, particularly those in the developing world where capacity issues are commonplace. Establishing an effective trading market depends on technical expertise to create emissions inventories; monitoring, reporting, and verification systems; and robust market monitoring and regulatory enforcement capacity. These are particularly strong in the major jurisdictions that have pioneered emissions trading – the US federal government, California, Quebec, and the EU. But markets can be susceptible to manipulation and the complexity of markets can mask poor performance in practice. Indeed, observers of emissions trading markets often focus on metrics that have little to do with environmental performance, such as trade volume and compliance rates. In short, we should be cautious about assuming that market measures would be easier to implement than traditional command-and-control measures in many places around the world.

III | A CASE STUDY OF CALIFORNIA'S RECLAIM PROGRAM

A | Legal background for the RECLAIM program

California's RECLAIM program grew out of an effort to reduce NO_x and SO_2 emissions in the Los Angeles metropolitan region and Orange County, a region known as the South Coast Air Basin. For many decades, this region has had some of the worst air quality in the US Federal law requires the South Coast Air Quality Management District (SCAQMD) to limit the concentrations in the atmosphere of a number of air pollutants, including ozone and $PM_{2.5}$, in the South Coast Air Basin.[48] Additionally, California law requires that all sources of NO_x and SO_2 install the "best available retrofit control technology" (BARCT) for reducing those pollutants, which is defined as "the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts."[49]

State law also authorizes SCAQMD to implement a market-based mechanism, but *only if* it results in an emissions reduction equivalent to or greater than the reductions obtained under BARCT.[50] This was the origin of RECLAIM: SCAQMD decided to use an emissions trading system, rather than command-and-control regulations, to try to reduce NO_x and SO_2 emissions more quickly and cost-effectively. In exchange, covered facilities were exempt from a large set of command-and-control rules that would otherwise have applied to them.[51]

B | RECLAIM program design[52]

1 | RECLAIM coverage

RECLAIM covers emissions of NO_x and SO_2 and applies to most facilities that emit at least four tons of either pollutant in a year.[53] When the program started in 1993, it included 394 facilities. That number has decreased to 246 as of 2019, mostly because of facility shutdowns.[54] All 246 of those facilities are regulated for their NO_x emissions. Thirty are also regulated for SO_2 emissions and must participate in both markets.[55]

RECLAIM covers stationary sources, primarily refineries and power plants.[56] Because vehicles produce much of the NO_x and SO_2 pollution in the South Coast Air Basin, which RECLAIM does not cover, the program regulated a relatively small portion of total emissions: about 17% of NO_x and 31% of SO_2 emissions in the area in 1993.[57]

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48 *See generally* 40 C.F.R. §§ 50.7, 50.9, 50.10, 50.13, 50.18 (2021).

49 Cal. Health & Safety Code § 40406 (West).

50 Cal Health & Safety Code § 39616 (West).

51 EPA, An Overview of the Regional Clean Air Incentives Market (RECLAIM) 3 (2006), https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.187.7379&rep=rep1&type=pdf#:~:text=Emissions%20have%20been%20reduced%20under,and%20perpetuating%20complexity%20and%20uncertainty.

52 Electronic versions of all rules and appendices under SCAQMD Regulation XX – Regional Clean Air Incentives Market (RECLAIM), available at http://www.aqmd.gov/home/rules-compliance/rules/scaqmd-rule-book/regulation-xx.

53 SCAQMD Regulation XX, Rule 2001(b).

54 SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 1-3 (2021).

55 *Id.*

56 *Id.* at 7-4.

57 SCAQMD, RECLAIM: Program Summary, at EX-17 to EX-18 (1993), https://www.aqmd.gov/docs/default-source/reclaim/reclaim_program_summary.pdf.

2 | RECLAIM initial total allocation and reduction

California law requires that RECLAIM achieve reductions equal to or greater than those that would be available if the covered facilities installed BARCT. Thus, the initial emissions budgets for RECLAIM were intended to track the BARCT standard and were set based on a projection of the reductions that would be achieved if all covered facilities installed all technologies that were technically and economically feasible. These projections were made for each facility for the years 1994, 2000, and 2003.[58]

These calculations resulted in an initial NO_x cap of about 39 kilotons (KT) in 1994, declining to about 13 KT in 2000 and 9.5 KT in 2003.[59] This NO_x cap was later adjusted upward to 17 KT in 2000 and 12 KT in 2003.[60] Facilities were then assigned a straight-line reduction between the baseline values at 1994, 2000, and 2003.[61] For SO_2, the initial cap was set at 8.8 KT, declining to 5.1 KT by 2000 and 4.3 KT by 2003.[62] This was later adjusted to 11 KT in 1994, 6.2 in 2000, and 4.3 (as expected) in 2003.[63] Put another way, facility allocations created about an 8% annual decline for NO_x allocations, and a 7% annual decline in SO_2 allocations, between 1994 and 2003, on average.[64]

After the completion of the initial 10-year schedule, SCAQMD continued to reduce the allocation cap for NO_x credits with two "shaves" (*i.e.*, cap reductions) in 2005 and 2015.[65] The 2005 shave reduced total NO_x allocations by 22.5% between 2007 and 2011 (such that, after 2011, annual NO_x emissions from all RECLAIM facilities were 2.8 KT lower than in 2007).[66] The 2015 shave reduced allocations by 45% between 2016 and 2022 (or a 4.4 KT reduction in annual NO_x emissions by the end of the shave period).[67] Similarly, in 2010 SCAQMD instituted a reduction in the SO_2 allocation cap of about 2.1 KT, phased in between 2013 and 2019.[68]

58 SCAQMD, First Annual RECLAIM Program Audit Report 17 (1996), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/1994-reclaim-report.pdf?sfvrsn=6.

59 *Id.* at 21. These values are originally given in tons per day, and have been converted to tons per year by the authors. Additionally, since these "caps" are actually just the sum of all facility allocations, and facility allocations depend on variable factors (see below), the number of credits actually issued varies somewhat from the total allocation targets. *See generally* SCAQMD Regulation XX, Rule 2002(c)-(e).

60 According to SCAQMD, these adjustments "largely reflect adjustments to projected emissions which would also have occurred under command-and-control rules and do not adversely impact the ability of RECLAIM to achieve emission reductions equivalent to the subsumed rules and control measures." The claim is apparently that initial estimates of emissions reductions achievable via BARCT were too aggressive, and "new information and technology reviews" required a looser cap to reflect what could be achieved via existing technologies. These adjustments included, among other things, emission factor corrections, re-apportionment of fuel usage, changing the peak activity year, and amendment of previously submitted emissions data by facilities." *See* SCAQMD, First Annual RECLAIM Program Audit Report 17–18 (1996).

61 SCAQMD Regulation XX, Rule 2002(f)(1).

62 *See* note 58, *supra*, at 21.

63 SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 3-3 (2021).

64 EPA, An Overview of the Regional Clean Air Incentives Market (RECLAIM) 3 (2006).

65 The 2015 NO_x shave was particularly controversial and is an example of how political dynamics can limit the ambition of emissions trading systems. *See infra* § III.C.

66 *See* SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 2-6 (2021).

67 *Id.*

68 *Id.*

The credit allocations for each pollutant are provided in the following figures:

Fig. 1 NOx RECLAIM credits allocated (tons)[69]

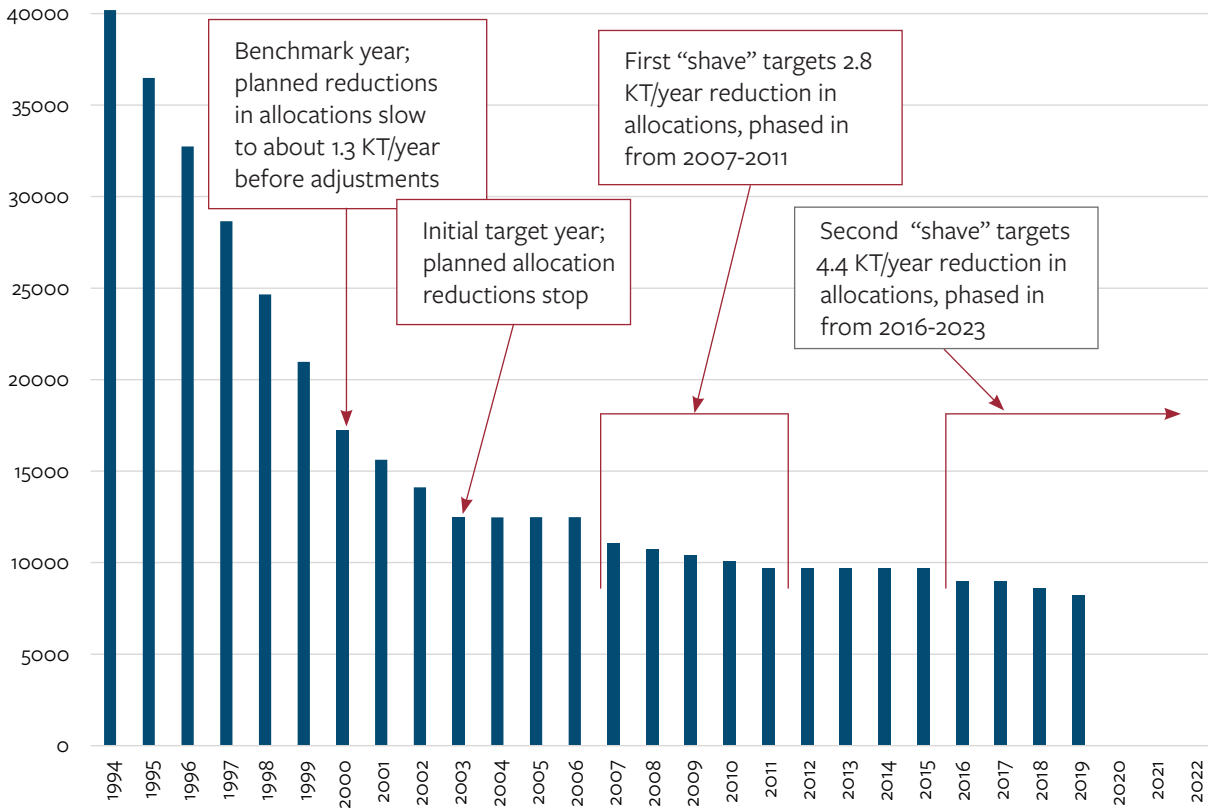
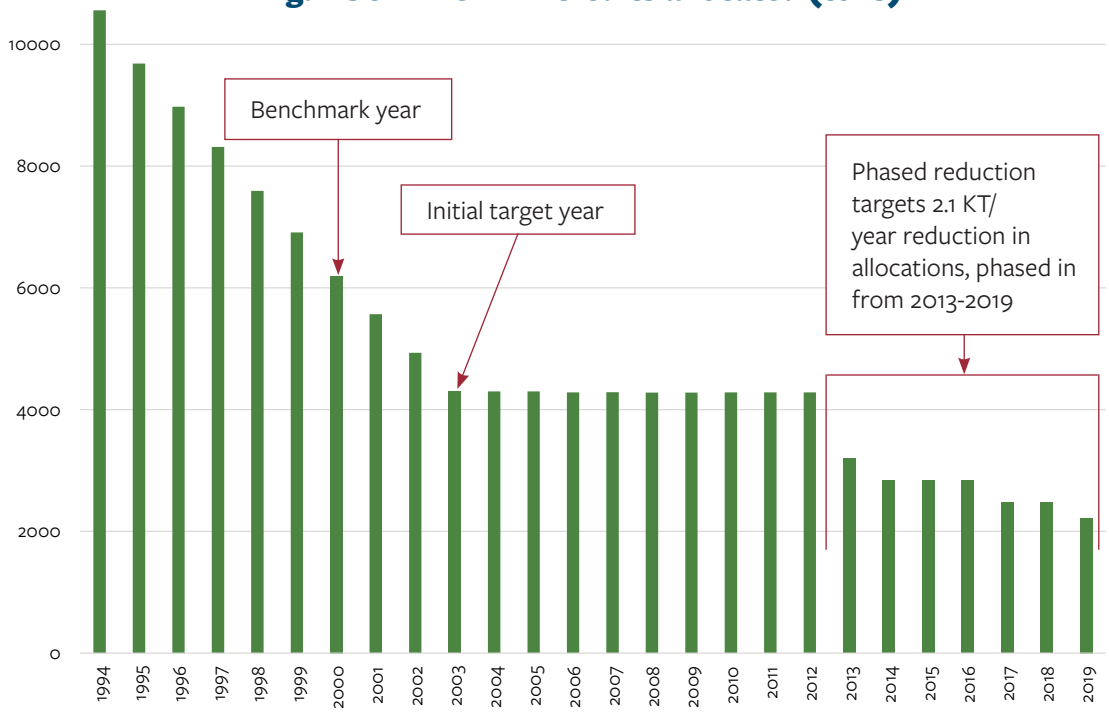


Fig. 2 SO2 RECLAIM credits allocated (tons)[70]



69 Data from SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 3-3, 3-5 (2021).

70 *Id.*

3 | Credit allocation

All RECLAIM credits are issued for free to covered facilities. The initial allocations issued in 1994 were based on each facility's peak production level between 1987 and 1993, multiplied by benchmark levels of emissions.[71] Emissions allocations for 2000 were determined similarly, but with reduced benchmarks.[72] Allocations for 2003 were calculated from projections of the district-wide emissions reductions that would have been achieved under BARCT; each facility would have received the same percentage decrease in allocations between 2000 and 2003, such that the total 2003 allocations were equal to the projected amount of emissions that the facilities collectively if they installed BARCT.[73] Facilities were allocated annual allowances so as to create a straight-line decrease in their allocations between 1994 and 2000, and between 2000 and 2003.[74]

However, the California energy crisis in 2000 changed RECLAIM NO_x allocations dramatically. First, SCAQMD effectively removed the power sector from the market and returned power sector facilities to command-and-control requirements, including the requirement that each piece of NO_x-emitting equipment achieve BARCT by 2004; they technically continued to receive allocations but had to make up any shortfall by purchasing credits directly from SCAQMD, effectively turning the credits into an emissions-based fee.[75] Second, SCAQMD allowed industrial facilities to generate their own credits by undertaking various projects to reduce emissions from large trucks, ships, and refrigerated shipping.[76] Notably, some projects allowed for credits to be issued based on prospective work, so that covered facilities could obtain credits immediately in exchange for promised reductions in the future.[77] These new credit-generation programs appear to have been intended to increase credit supply during the crisis period, although they did not end up substantially adding to the supply until 2003.[78]

4 | Monitoring, Reporting, and Verification requirements for RECLAIM

RECLAIM outlines different monitoring, reporting, and recordkeeping (MRR) requirements for sources, depending on source size.[79] Larger sources have more stringent MRR requirements.

There are three levels of emission quantification and reporting requirements for NO_x.

- **Major sources** report emissions daily and are required to have continuous emission monitoring systems (CEMS) or an approved alternative.[80]

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71 SCAQMD Regulation XX, Rule 2002(c)(1), (h)(1). Specifically, starting allocations were based on the sum of the peak productivity for each process within each facility between 1989 and 1992, multiplied by a benchmark for each process, plus additional non-tradable credits for facilities with peaks in 1987-1988 or 1993. *Id.* Thus, a facility in which units' productivity were not highly correlated could have allocations based on a higher amount than the facility ever actually emitted in that period.

72 *Id.* Rule 2002(d)(1).

73 *Id.* Rule 2002(e).

74 *Id.* Rule 2002(f).

75 EPA, An Overview of the Regional Clean Air Incentives Market (RECLAIM) 9 (2006); *see also* SCAQMD Regulation XX, Rule 2009(b)(2).

76 EPA, *supra* note 74 at 10; *see also generally* SCAQMD Regulation XVI, Rules 1612.1, 1631-1634 (new credit-generation programs adopted in 2001).

77 *See, e.g.*, *id.* Rule 1632(d)(4) (for credits generated through replacement of marine engines, replacement can be done any time before January 1, 2005).

78 *See infra* § III.D.2.

79 *See generally* SCAQMD Regulation XX, Rule 2012, Appx. A, c.1.

80 *Id.* Rule 2012(c)(1), (c)(3)(A). Major sources generally include the largest combustion equipment, engines, and turbines, as well as catalytic-cracking and tail-gas units and other high-emitting equipment. *Id.* Rule 2012(c)(1). Although they are a minority of covered facilities, major sources are responsible for the majority of NO_x emissions. *See, e.g.*, SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 5-7 (2021) (noting that, for 2019, sources monitored by CEMS made up 19% of NO_x sources, but 77% of NO_x emissions).

- **Large sources** may use CEMS or report on a monthly basis the total fuel burned and calculate the emissions based on the emissions rate for the relevant processes; these rates are generally specified in the facility's permit.[81]

- **Minor sources** (process units and Rule 219-exempt equipment) report quarterly. Process units may use the methods for major or large sources or may use timers and assume the unit is operating at its maximum rated capacity to determine the amount of fuel burned.[82] Rule 219-exempt equipment – equipment that is otherwise exempt from permitting because of its small size – may use fuel bills to demonstrate fuel usage.[83]

SO_2 source requirements are similar, except that there is no large-source category. Units that would be large sources for NO_x and also emit SO_2 are generally major sources for SO_2, and must install CEMS and report daily.[84]

RECLAIM facilities must reconcile their emissions with their holdings of RECLAIM Trading Credits (RTCs) on a quarterly and annual basis.[85] That is, they must ensure that they hold RTCs equal to or greater than their emissions. SCAQMD audits each facility's reports annually.[86]

5 | Trading and banking RECLAIM credits

RECLAIM credits use a zone system with two zones. Each credit is tied to the zone in which it was created: Zone 1 covers the coast and many of the major cities, which are upwind of the rest of the South Coast Air Basin because the prevailing winds blow inland from the sea. Zone 2 covers the inland, downwind portion of the South Coast Air Basin, which has worse air quality than Zone 1.[87] Credits initially allocated to Zone 2 may only be used in that zone, while credits originating in Zone 1 may be used in either zone.[88] This provides a check against one way in which the emissions trading system could worsen Zone 2 air quality.

Other than this, RECLAIM credits may be freely transferred, though all transfers must be registered with SCAQMD before they are effective.[89] Forward contracts must also be registered with SCAQMD.[90] There does not appear to have been any major secondary market for RECLAIM credits, although external traders, commodity traders, and mutual funds have invested in RTCs.[91]

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81 SCAQMD Regulation XX, Rule 2012(d)(1)-(2). Large sources include middling combustion equipment, engines, turbines, and kilns; sulfuric-acid production; and major sources that reduce emissions to their 2003 target by 1998. *Id.*

82 *Id.* Rule 2012(e); *see also id.* Appx. A, c.4, § B.3 (process for using timer-based reporting).

83 *Id.* Appx. A, c.4, § F.1.

84 *See generally id.* Rule 2011(c)-(d). Facilities that reduced emissions to below their 2003 allowances by 1998 were allowed to reclassify their major sources as process units. *Id.* Rule 2011(c)(4).

85 *Id.* Rule 2004(b); SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 5-2 (2021).

86 SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 5-2 (2021).

87 SCAQMD Regulation XX, Rule 2005, Appx. A.

88 *Id.* Rule 2005(e).

89 *See generally id.*, Rule 2007(e)(2).

90 *Id.* Rule 2007(e)(2)(I).

91 *See, e.g.*, SCAQMD, Annual Reclaim Audit Report for 2005 Compliance Year, at 2-21 to 2-23 (2007), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2005-reclaim-report.pdf?sfvrsn=8 (describing increase in investor activity and beginning of foreign investment); SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 2-34 (2021) (noting significance of investment for price-setting, even when total credits owned by investors is low).

Credits under the RECLAIM program cannot be banked. All credits issued expire within a year of issuance.[92] The credits have a small amount of flexibility, in that they can be used immediately after expiration if they are claimed for emissions that occurred while they were still active.[93] The credits are also issued on two alternating "cycles," one that expires June 30 and one that expires December 31.[94]

One trading practice that evolved to account for the credits' short expiration date was the use of "infinite-year blocks" (IYBs). An IYB is a stream of credits, beginning in a certain year, but continuing in perpetuity.[95] Thus, although a facility may not bank credits, it may buy IYBs from another facility, guaranteeing that it will have a certain amount of credits available (above its initial allocation) in the future. This practice was predominantly used by petroleum refineries.[96]

C | RECLAIM in Action

RECLAIM's initial allocations were quite generous, providing the covered facilities with approximately 60% more credits than needed in 1995.[97] This overallocation was designed to decrease rapidly between 1995 and 2003, so that by 1999 the amount of RTCs roughly equaled the reported annual emissions.[98]

In 2000, as emissions and RTC allocations were converging, energy prices increased rapidly in California due to a combination of weather and market manipulation.[99] As a result, energy suppliers began using older units and inefficient "peaker" units more frequently, leading to higher NO_x emissions.[100] This combination of factors led to RTC prices spiking by factors of 10 to 40,[101] as well as a large amount of noncompliance.[102]

After the 2000-2001 energy crisis, SCAQMD made two major changes to RECLAIM. First, it removed power plants from the market, instead requiring them to install emissions-reductions technology meeting the BARCT standard.[103] Second, it added several new programs to allow covered facilities to receive new allowances for making efforts to reduce mobile- and area-source emissions.[104]

In 2005 and 2015, SCAQMD used two "shaves" to reduce the total amount of NO_x emissions permitted each year. These were meant to ensure that reductions under RECLAIM matched the reductions under California's BARCT requirements, and therefore involved a detailed examination of the extent

92 *Id.* Rule 2007(c)(1).

93 *Id.* Rule 2007(d).

94 *Id.* Rule 2007(c)(1).

95 SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 2-8 (2021).

96 *See, e.g., id.* at 2-29 (noting that refineries purchased 98.6% of IYBs sold in 2018 and 85.9% of those sold in 2019).

97 EPA, An Evaluation of the South Coast Air Quality Management District's Regional Clean Air Incentives Market 23 (2002), https://www3.epa.gov/region9/air/reclaim/reclaim-report.pdf.

98 *Id.* at 14.

99 *See* Fed. Energy Regul. Comm'n, Final Report on Price Manipulation in Western Markets, at I-10 to I-11 (2003), https://elibrary.ferc.gov/eLibrary/idmws/common/opennat.asp?fileid=9666688.

100 EPA, An Overview of the Regional Clean Air Incentives Market (RECLAIM) 6–8 (2006).

101 *Id.* at 7.

102 *See* SCAQMD, Over a Dozen Years of RECLAIM Implementation: Key Lessons Learned Part II – RECLAIM Implementation, at II-3-2 (2007), http://www.aqmd.gov/docs/default-source/reclaim/policy-paper/policy-paper-part-2.pdf (noting that emissions exceeded allowances by 3,294 tons in 2000).

103 *Id.* at II-3-1; *see also* SCAQMD Regulation XX, Rule 2009(b).

104 SCAQMD, Over a Dozen Years of RECLAIM Implementation: Key Lessons Learned Part II – RECLAIM Implementation, at II-3-5, II-3-11 (2007).

of reductions expected from BARCT requirements.[105] In 2005, SCAQMD agreed to the first "shave," which reduced the total number of allocated credits by approximately 20% over the course of five years, from 2007-2011.[106]

However, the supply of RTCs continued to exceed actual emissions by a substantial amount, leaving a surplus of 20-30% throughout the period of the first "shave."[107] And although actual emissions did decrease during this period, most of the decrease came from covered facilities shutting down, rather than from greater efficiencies or increased pollution control.[108]

In December 2015, the SCAQMD governing board rejected a staff proposal to require a 14 tons per day (tpd) reduction in NO_x emissions from the RECLAIM program (NO_x RECLAIM "shave"), and instead approved a less stringent petroleum industry-proposed 12 tpd NO_x RECLAIM "shave", without a description of how this industry proposal related to the 2015 BARCT levels.[109] The industry-favored proposal also deferred emissions reductions to later in the "shave" period. In 2016, environmental groups including Communities for a Better Environment, Center for Biological Diversity, Sierra Club, and Natural Resources Defense Council sued SCAQMD over the 2015 NO_x RECLAIM "shave" decision for violating the statutory requirement that the market-based RECLAIM program should achieve the same pollution reductions as direct pollution controls.[110]

Finally, in 2016 SCAQMD determined that it would end the RECLAIM market-based mechanisms and revert to the command-and-control BARCT requirements, while also decreasing NO_x emissions by an additional 5 tpd by 2025.[111] As of this writing, SCAQMD is in the process of developing command-and-control rules that will apply after the market-based mechanism's end.[112]

D | Assessment of RECLAIM's efficacy

1 | Emissions from covered sources declined substantially, but significant portions of this were achieved through facility shut downs and command-and-control regulation.

The total NO_x emissions covered by RECLAIM have fallen substantially since its inception. NO_x emissions fell by about 74% between 1994 and 2019, with most of those reductions occurring

105 *See, e.g.*, SCAQMD, Annual RECLAIM Audit Report for 2005 Compliance Year 2-2 (2007).

106 *Id.* at 2-3; *see also* SCAQMD, Annual RECLAIM Audit Report for 2011 Compliance Year 3-1 (2013), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2011-reclaim-report.pdf?sfvrsn=9 (confirming that the "shave" was completed in 2011).

107 SCAQMD, Annual RECLAIM Audit Report for 2011 Compliance Year 3-3 (2013).

108 SCAQMD, Preliminary Draft Staff Report: Proposed Amendments to Regulation XX 3–4 (2016), https://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/regxx/noxreclaim_pdsr_072216.pdf?sfvrsn=2.

109 *See* SCAQMD, Governing Board Monthly Meeting Minutes – Dec. 4, 2015 and Dec. 11, 2015, at 8, 15 (2016), http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2016/2016-jan8-001.pdf?sfvrsn=7 (discussing proposal of 12 tpd shave by Western States Petroleum Association, and decision to adopt); SCAQMD, Materials for Dec. 4, 2015 Board Meeting, Agenda No. 30, Proposed Amendments to NO_x RECLAIM Program (Regulation XX), Final Staff Report 7 (2015), http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2015/2015-dec4-030.pdf?sfvrsn=9 (recommending 14 tpd shave).

110 Verified Petition, *Communities for a Better Envt. v. S. Coast Air Quality Mgmt. Dist.*, No. BS161399 (Sup. Ct. Cnty L.A., filed Mar. 9, 2016), *available at* https://earthjustice.org/sites/default/files/files/2016-0309-Verified-Petition.pdf.

111 SCAQMD, RECLAIM Transition Plan Version 2.0, at 1-1 (Dec. 2020), http://www.scaqmd.gov/docs/default-source/rule-book/Proposed-Rules/regx111/reclaim-transition-plan-draft-version-2-0.pdf?sfvrsn=6.

112 SCAQMD is currently publishing regular updates on its website. *See RECLAIM Transition*, SCAQMD (last visited Apr. 11, 2022), http://www.aqmd.gov/home/rules-compliance/reclaim-transition.

between 1995-1996 and 1999-2003.[113] SO_2 emissions fell by 76% during that time, primarily between 1997-2004 and 2007-2013.

However, this does not appear to be primarily the result of efficiencies created by market forces, at least on the NO_x side. About a third of the NO_x decrease (6.1 of 19 KT) came from reductions in power plant emissions between 2000 and 2003,[114] when they were subject to a command-and-control requirement and were not permitted to trade with the rest of the market.[115]

Facility shut downs also appear to have contributed significantly to emissions reductions. NO_x facilities declined by a net of about 37% over the course of the program, from 392 to 246, which presumably caused a corresponding level of emissions reductions. Data on the specific emissions reductions caused by facility shutdowns are conflicting, possibly due to differing definitions of when a facility has shutdown. It is worth noting, however, that during the first years of the program several large facilities shut down, accounting for a net loss of 1.6 KT between 1994 and 1999[116] – about a third of all RECLAIM NO_x reductions during that period.[117] Similarly, an assessment by SCAQMD staff found that during the implementation of the 2005 NO_x "shave" from roughly 2006 to 2012, about 65% of the reductions during that period came from facility shutdowns.[118] An EPA analysis of RECLAIM's early performance noted that "NO_x emissions had been reduced from RECLAIM's inception through 1999, but reductions occurred primarily through shutdowns, relocation outside the AQMD's jurisdiction, improved housekeeping, and improved process efficiency."[119] Thus, a substantial portion of the emissions reductions achieved under the RECLAIM program appear to be the result of facilities shutting down and reasons other than reducing their emissions during operation.

2 | RECLAIM's allocation strategy does not appear to have worked as intended.

RECLAIM intentionally provided a large number of excess credits in its first few years, planning to reach a "cross-over" point at which the emissions budget would catch up with actual emissions and start driving reductions.[120] However, this strategy ended up creating even more surplus than expected.[121]

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113 SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year, at 3-3 to 3-4 (2021).

114 SCAQMD, Annual RECLAIM Audit Report for the 2003 Compliance Year 3-4 (2005), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2003-reclaim-report.pdf?sfvrsn=8.

115 SCAQMD Regulation XX, Rule 2009(b). The start of this period coincided with the California energy crisis, which likely increased the emissions reduction during this period; we do not have access to power sector-specific data prior to 2000 to determine how much, though it is notable that: first, there was no increase in overall emissions during this period and, second, that SCAQMD attributed the reduction to new NO_x controls installed after the command-and-control period started. SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 3-3 (2021).

116 SCAQMD, Annual RECLAIM Audit Report for the 1999 Compliance Year, at 3-6 to 3-7 (2001), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/1999-reclaim-report.pdf?sfvrsn=8.

117 SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 3-3 (2021) (total NO_x emissions decreased from 25,420 tons to 20,889 tons from 1994 to 1999). We use the later audit reports' record of historical emissions because SCAQMD's review of past years occasionally uncovers corrections to past emissions.

118 SCAQMD, Draft Staff Report : Proposed Amendments to Regulation XX – Regional Clean Air Incentives Market 3–4 (2016), http://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/regxx/2-regxx-dsr-final.pdf?sfvrsn=2. The RECLAIM Annual Reports issued during this period indicate a smaller quantity of reductions due to shutdowns, but this appears to be a question of definition: For example, the staff report considered the California Portland Cement facility to have shut down during the shave period. *Id.* at 5. But it also notes that "small ancillary equipment remained in operation" after the shutdown. *Id.* at 11. The Annual Reports, presumably on the basis of that "small ancillary equipment," continued listing that facility as "active" through 2019, the latest report available. *See* SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year A-2 (2021). Therefore, the California Portland facility (and any similarly situated facility) probably was not included in the Annual Reports' tally of emission reductions due to facility shutdowns.

119 EPA, An Overview of the Regional Clean Air Incentives Market (RECLAIM) 8 (2006).

120 SCAQMD, First Annual RECLAIM Program Audit Report 24 (1996).

121 SCAQMD, Over a Dozen Years of RECLAIM Implementation: Key Lessons Learned Part III – Conclusions and Recommendations, at III-1-3 (2007), http://www.aqmd.gov/docs/default-source/reclaim/policy-paper/policy-paper-part-3.pdf?sfvrsn=4.

And when the "cross-over" was reached, prices skyrocketed.[122] This is partially due to the fact that the state faced an energy crisis at the same time, leading to high energy prices that incentivized power plants to produce more, and therefore emit more NO_x pollution.[123] The RECLAIM market worked to a certain extent here: non-power facilities appear to have slowed or stopped production in favor of selling their credits to power facilities, in response to the high market prices.[124] But this did not ultimately produce enough reductions in industrial emissions to balance out the increased power-plant emissions. And ultimately, SCAQMD's removal of power plants from the RECLAIM market and application of command-and-control measures was what kept RECLAIM facilities as a whole within the NO_x budget.[125]

Looking back, SCAQMD's strategy – overallocating in the initial years, decreasing allocations rapidly, and trusting covered facilities to make the investments necessary to handle the "cross-over" – did not function as expected.[126] Instead, facilities failed to install pollution controls until *after* the 2000 price shock, at which point emissions did drop by about 50% by 2003. Again, this decrease was primarily driven by power-producing facilities, which decreased emissions by about 90% between 2000 and 2003 under a command-and-control regime, compared to a 32% decrease in the non-power sector during that period.[127]

The immediate reductions after the 2000 crisis were followed by a long period of stagnation, apparently because of a credit surplus at this time. After dropping by about 15 KT from 1994 to 2003, emissions decreased by only about 3 KT from 2004 to 2013.[128] Meanwhile, a large number of surplus credits remained in the system; between 19-30% of credits were unused in every year after 2003.[129] This was partially due to the fact that no reductions were originally planned after the 2003 benchmark year, though small allocations reductions were implemented between 2007 and 2011 and from 2017 onward (the NO_x "shaves"). This was also influenced by facility shutdowns, as discussed above. Until 2016 (and to a limited extent afterward), facility owners were permitted to retain and sell their allocations after shutdown, so that emissions fell without a corresponding reduction in allocations. [130]

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122 *See* SCAQMD, Annual RECLAIM Audit Report for the 2000 Compliance Year, at 2-7 to 2-8 (2002), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2000-reclaim-report.pdf?sfvrsn=8.

123 For example, the SCAQMD noted that non-power plant emissions remained below allocations in 2000, but that power plants purchased all the excess credits in other sectors. *Id.* at 3-3 to 3-4. Moreover, "[w]hile initially allocated 14 percent of total allocations for 2000 (down from 23 percent at the start of the program), the power sector purchased 60 percent of NO_x RTCs expiring in June 2000 and 67 percent of NO_x RTCs expiring in December 2000 (SCAQMD, 2001)." EPA, *An Overview of the Regional Clean Air Incentives Market* (RECLAIM) 7 (2006)

124 EPA's assessment was that, during the energy crisis, "several facilities stopped operations during the price spike because selling their RTCs became more profitable than continuing production." EPA, An Evaluation of the South Coast Air Quality Management District's Regional Clean Air Incentives Market 51 (2002). This is also supported by the fact that trading prices and volume both spiked during this period. *See* SCAQMD, Annual RECLAIM Audit Report for the 2000 Compliance Year, at 2-7 (2002).

125 SCAQMD, Annual RECLAIM Audit Report for the 2001 Compliance Year 3-3 (2003), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2001-reclaim-report.pdf?sfvrsn=8. *See* Regulation XX, Rule 2009(b). Specifically, the emissions of each piece of major equipment at each plant was required to be reduced to the amount that would be achieved under BARCT. *Id.* Rule 2009(b)(2).

126 SCAQMD acknowledges this, noting that "facilities did not foresee that the program was reaching a 'crossover point' (at which emissions would equal or exceed allocations) in sufficient time to install controls." SCAQMD, Over a Dozen Years of RECLAIM Implementation: Key Lessons Learned Part I–RECLAIM Design, at I-3-8 (2007), http://www.aqmd.gov/docs/default-source/reclaim/policy-paper/policy-paper-part-1.pdf.

127 SCAQMD, Annual RECLAIM Audit Report for the 2003 Compliance Year 3-3 (2005) ("The decrease in emission [at power producing facilities] was due to the installation of NO_x control equipment ... and a reduced generation level.").

128 SCAQMD, Annual RECLAIM Audit Report for 2019 Compliance Year 3-3 (2021).

129 *Id.*

130 SCAQMD Regulation XX, Rule 2002(i).

Finally, new credit-generation options that SCAQMD permitted from 2001 to 2005 further increased surpluses, since they primarily generated credits in 2003 to 2005, when emissions were already well below allocations (though they produced only a little over 1 KT worth of credits).[131]

3 | The ETS portion of RECLAIM appears not to have delivered the same level of emissions reductions as the command-and-control alternative.

Although emissions decreased substantially during the RECLAIM period, these reductions appear ultimately not to have matched the reductions available under the command-and-control alternative required by state and federal law. As discussed above, the temporary application of command-and-control measures to power plants from 2000-2003 resulted in a 90% reduction in emissions for that sector, and accounts for about a third of the overall reductions achieved under RECLAIM. These reductions were achieved by simply requiring those power plants to achieve the emission levels required under BARCT, a command-and-control regulation, rather than through emissions trading. SCAQMD's 2005 NO_x "shave," meant to reduce emissions to the level achievable by BARCT in 2011, only achieved 4 of the 7.7 tons per day anticipated (about 1.5 of the 2.8 KT annually); even then, about two-thirds of those reductions resulted from facility shutdowns.[132]

At least one study, however, concluded that RECLAIM produced greater emissions reductions as compared to facilities regulated under command-and-control regulations. Fowlie and her co-authors analyzed the differences between emissions reductions in RECLAIM facilities and similar facilities in nonattainment areas outside of the RECLAIM program, between 1993 and 2005.[133] The study found that, in the early years of the program (when the aggregate cap far exceeded emissions), "emissions of RECLAIM facilities appear to increase slightly relative to facilities outside the program." However, due to relatively greater emissions reductions from RECLAIM facilities in subsequent time periods from 2000 to 2005, the study found that RECLAIM facility emissions fell 20% relative to non-RECLAIM facilities over the first 10-years of the program. Such comparisons are difficult to interpret, among other reasons, because the facilities outside the RECLAIM area were subject to a different set of regulations than those within SCAQMD even before RECLAIM, and because the level by which SCAQMD exceeded the applicable air quality standards – and therefore the extent of reductions required by state and federal law – was almost unmatched in California at the time.[134]

In any event, SCAQMD and EPA determined that, by 2012, RECLAIM was no longer achieving reductions equivalent to command-and-control. SCAQMD determined in a 2015 analysis of the RECLAIM program that achieving reductions equivalent to BARCT (technology-based standards) would require reducing emissions at covered facilities to 10.2 tons per day (or 3.7 KT a year).[135] The emissions reduction plan eventually adopted by SCAQMD only required reductions to 14.5 tons per

131 Almost all credits from these programs were generated pursuant to Rule 1631, which generated 135 tons of credits in 2002, 326.6 in 2003, 400.7 in 2004, and 180.4 in 2005. *See* SCAQMD, Annual RECLAIM Audit Report for the 2001 Compliance Year, at 3-12 to 3-13 (2003); SCAQMD, Annual RECLAIM Audit Report for the 2002 Compliance Year, at 3-10 to 3-11 (2004), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2002-reclaim-report.pdf?sfvrsn=8; SCAQMD, Annual RECLAIM Audit Report for the 2003 Compliance Year, at 3-10 to 3-11 (2005); SCAQMD, Annual RECLAIM Audit Report for the 2004 Compliance Year, at 3-12 to 3-13 (2006), http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2004-reclaim-report.pdf?sfvrsn=8.

132 SCAQMD, Preliminary Draft Staff Report: Proposed Amendments to Regulation XX – Regional Clean Air Incentives Market 3–4 (2016), https://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/regxx/noxreclaim_pdsr_072216.pdf?sfvrsn=2.

133 Meredith Fowlie, Stephen P. Holland & Erin T. Mansur, *What Do Emissions Markets Deliver and to Whom? Evidence from Southern California's NO_x Trading Program*, 2012 Am. Econ. Rev. 965 (2012), *available at* https://faculty.tuck.dartmouth.edu/images/uploads/faculty/erin-mansur/mansur_emissions_markets.pdf. The study also examined non-RECLAIM firms within SCAQMD.

134 *See* EPA, *California Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants* (2021), https://www3.epa.gov/airquality/greenbook/anayo_ca.html (SCAQMD was in "extreme" nonattainment for ozone at the time, a level reached by only one other air basin at the time, the San Joaquin Valley).

135 SCAQMD, Materials for Dec. 4, 2015 Board Meeting, Agenda No. 30, Proposed Amendments to NO_x RECLAIM Program (Regulation XX) 7 (2015).

day (5.3 KT a year), ensuring that the BARCT standard would not be met.[136] EPA's own analysis of the 2015 NO_x shave, meanwhile, concluded that it did not satisfy the necessary federal standards, which required reductions as rapidly as feasible, taking the surplus credits that would remain in the market after the shave as evidence that additional reductions were necessary.[137]

RECLAIM's failure to match the levels of emissions reductions available under a command-and-control approach is also evident in the failure of many facilities to install emissions-reducing technology. In a 2018 analysis, SCAQMD found that "well over half of the equipment at RECLAIM facilities is currently not at BARCT."[138] Similarly, a retrospective analysis found that the 2005 NO_x "shave," which was meant to create emissions reductions equivalent to installing 51 selective catalytic reducers (SCRs), did not lead to a single new SCR installation; instead, the reductions mostly resulted from facility shutdowns, as discussed above.[139]

4 | Literature on the distributive impact of RECLAIM is unclear, but existing inequities likely persisted.

Emissions trading systems have been criticized for creating unjust distributions of pollution. Such debates are often framed in terms of "environmental justice." The research on the distributive (or environmental justice) impacts of RECLAIM is mixed, however. Fowlie et al., for example, conclude that "no racial or income group experienced a significant increase in emissions due to RECLAIM."[140] However, a more recent study, which used a pollutant-dispersal model to determine impact, found that RECLAIM reduced pollution more in higher-income areas.[141] A third study, published only as a working paper, found mixed impacts.[142] We found no empirical studies arguing that RECLAIM reduced existing inequities in pollutant burden across the board.

Assessing changes to the average concentration of pollution does not fully answer the question of whether RECLAIM was equitable. Because RECLAIM replaced a permit-based, command-and-control system for regulating plants, it removed the hard requirement that each plant reduce its emissions. This created the possibility of local "hotspots" of emissions,[143] though, as discussed above, evidence is mixed as to whether there is an overall tendency for emissions to concentrate in poorer areas or areas with a higher percentage of people of color. In addition, the shift to market-based compliance

136 *Id.* Even the most stringent staff recommendation would result in 12.5 tpd of emissions (2.3 tpd or 22.5% above emissions at 2015 BARCT). *Id.* at 6–7.

137 81 Fed. Reg. 22025, 22027-29 (Apr. 14, 2016).

138 SCAQMD, RECLAIM Transition Plan Version 1.0, at vi, 13 (Mar. 2018).

139 SCAQMD, Materials for Dec. 4, 2015 Board Meeting, Agenda No. 30, Proposed Amendments to NO_x RECLAIM Program (Regulation XX), Final Staff Report 276–77 (2015); *see also* 81 Fed. Reg. 22028 (noting that "refineries did not install any SCR control technologies in response to the 2005 NO_x RECLAIM amendment even though SCAQMD staff had estimated about 51 SCRs would be installed by 2011").

140 Meredith Fowlie et al., *What do Emissions Markets Deliver and to Whom? Evidence from Southern California's NO_x Trading Program*, 102 Am. Econ. Rev. 965, 991 (2012).

141 Corbett Grainger & Thanicha Ruangmas, *Who Wins from Emissions Trading? Evidence from California*, 71 Env't. & Res. Econ. 703 (2018).

142 Erin T. Mansur & Glenn Sheriff, *Do Pollution Markets Harm Low Income and Minority Communities? Ranking Emissions Distributions Generated by California's RECLAIM Program* (Natl. Bureau of Econ. Rsch., Working Paper, 2019), https://www.nber.org/system/files/working_papers/w25666/w25666.pdf. Specifically, Mansur and Sheriff's findings suggest that the Hispanic population was better off than the White population with regard to NO_x pollution prior to RECLAIM, and that their relative positions switched after RECLAIM, but that their positions would still have switched under a command-and-control alternative. *Id.* at 6, 30–31, 41. In terms of income, the study found that population earning more than twice the poverty level did better under RECLAIM relative to other populations than it would have under a command-and-control alternative. *Id.* It is worth noting that the study's assessment of policy preferences found that White and higher-income people had worse pollution exposure even prior to RECLAIM. *Id.*

143 Raul P. Lejano & Rei Hirose, *Testing the Assumptions Behind Emissions Trading in Non-market Goods: The RECLAIM Program in Southern California*, 8 Env't. Sci. & Pol'y 367 (2005).

removes the decision of where to site pollution from the public and from policymakers, who represent them. A substantial increase in emissions from a particular facility would ordinarily require a permit amendment, which would be subject to public comment,[144] but RECLAIM only requires that the facility demonstrate it holds enough credits to cover the additional emissions. As a result, people who live nearby the facility have no opportunity to participate in the decision-making process and cannot take action to reverse pollution increases they feel are unjustified; for example, by suing to enforce the permit.[145] This implicates *procedural* equity, as well as distributional equity.

144 *See Permitting Public Notices*, SCAQMD, https://www.aqmd.gov/nav/about/public-notices/permitting-public-notices ("Public notice is required if a facility applies to permit a new or modified emission source located within 1,000 feet from the outer boundary of a school, or if the emission increase from a new or modified facility exceed certain threshold levels, or if a new or modified emission source from a RECLAIM or Title V facility increases the emission of toxic air contaminants that may expose a person to cancer risks above a certain threshold."). Other areas in California have similar requirements; for example, the Bay Area Air Quality Management District requires that any change to a permit allowing for an increase of at least 40 tons per year must be open to public comment. BAAQMD Reg. 2, Rule 2, §§ 2-2-218, 2-2-404.

145 *See* Richard Toshiyuki Drury et al., *Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy*, 9 Duke Env't. L. & Pol'y Forum 231, 278–83 (1999).

IV | A CASE STUDY OF CALIFORNIA'S GREENHOUSE GAS EMISSIONS TRADING SYSTEM

A | Legal background for the GHG ETS

California launched its statewide cap-and-trade program for greenhouse gases (GHGs) in 2013. It is part of a suite of policies designed to achieve the state's broader climate change strategy, as authorized in state laws AB 32 (2006) and SB 32 (2016). AB 32 required California to return to 1990 levels of GHG emissions by 2020, a goal which was met in 2016. SB 32 added a statewide GHG emissions target of 40% below 1990 levels by 2030. California also created the additional goal, by Executive Order, of achieving statewide carbon neutrality by 2045 (EO B-55-18, 2018),[146] which builds upon an earlier goal to reduce GHG emissions to 80% below 1990 levels by 2050 (EO S-3-05, 2005).[147]

AB 32 and SB 32 assigned the task of developing and operating the cap-and-trade program to the California Air Resources Board (CARB), the agency that regulates air quality and climate change in California. Together with another state law passed in 2017, AB 398, these laws provide the primary authority for the cap-and-trade program. CARB adopted its first detailed cap-and-trade regulations on October 20, 2011 via Resolution 11-32 (final regulation order Dec. 21, 2011)[148] and has amended them eight times since then. Most notably, CARB amended the program at the end of 2018 to incorporate the requirements of AB 398, which both extended the program through 2030 and made several changes to the program, discussed below.[149] The 2018 Regulation is the currently effective cap-and-trade regulation in California. At the time of this writing, California is considering the future role of cap-and-trade within the context of the entire portfolio of measures as part of the Scoping Plan (climate planning) process.

California is also part of the Western Climate Initiative (WCI), Inc., which is a non-profit corporation created to provide administrative and technical support to state and provincial governments implementing emissions trading programs to reduce GHG emissions.[150] California has linked its carbon market with the Canadian province of Québec. Nova Scotia is also a WCI, Inc. member, but has not linked its market to the other two. A third Canadian province, Ontario, was once part of WCI, Inc. as well, but its government repealed its cap-and-trade program and delinked from California and Québec in 2018.[151]

B | GHG ETS program design

1 | GHG ETS coverage

California's cap-and-trade program regulates the six categories of GHGs that were covered by the Kyoto Protocol (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6), plus NF_3 and other fluorinated GHGs.[152] CARB sets

146 Cal. Exec. Order B-55-18 to Achieve Carbon Neutrality (2018).

147 Cal Exec. Order S-3-05 (2005), https://www.library.ca.gov/wp-content/uploads/GovernmentPublications/executive-order-proclamation/5129-5130.pdf.

148 *Cap and Trade 2010*, CARB (last visited Dec. 22, 2011), https://ww3.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm.

149 *California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation*, CARB (last visited Mar. 29, 2019), https://ww2.arb.ca.gov/rulemaking/2018/california-cap-greenhouse-gas-emissions-and-market-based-compliance-mechanisms. *See also* Cal. AB No. 398.

150 *Purpose*, WIC, https://wci-inc.org/.

151 *See infra* § IV.C.

152 Cap-and-Trade Regulations, 17 C.C.R. § 95810.

a limit ("cap") for the total amount of permissible emissions for all covered entities annually, and creates allowances equal to the amount of this cap. One allowance equals one metric ton of carbon dioxide equivalent emissions.[153] The cap declines every year to help achieve the statewide GHG emissions reduction targets.[154]

The program began on January 1, 2013 for electricity generators and large industrial facilities emitting 25,000 metric tons of CO_2e or more annually, including importers of electricity to the state.[155] The program coverage was expanded starting January 1, 2015 to include suppliers[156] of transportation fuels and natural gas. As of 2021, the cap-and-trade program covers about 74% of California's GHG emissions.[157]

2 | GHG ETS initial total allocation and reduction

CARB has set statewide annual allowance budgets for budget years 2013-2050. The year for the budget in which an allowance is included is also referred to as its "vintage" year. The program started with a cap of 162.8 million vintage 2013 allowances, corresponding to 162.8 million metric tons of CO_2 equivalent ($MMTCO_2e$) in 2013, or about 37% of the state's emissions, by CARB's estimate. CARB then raised the cap to 394.5 $MMTCO_2e$ in 2015 (77% of statewide emissions) when it included fuel suppliers in the program.[158] These caps were set based on the projected amount of emissions from included sectors in 2012 and 2015.[159] CARB then identified a 2020 cap of 334.2 $MMTCO_2e$, based on the economy-wide target of 427 $MMTCO_2e$,[160] and mandated a "straight-line" path between the 2015 and 2020 caps; that is, the caps decrease by the same amount (12 $MMTCO_2e$ annually) each year.[161]

The 2021-2030 caps were established based on the new target set by SB 32, following a similar approach. CARB applied the same cap-to-target ratio used for the 2020 budgeting (77.5%) to the SB 32 economywide target of 258.6 $MMTCO_2e$ by 2030, resulting in a 2030 cap of 200.5 $MMTCO_2e$ (*i.e.*, 77.5% of 258.6).[162] CARB also continued the "straight-line" approach from 2015 to 2020, resulting

153 *Id.* § 95802(a) (definition of "Carbon Dioxide Equivalent"); Regulation for the Mandatory Reporting of Greenhouse Gas Emissions, 17 C.R.R. § 95102(a) (definitions of "Carbon dioxide equivalent" and "global warming potential"). These regulations currently use the federal values in 40 C.F.R. Pt. 98, Subpt. A, Tbl. A-1.

154 *Cap-and-Trade Program: Allowance Distribution Factsheet*, CARB, https://ww2.arb.ca.gov/resources/documents/cap-and-trade-program-allowance-distribution-factsheet.

155 For detailed explanation of the covered entities of the electricity sector, *see* Cal. Pub. Utility Comm'n (CPUC), Decision Adopting Cap-and-Trade Greenhouse Gas Allowance Revenue Allocation Methodology for the Investor-Owned Electric Utilities (Decision 12-12-033) 13 (Dec. 20, 2012), https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M040/K631/40631611.PDF ("For imported electricity, the covered entity is the first entity to deliver electricity onto the California grid.").

156 "Supplier" means a producer, importer, exporter, position holder, interstate pipeline operator, or local distribution company of a fossil fuel or an industrial greenhouse gas. Cap-and-Trade Regulations, 17 C.C.R. §95802.

157 *See* ICAP, Emissions Trading Worldwide: Status Report 2022, at 88, https://icapcarbonaction.com/system/files/document/220408_icap_report_rz_web.pdf; *see also Mandatory GHG Reporting - Reported Emissions*, CARB (last visited Apr. 18, 2022), https://ww2.arb.ca.gov/mrr-data; CARB, 2000–2019 GHG Emissions Trends Report Data (updated on Apr. 1, 2022), https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/2000_2019_ghg_inventory_trends_figures_04-01.xlsx.

158 ICAP, *USA – California Cap-and-Trade Program* (2021), https://icapcarbonaction.com/en/ets/usa-california-cap-and-trade-program; Indep. Emissions Market Advisory Comm., 2020 Annual Report of the Independent Emissions Market Advisory Committee 2 (2020), https://calepa.ca.gov/wp-content/uploads/sites/6/2021/01/2020-ANNUAL-REPORT-OF-THE-INDEPENDENT-EMISSIONS-MARKET-ADVISORY-COMMITTEE_FINAL_a.pdf [hereinafter Indep. Emissions Market Advisory Comm. 2020 Report]. Cap-and-Trade's coverage is now estimated to be 75% of the state's emissions. Indep. Emissions Market Advisory Comm. 2021 Report, *supra* note 34, at 3.

159 CARB, California's Cap-and-Trade Program: Final Statement of Reasons 165 (2011), *available at* https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/capandtrade10/fsor.pdf.

160 *Id.* The economy-wide target is CARB's estimate of the state's 1990 emissions, as required by AB 32. *See* Cal. Health & Safety Code § 38550 (West).

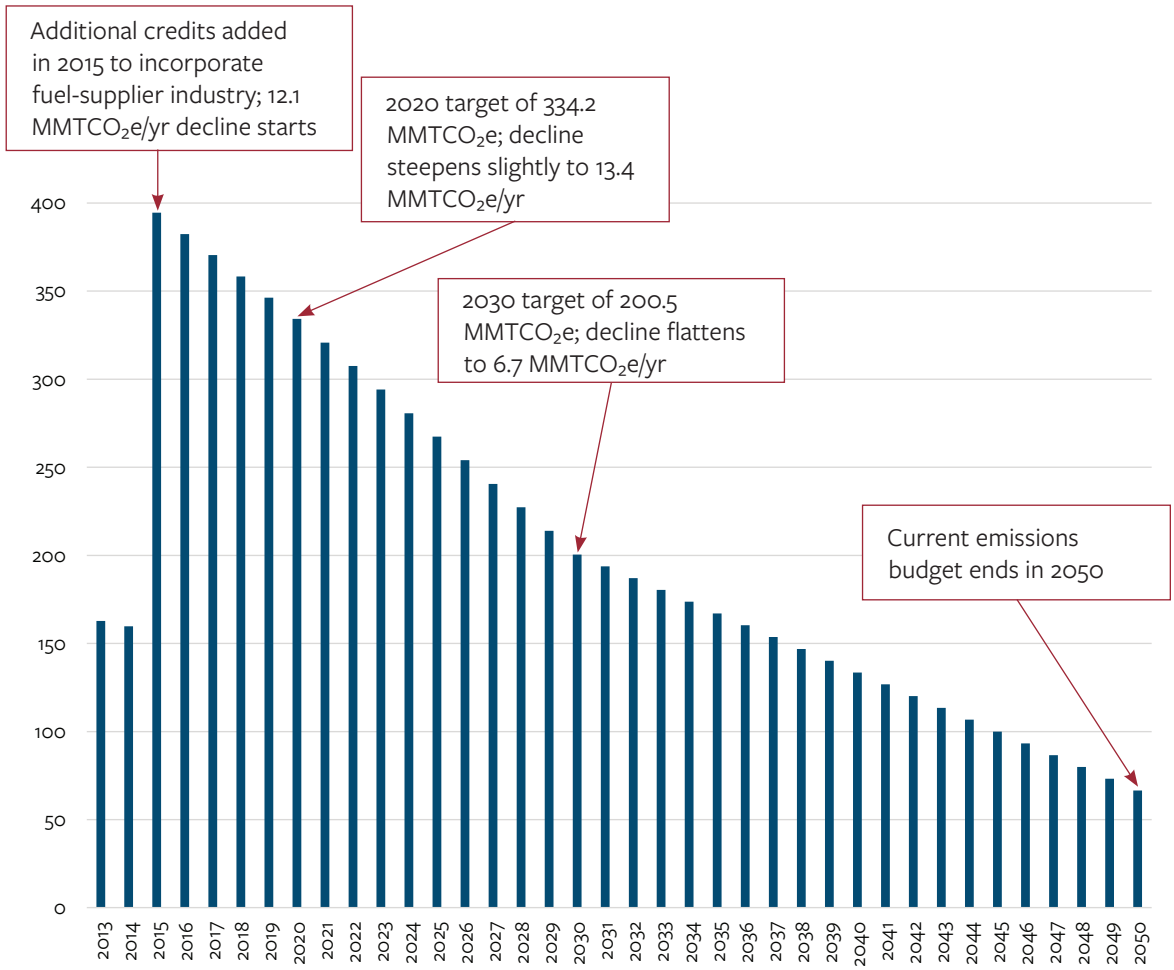
161 Cap-and-Trade Regulations, 17 C.C.R § 95841(a).

162 CARB, Proposed Amendments to the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation Appx. D 7–8 (2018), https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/capandtrade18/ct18398.pdf?_ga=2.65568110.1719232368.1634231775-1158618940.1627694642#page=7. The 77.5% figure is calculated using 431 $MMTCO_2e$ as the 2020 target, rather than 427 $MMTCO_2e$, because the 2020 targets were recalculated after the global-warming factors of some gases were changed in 2014. *See* CARB, First Update to the Climate Change Scoping Plan 24 (2014), https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf.

in an annual decline of about 13.4 $MMTCO_2e$ annually from 2021 to 2030.[163] After 2030, the annual budget is currently set to continue declining until 2050, but at half the 2021-2030 rate; that is, at 6.7 $MMTCO_2e$/year.[164]

The budgets and annual declines are summarized in the following chart:

Fig 3. Annual Allowance Budgets for Budget Years 2013-2050[165]



3 | Allowance allocation rules

California distributes allowances in two ways: (1) direct (free) allocation to certain entities, and (2) sale to all participants, at auction or at a reserve sale. California allocates free allowances to electrical distribution utilities, natural gas suppliers, and public wholesale water agencies, in order to reduce

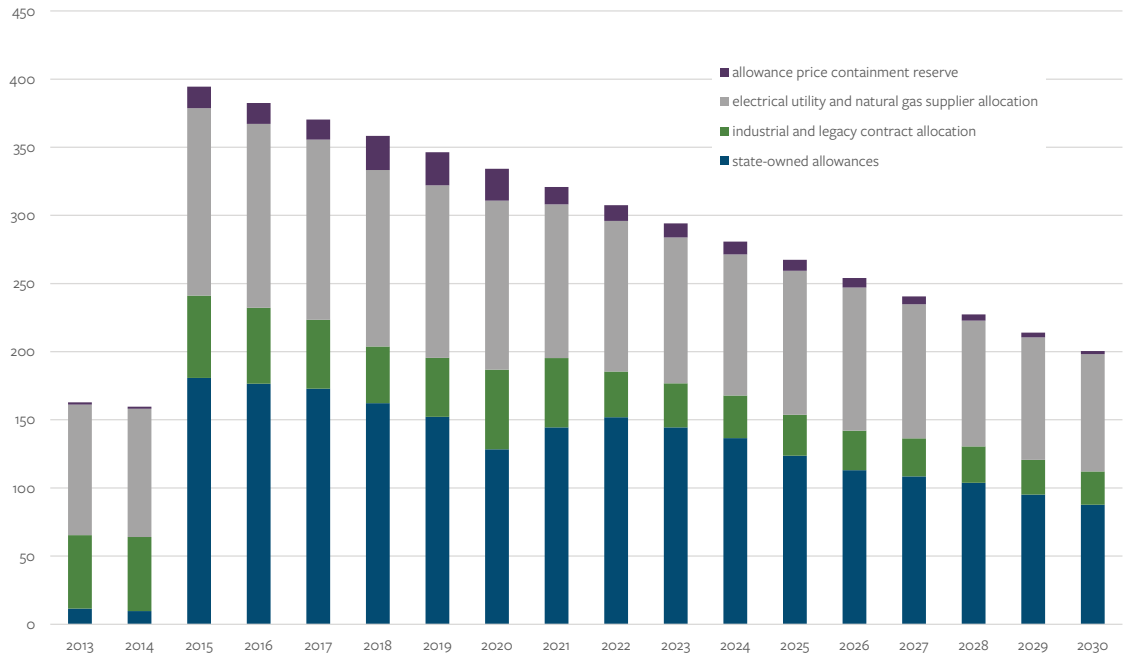
163 Cap-and-Trade Regulations, 17 C.C.R. § 95841, tbl. 6-1.

164 *Id.* § 95841(b).

165 *Id.* § 95841.

the price impacts of the cap-and-trade program on ratepayers (essentially, consumers).[166] Industrial facilities also receive some amount of free allowances, which are intended to reduce industrial emissions leakage and provide transition support during the first few years of the market.[167] Other covered entities (primarily fuel suppliers) do not receive free allocation. All covered entities may purchase allowances through bilateral transactions with other entities registered in the program, through secondary market activities, and at auction. A portion of allowances are also allocated to the Allowance Price Containment Reserve. The figure below shows a rough distribution of allowances.

Fig. 4 Distribution of Allowances[168]



166 *Allowance Allocation*, CARB (last visited Apr. 18, 2022), https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/allowance-allocation; *Other Allocation*, CARB (last visited Apr. 18, 2022), https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/allowance-allocation/other-allocation.

167 *Allowance Allocation to Industrial Facilities*, CARB (last visited Apr. 18, 2022), https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/allowance-allocation/allowance-allocation-industrial; CARB, Proposed Regulation to Implement the California Cap-and-Trade Program: Initial Statement of Reasons Appx. J, at J-19 (2010), *available at* https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/capandtrade10/capv4appj.pdf. A small number of other entities receive free transition-assistance allocations. These include "legacy contract generators" – electricity generators with pre-2006 contracts for electricity purchases – universities and other public facilities, and waste-to-energy plants. *See* Cap-and-Trade Regulations, 17 C.C.R. §§ 95891(d), (f), 95894. The total free allocation to these entities is small (less than 3 million allowances in 2021) and we therefore do not discuss this allocation process further. *See* CARB, Cap-and-Trade Program Vintage 2021 Allowance Allocation Summary 12–14 (2020), https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/v2021allocation.pdf?_ga=2.229837404.1361840485.1634867930-1158618940.1627694642.

168 Data from Cap-and-Trade Regulation, 17 C.C.R. § 95841, tbls. 6-1, 6-2 (total emissions budget for each year); *id*. §§ 95870(a), 95871(a) & tbl. 8-2 (allowance price containment reserve amounts for each year); *id*. §§ 95891, tbl. 9-2, 95893(a) (formula and data for determining natural-gas sector allocations from 2011 emissions); CARB, *California Cap-and-Trade Program: Examples of Data Uses & Overview of Publicly Available Information* 33 (2020), https://ww2.arb.ca.gov/sites/default/files/2020-09/data_uses_and_overview.pptx (natural-gas sector emissions for 2011); CARB, *Annual Allocation to Electrical Distribution Utilities (EDU) under the Cap-and-Trade Regulation* (2017), https://www.arb.ca.gov/cc/capandtrade/allowanceallocation/edu-ng-allowancedistribution/electricity-allocation.xlsx (electrical utility allocation amounts for 2013-2020); CARB, *Post-2020 EDU Allocation Table* (2016), https://www.arb.ca.gov/regact/2016/capandtrade16/attach10.xlsx (electrical utility allocation amounts for 2021-2030); CARB, *Allocated Allowances* (last visited May 31, 2022), https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/cap-and-trade-program-data#allocation (industry allocation amounts for 2013-2022). Figure assumes continued industrial output at rate equal to 2022 rate for years 2023-2030.

a | Free Allowance Allocation

Freely allocated (state-owned) allowances made up the majority of the emissions budget for each year through 2021, though that share declined to just under half in 2022: for 2022, about 143.1 million allowances were allocated for free, out of a total allowance budget of 307.5 million.[169] Roughly 50% of free allowance allocations in 2022 go to electrical-distribution utilities (EDUs), with slightly smaller amounts provided to natural-gas suppliers (NGSs) (roughly 26% in 2022) and industry (roughly 23% in 2022).[170] Some of these free allocations (about 81.30 million in 2021) are required to be sold through consignment auction, as discussed below.[171] In total, a majority of the annual allowance budget (including state-owned and consigned allowances) is made available to the broader market through auctions.

Electrical Distribution Utilities

About half of freely allocated allowances go to **electrical distribution utilities** (EDUs).[172] There are three types of EDUs in California: (1) investor-owned utilities (IOUs), (2) publicly owned utilities (POUs), and (3) electrical cooperatives (COOPs). POUs and COOPs can use their allocated allowances for their own compliance requirements or put them up for auction alongside the other allowances offered for sale by CARB, in a process known as "consignment."[173] If the POU or COOP consigns its allowances, it must use the proceeds of auction sales for the benefit of their customers, through uses such as an on-bill climate credit and through energy-efficiency projects or purchasing renewable energy.[174] IOUs, however, are under stricter requirements. They must consign all the allocated allowances they receive, and they must return the proceeds from the consignment auction directly to customers.[175] Thus, allowances allocated to IOUs effectively result in providing money directly to utility customers (through an on-bill climate credit pursuant to California Public Utilities Commission requirements), which helps to reduce the cost impact of the cap-and-trade program on ratepayers.[176]

The cap-and-trade program requires EDUs to report to CARB annually on their use of allocated allowances (and the proceeds from their sale) for the previous year and their compliance with applicable requirements.[177] As of 2020, IOUs had returned to their customers – primarily to residential

169 *See* CARB, Cap-and-Trade Program Vintage 2022 Allowance Allocation Summary 2 (2021), https://ww2.arb.ca.gov/sites/default/files/2021-12/nc-v2022%20Public%20Allocation%20Summary.pdf (allocated allowances); Cap-and-Trade Regulations, 17 C.C.R. § 95841 (total budget).

170 *See* CARB, Cap-and-Trade Program Vintage 2022 Allowance Allocation Summary 2 (2021). Note that a small number of allowances go to other facilities. *See supra* note 166.

171 *See* Summary Results Reports for February, May, August, and November 2021 Auctions, *available at* https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/auction-information/auction-notices-and-reports.

172 *Allowance Allocation*, CARB, *supra* note 165; CARB, Cap-and-Trade Program Vintage 2021 Allowance Allocation Summary 14 (2020), http://ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/v2021allocation.pdf.

173 Cap-and-Trade Regulations, 17 C.C.R. § 95892(b)(2).

174 *Id.* § 95892(d).

175 *See id.* § 95892(c)-(d); Cal. Pub. Utility Comm'n (CPUC), Decision Adopting Cap-and-Trade Greenhouse Gas Allowance Revenue Allocation Methodology for the Investor-Owned Electric Utilities (Decision 12-12-033) 2–3 (Dec. 20, 2012).

176 The complexity of this process is likely due to legal issues that are specific to California. One factor seems to be restrictions on increasing taxes, which in California is more difficult than enacting environmental laws. If the state had used its auction revenues in ways that do not support California's climate-change goals, the courts may have considered the program to be a tax rather than a climate regulation. *See Cal. Chamber of Com. v. State Air Res. Bd.*, 10 Cal. App. 5th 604 (Ct. App. 3d Dist. 2017) (noting that a lower court considered the use of revenues in assessing whether the cap-and-trade auctions were a tax, but ultimately deciding the issue on a different basis). Since these issues are not relevant in the Chinese context, this report does not discuss the specifics of the consignment program, and instead focuses on the policy goal behind it: reducing the impact of increased energy prices on consumers.

177 Cap and Trade Regulation, 17 C.C.R. § 95892 (e); CARB, Cap-and-Trade Program: Summary of 2013-2018 Electrical Distribution Utility Allocated Allowance Value Usage 2 (2020), https://ww2.arb.ca.gov/sites/default/files/classic//cc/capandtrade/allowanceallocation/edu2013-2018useofvaluereport.pdf.

customers – about 95% of the revenue they received from selling their free allocations.[178] In contrast, POUs and COOPs, which are not required to consign their allocations and have looser restrictions on the use of revenue from the allocations they do sell, returned only about 1.3% of their total free allocations; they spent about 19% on energy-efficiency and renewable-energy projects and used almost all of the remainder for compliance.[179]

Natural Gas Suppliers

Since their inclusion in the GHG ETS in 2015, **natural gas suppliers** (NGSs) have also received a large number of free allocations (about 26% of the total free allocations in 2022 as mentioned above).[180] NGSs were required to put 25% of their free allocations up for auction in 2015, and that requirement increases by 5 percentage points each year: 30% in 2016, 35% in 2017, etc. In 2030 and thereafter, NGSs will be required to put all of their free allocations up for auction, as IOUs are required to now.[181] NGSs can use the remainder of the free allocations as compliance instruments directly, just as POUs and COOPs can.

California's public-utilities regulator places strict requirements on the use of auction revenue by investor-owned NGSs, which provide nearly all the natural gas used in California. Investor-owned NGSs must first pay for any allowances they are required to purchase for compliance, and then return the remainder to their residential customers.[182] Additionally, for the years 2019 through 2023, investor-owned NGSs will also be required to spend $50 million each year out of the revenue from selling free allocations (about 15% of auction proceeds) on building decarbonization programs.[183]

Industrial Facilities

Virtually all of the remaining allocated allowances (23% in of all allocated vintage 2022 allowances; or less than 11% of the total vintage 2022 allowance budget) go to **industrial facilities**.[184] These allowances serve two purposes: (1) transition assistance and (2) leakage prevention. Transition assistance is meant to be short-term support to industry to prevent unnecessary economic shocks.[185] Leakage prevention is a longer-term program to reduce some of the cost of compliance with the GHG ETS in order to prevent shifts in industrial production from inside California to outside the state, a form of emissions leakage.[186] These two concepts were originally used to vary the amount of

178 CARB, Cap-and-Trade Program: Summary of 2013-2020 Electrical Distribution Utility Use of Allocated Allowance Value 6 (2022), https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/edu_2013to2020useofvaluereport.pdf.

179 *Id.* at 12. Specifically, POUs and COOPs deposited 64% of their allocated allowances directly and used the proceeds from selling 9.8% of their allocated allowances to purchase more allowances, a practice that is no longer permitted. *Id.*

180 CARB, Cap-and-Trade Program Vintage 2022 Allowance Allocation Summary 2 (2021).

181 Cap-and-Trade Regulations, 17 C.C.R. § 95893(b), tbls. 9-5, 9-6.

182 *See* CARB, Cap-and-Trade Program: Summary of 2015-2019 Natural Gas Supplier Allocated Allowance Value Usage 4–6 (2021), https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/ngs_2015to2019useofvaluereport.pdf; *see also* CPUC, Decision Adopting Procedures Necessary for Natural Gas Corporations to Comply with the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms (Cap-and-Trade Program) (D.15-10-032) (Oct. 2015), *available at* http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M155/K330/155330024.PDF (requiring return of proceeds to customers).

183 *See* CPUC, Decision Establishing Building Decarbonization Pilot Programs, (D.20-03-027) (Mar. 26, 2020), *available at* https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF (requiring $50 million annual dedication to building decarbonization); *see also* CARB, Cap-and-Trade Program: Summary of 2015-2019 Natural Gas Supplier Allocated Allowance Value Usage 6 (2021) (describing program).

184 Cap-and-Trade Regulation, 17 C.C.R. § 95892 (e) and table 6-2 of § 95841; CARB, Cap-and-Trade Program: Summary of 2013-2018 Electrical Distribution Utility Allocated Allowance Value Usage 2 (2020); CARB, Cap-and-Trade Program Vintage 2022 Allowance Allocation Summary 2 (2021).

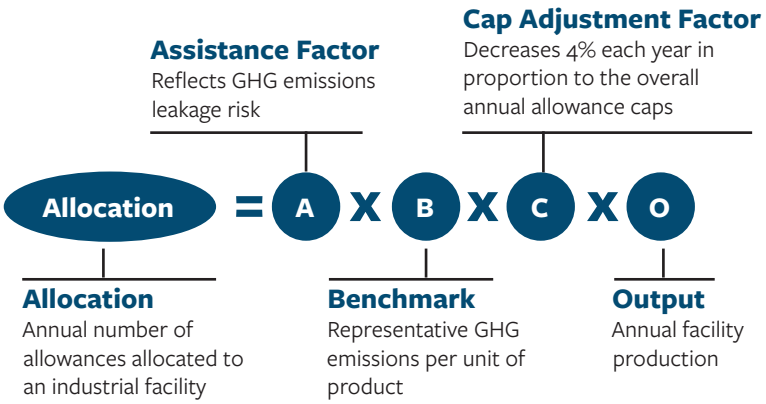
185 *See* CARB, Proposed Regulation to Implement the California Cap-and-Trade Program: Initial Statement of Reasons Appx. J, at J-19 to J-21 (2010).

186 *See* CARB, Proposed Regulation to Implement the California Cap-and-Trade Program: Initial Statement of Reasons Appx. K, at K-4 (2010), *available at* https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/capandtrade10/capv4appk.pdf.

free allocations by industry – industries deemed less likely to move production out of state would have had their free allocations reduced by as much as 70% by 2018 – but this variation was eliminated by the legislature in AB 398.[187]

Under current regulations, all covered industrial facilities receive free allocations based on the following formula: annual industrial allocation = leakage assistance factor (now equal to 1 per AB 398) x industry-wide product efficiency benchmark x steadily declining "cap adjustment factor" x actual production output.[188] The allocation formula is shown below.

Fig. 5 Product-Based Allocation Method[189]



The cap adjustment factor for most industries began at 98.1% in 2013 and declines at a rate consistent with the cap decline in the overall allowance budget to 49.4% in 2031.[190] It is also important to note that for the product benchmark, the GHG intensity of each unit of production is based on an industry-wide benchmark value,[191] creating an additional incentive to produce goods efficiently. The product benchmark may be updated periodically in response to new entrants or facility closures for a particular product. Figure 6 below shows how this formula would work to reduce allowance allocations relative to emissions over time for a hypothetical industrial facility.

187 In the original version of the regulation, free allocations to some industrial manufacturers would be reduced by an "assistance factor" after 2015. *See* CARB, Final Regulation Order: Subchapter 10 Climate Change, Article 5, Sections 95800 to 96023 § 95870(e)(2), tbl. 8-1 (2010), *available at* https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/capandtrade10/finalrevfro.pdf?_ga=2.188658344.1298492686.1637032871-1158618940.1627694642. Industries considered to be at "Medium" risk of leakage would have their free allocations reduced to 75% of the original amount in 2015 and to 50% in 2018; industries at "Low" risk of leakage would have their free allocations reduced to 50% in 2015 and 30% in 2018. *Id.*; *see also* CARB, Proposed Regulation to Implement the California Cap-and-Trade Program: Initial Statement of Reasons Appx. J, at J-22 (2010); CARB, Proposed Regulation to Implement the California Cap-and-Trade Program: Initial Statement of Reasons Appx. K (analysis used to determine each industry's leakage risk). CARB then eliminated the 2015 free allocation reductions and increased the 2018 free allocations to 75% of the original value for medium-risk industries and 50% for low-risk industries. CARB, Final Regulation Order: California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms § 95870(e)(2), tbl. 8-1 (2013), *available at* https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2013/capandtrade13/ctreg.pdf?_ga=2.178000889.1298492686.1637032871-1158618940.1627694642. Finally, AB 398 mandated that CARB set the "assistance factor" for all industries to 100%, functionally eliminating the assistance-factor concept. AB 398 § 4 (codified at Cal. Health & Safety Code § 38562(c)(2)(G) (West)).

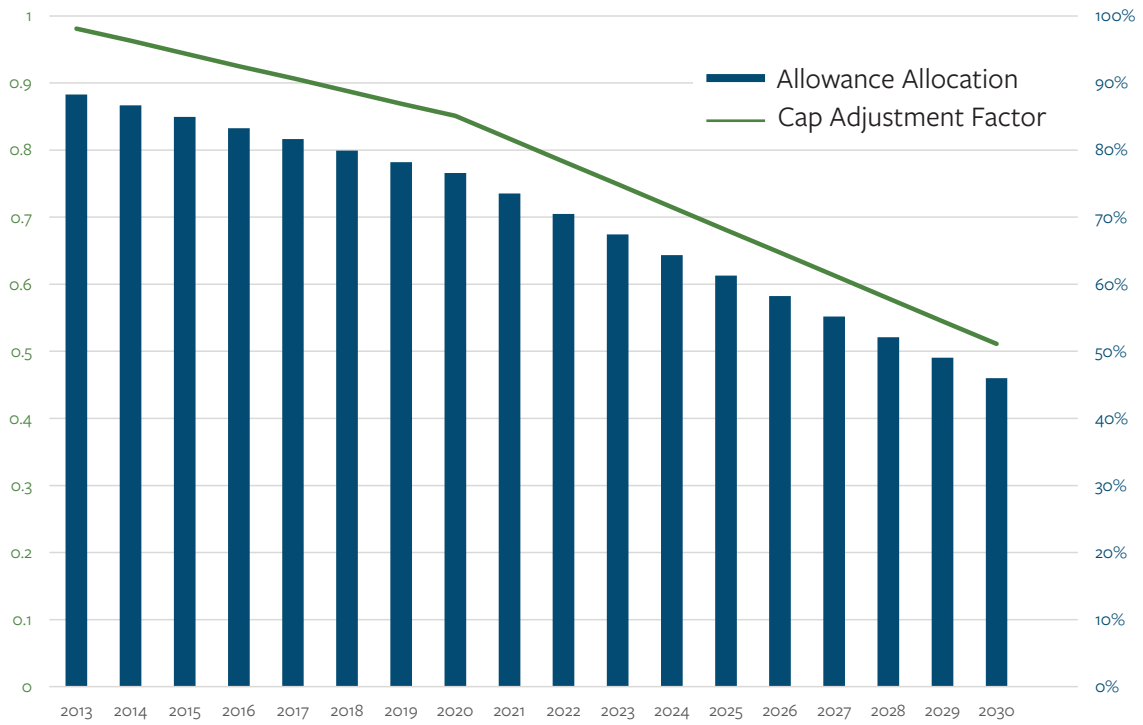
188 Cap-and-Trade Regulations, 17 C.C.R. § 95891(b)-(c). Three industrial processes that CARB considers to have particularly high emissions intensity and leakage risk (coke calcining, nitrogenous fertilizer manufacturing, cement manufacturing, and lime manufacturing) were placed on a separate scale, beginning at 99.1% and declining at about half the rate of other processes, reaching 74.7% by 2031.

189 CARB, Allowance Allocation to Industrial Facilities (last visited May 31, 2022), https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/allowance-allocation/allowance-allocation-industrial.

190 *Id.* tbl. 9-2.

191 *Id.* § 95891(b); *see also id.* tbl. 9-1 (listing benchmarks for each production activity). Facilities for which CARB has not established a benchmark GHG intensity use an alternate method, based on historical energy consumption at that facility, *id.* § 95891(c), but this is rare: over 98% of free allocations are made using the product-based method. *Allowances Allocation to Industrial Facilities*, CARB, *supra* note 166.

Fig. 6 Allowance Allocation as a Percentage of Emissions for a Hypothetical Industrial Facility[192]



b | Allowance auctions

Covered entities may also purchase allowances at quarterly auctions held by CARB.[193] Four times a year, CARB holds a **current auction** at which one quarter of the remaining allowances for the year are sold, along with any unsold allowances from prior current auctions. CARB also holds **advance auctions** at the same time as current auctions, where it sells allowances from three years in the future. Ten percent of each future year's budgeted allowances are set aside in advance and make up the stock for the advance auctions.[194] Advance auctions provide a price signal to the market about future price expectations.

Each current auction includes freely allocated allowances that are consigned to CARB for sale, as well as remaining allowances that were not allocated for other purposes under the regulation (these are sometimes called "state-owned allowances"). IOUs are required to consign all of their free allocations, and NGSs are required to consign a portion of their free allocations.[195] POUs and COOPs may also consign their freely allocated allowances for auction, but they are not required to do so.[196] Any revenues from the sale of consigned allowances are given to the consigning entity, but as discussed above, utilities are generally obligated to return those revenues to their customers.

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192 Data from Cap-and-Trade Regulation, 17 C.C.R. § 95891(b) & tbl. 9-2 (formula and data for determining industrial allocation based on year, process benchmark, and process output). Figure assumes that facility produces single product through single process, and benchmark is set at 90% of process emissions rate by output.

193 Cap-and-Trade Regulations, 17 C.C.R. § 95910 (c)(1)-(2).

194 *Id.* § 95910(a)-(c).

195 *Id.* § 95892(b)(1), (c) (IOU consignment requirement); *id.* § 95893(b)(1)(A), (c) (NGS partial consignment requirement).

196 *Id.* § 95910(d)(1).

California began its quarterly GHG allowance auctions in November 2012. Since cap-and-trade markets in California and Québec became linked on January 1, 2014, compliance instruments issued by one system are accepted for compliance with the other system. As a result, CARB and Québec's Ministry of the Environment and the Fight against Climate Change (MELCC) have been holding joint allowance auctions every quarter since November 2014.

Anyone registered with CARB for the cap-and-trade program can participate in auctions, including individuals, non-profits, and other entities, so long as they abide by the applicable requirements and have not been disqualified for prior violations.[197]

c | Price controls

CARB uses both auctions and scheduled reserve sales to regulate the price of allowances. First, each auction has a **price floor**, which is the minimum price at which any allowance can be sold at auction. The auction price floor guarantees, in most cases, that allowance prices will never trade below that level.[198] The price floor was set at $10 in 2013 and increases at a real rate of 5% each year; that is, 5% plus the current rate of inflation. The price floor is set at $19.70 in 2022.[199]

Second, CARB has created a system for **reserve sales** to contain price spikes that has not been used to date. The reserve sales allow covered entities to purchase allowances at predetermined prices from a stock of allowances that are set aside from each year's allowance budget.[200] This effectively releases allowances from within the cap whenever prices reach the specified price containment tiers, blunting a price spike.[201] Currently, California uses a two-tiered reserve sale system:[202] The first "tier" consists of about 67 million allowances, which are available for purchase at $46.05 each in 2022. The second tier contains about 90 million allowances, which are available at $59.17 each in 2022.[203] The price of each tier's allowances increases in the same manner as the auction price floor.[204]

Finally, CARB sets a **price ceiling** by guaranteeing an unlimited number of allowances at a specified price, which is $72.29 in 2022. Price-ceiling sales are similar to reserve sales, but with two key differences: First, a price ceiling sale is only held if the reserve allowances are all sold, and at least one

197 *Id.* § 95912(d).

198 *See* CARB, California and Québec Carbon Allowance Prices (2021), http://ww2.arb.ca.gov/sites/default/files/cap-and-trade/carbonallowanceprices.pdf. The major exception to the effectiveness of the auction-based price floor is the market crash between the February and May 2020 auctions, presumably related to COVID-19. *Id.* That crash was also the most recent point at which large numbers of allowances went unsold at auction: about 36 million allowances went unsold in May 2020, out of a total of about 58 million available. CARB, Summary of California-Québec Joint Auction Settlement Prices and Results (2022), https://ww2.arb.ca.gov/sites/default/files/2020-08/results_summary.pdf.

199 Cap-and-Trade Regulations, 17 C.C.R. § 95911(b)-(c); CARB, 2022 Annual Auction Reserve Price Notice 1 (2021), https://ww2.arb.ca.gov/sites/default/files/2021-12/nc-2022_annual_reserve_price_notice_joint_auction.pdf.

200 *See generally* Cap-and-Trade Regulations, 17 C.C.R. § 95913.

201 Pursuant to the regulation, "[e]xcept for the Reserve sale immediately preceding the compliance obligation instrument surrender deadline on November 1, a Reserve sale will only be offered if the Current Auction held in the preceding quarter resulted in a settlement price greater than or equal to 60% of the lowest Reserve tier price." *Id.* § 95913(d)(1)(A). This means that technically, an entity can purchase allowances at the two price tiers of the reserve sales at least once a year, regardless of the current price of allowances. *Id.* § 95913(d)(1)(B). But covered entities will have much more incentive to do so as the actual price of allowances approaches the reserve prices; in addition, reserve sales are offered quarterly if the auction settlement price of the preceding quarter reaches 60% of the lowest reserve price. *Id.* § 95913(d)(1)(A).

202 *Id.* § 95913(h)(1).

203 *Id.* § 95913(h)(1); § 95911(b)-(c); CARB, 2022 Annual Auction Reserve Price Notice 1 (2021). Prior to AB 398, California used a three-tier system, which started at $40, $45, and $50 in 2013. Cap-and-Trade Regulations, 17 C.C.R. § 95910(h)(3).

204 *Id.* §§ 95913(h)(6), 95915(f)(1)(B).

covered entity still cannot meet their compliance obligation.[205] Second, there is no limit to the number of allowances that can be purchased at the ceiling price; CARB maintains a reserve of allowances set aside from each year's budget, but if that reserve of allowances is exhausted CARB will generate new allowances and sell them at the same price, but only in the exact amount needed for compliance.[206] This effectively guarantees a maximum price for allowances. However, it also means that, if the price ceiling is reached, CARB could sell allowances beyond the carbon budget, although CARB is under an obligation to use the proceeds to reduce emissions on at least a metric ton for metric ton basis.[207]

The price floor, reserve prices, and price ceiling all increase by a real rate of 5% each year.[208] Among other impacts, this has the effect of forcing an incremental increase in the market rate of allowances each year, increasing the incentive for covered entities to reduce their emissions.

4 | Use of GHG ETS auction proceeds

California uses the revenue from allowance auctions to fund other climate initiatives. This money is deposited into the state's Greenhouse Gas Reduction Fund (GGRF), which is in the state treasury.[209] Revenue from the GGRF is generally required to be used for climate purposes, including both mitigation and adaptation measures.[210] Funds awarded to CARB through the annual budget from the GGRF are generally used to subsidize four large programs: community air protection, funding agricultural replacement measures for emission reductions, low-carbon transportation, and prescribed fire smoke monitoring.[211]

The state has also set aside portions of GGRF funding for areas with low income and high pollution burden.[212] First, 25% of GGRF funds are required to go to investments that are both located in "disadvantaged communities" and of benefit to residents of those communities.[213] "Disadvantaged communities" are identified by the California Environmental Protection Agency (CalEPA) according to a complex ranking system called CalEnviroScreen, which ranks census tracts by both pollution burdens, such as concentrations of pollutants and proximity to waste sites, and the vulnerability of the population, measured by health and socioeconomic indicators.[214] CalEPA ultimately designated the 25% of census tracts with the greatest amount of combined burden and vulnerability as "disadvantaged communities" eligible for the prioritized GGRF investments.[215]

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205 *Price Ceiling Information*, CARB (last visited Dec. 7, 2021), https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/cost-containment-information/price-ceiling-information.

206 Cap-and-Trade Regulations, 17 C.C.R. § 95915(f)(3)(B), (h)(1).

207 *Id.* § 95915(h)(2).

208 5% plus the rate of inflation. *Id.* §§ 95911(b)-(c), 95913(h)(6), 95915(f)(1)(B).

209 *See generally id.* § 95870(i); Cal. Govt. Code § 16428.8; Cal. Health & Safety Code §§ 39710 et seq (West).

210 Cal. Health & Safety Code § 39712(a)(2) (West).

211 Cal. Climate Inv., Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds (Apr. 2021), https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/2021_cci_annual_report.pdf.

212 *See generally* Cal. Health & Safety Code § 39713 (West).

213 *Id.* § 39713(a). Prior to 2017, only 10% of these funds were required to be located in those communities; the requirement that all of the investments counted toward the 25% requirement be located in those communities was added by AB 1550.

214 *See generally* Cal. Env't. Prot. Agency, Designation of Disadvantaged Communities Pursuant to Senate Bill 535 (De Leon) (2017), https://calepa.ca.gov/wp-content/uploads/sites/6/2017/04/SB-535-Designation-Final.pdf. A "census tract" is a statistical area smaller than a county, with a population of between 1,200 and 8,000 people. *Glossary: Census Tract*, US Census (last visited Oct. 25, 2021), https://www.census.gov/programs-surveys/geography/about/glossary.html#par_textimage_13/.

215 Cal. Env't. Prot. Agency, Designation of Disadvantaged Communities Pursuant to Senate Bill 535 (De Leon) 1 (2017).

Second, an additional 10% of GGRF funds have been earmarked for low-income households and communities since 2017.[216] Specifically, these funds must be spent either on investments that benefit low-income households, or on investments that are located in and benefit low-income census tracts, though the definition of "low-income" is fairly broad.[217] Half of these low-income funds (that is, 5% of the total GGRF funding) must be invested nearby the "disadvantaged communities" described above, specifically low-income households or census tracts that are outside of, but within a half-mile of, the census tracts designated as "disadvantaged communities."[218]

According to the state government, by early 2022, about $19.2 billion in cap-and-trade auction proceeds had gone to the GGRF, and about $9 billion of that total has gone into implemented projects (the remainder is awaiting allocation, award, or implementation).[219] About half of the implemented amount has gone to disadvantaged communities, low-income households, or low-income census tracts (which California refers to collectively as "priority populations").[220] Since 2017, when additional investment requirements were put in place, the share of GGRF implemented funds that benefit priority populations has increased to about 68%.[221] Some of these implemented projects also provide co-benefits such as decreasing locally harmful air pollutants.[222]

5 | Carbon offsets

Apart from submitting allowances, covered entities can satisfy a small percentage of their compliance obligation by funding emissions reduction or carbon sequestration projects. Offsets are meant to help with cost-containment (*i.e.*, by identifying lower cost emissions reductions), to achieve reductions in non-covered sectors, and to promote climate diplomacy with other states/regions. Pursuant to AB 32, these projects must be *real, quantifiable, permanent, verifiable, enforceable, and additional* to what is required by law and to what would otherwise occur in a conservative business-as-usual scenario.[223]

An offset that is "real" would result in actual carbon emissions reductions without inaccurate reporting or leakage of emissions to another area, product, or process in lieu of actual reductions.

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216 Prior to 2017, this additional 10% did not have to be additional to the 25% earmarked for disadvantaged communities, and had looser restrictions. *Compare* Cal. Stats. 2012, c.830 (SB 535), § 3 (setting requirements from 2013-2016), *with* Cal. Stats. 2016, c.359 (AB 1550), § 1 (setting requirements from 2017 onward).

217 Cal. Health & Safety Code § 39713(b)-(d) (West). "Low-income" is defined as income that is 80% or less of either the median income of the state or the median income of the county in which the household tract is located. *Id.* § 39713(d); *see also* CARB, Identification of Low-Income Communities under AB 1550: Methodology and Documentation for Maps (2021), https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/kml/ab1550_maps_documentation.pdf. CARB used a statewide median income figure of $61,818 in 2021; thus any household making less than that amount or any census tract with an average income less than that amount qualified. *Id.* at 1. The county-specific income figures are more complicated, because they vary by household size (or average household size in the case of census tracts). *Id.* at 2–3. But it is important to note that some counties have extremely high "low-income" values: in both San Francisco and Marin Counties, for example, a four-person household would qualify if they made $149,600 or less. Cal. Dept. of Housing & Community Dev't, Revised State Income Limits for 2021, at 8, 11 (2021), https://www.hcd.ca.gov/grants-funding/income-limits/state-and-federal-income-limits/docs/income-limits-2021.pdf.

218 Cal. Health & Safety Code § 39713(c) (West).

219 CARB, Summary of Proceeds to California and Consigning Entities 1 (last updated Mar. 2022), https://ww2.arb.ca.gov/sites/default/files/2020-09/proceeds_summary.pdf; Cal. Climate Initiatives, 2021 Mid-Year Data Update 6 (2021), https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/cci_2021mydu_cumulativeoutcomessummarytable.pdf.

220 *Id.* at 22.

221 *Id.*

222 *See id.* at 26–27.

223 Each of these terms is defined in the Cap-and-Trade Regulation. For instance, the definition of additional, in the context of offset credits, means "greenhouse gas emission reductions or removals that exceed any greenhouse gas reduction or removals otherwise required by law, regulation or legally binding mandate, and that exceed any greenhouse gas reductions or removals that would otherwise occur in a conservative business-as-usual scenario." Cap-and-Trade Regulations, 17 C.C.R § 95802(a).

An offset that is "permanent" would create long-term emission reductions, even with unintentional reversals from events such as wildfires. And an offset that is "additional" would reduce carbon beyond what would otherwise occur without the offset.

To ensure that these legal requirements are met, CARB requires offset projects to conform to "Compliance Offset Protocols." CARB currently issues credits (called "offset credits" or "offsets") under six approved Compliance Offset Protocols for the following project activities:

- Capturing and destroying methane generated by manure from livestock;
- Capturing and destroying methane from mining projects;
- Destroying ozone-depleting substances;
- Reducing GHG emissions from rice cultivation;
- Growing or preserving forests within the United States; and
- Planting trees in urban areas.[224]

All offset projects must be located within the United States,[225] and each offset credit is treated as equivalent to one $MTCO_2e$.

Entities can use up to a quantitative usage limit of offset credits against their emissions obligations, meaning that a covered entity can surrender offset credits on a one-to-one ratio for a small percentage of their actual emissions.[226] Offsets were limited to 8% of entities' emissions obligations corresponding to their 2013-2020 emissions; AB 398 reduced that limit to 4% for emissions from 2021-2025, and 6% for emissions from 2026-2030.[227] In addition, AB 398 specified that no more than one half of the quantitative usage limit may be sourced from projects that do not provide direct environmental benefits in the state.[228]

Determining how many offset credits to issue for a project is based on the underlying technical requirements of the applicable Compliance Offset Protocol. As noted above, each credit represents one $MTCO_2e$ of reduction or removal that is "real, additional, quantifiable, permanent, verifiable, and enforceable."[229] Most of these requirements are addressed by strictly limiting the types of projects that are eligible and providing specific quantification methods and calculations for determining the number of GHGs reduced. In addition, the Compliance Offset Protocol for US Forest Projects includes provisions to minimize leakage, which is to say, provisions to ensure credited activities represent real emissions reductions, rather than shifting those activities (and emissions) to another area. This same protocol also contains provisions to ensure the "permanence" of emissions reductions, including the inclusion of a "forest buffer account," which is a sort of insurance mechanism that covers unintentional reversals from disturbances such as wildfires, pest infestations, and drought.[230]

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224 *See generally Compliance Offset Program*, CARB (last visited Oct. 25, 2021), https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program (linking to offset protocols). Of these protocols, the US Forest Projects protocol is responsible for the majority of offset credits. *See ARB Offset Credit Issuance Table*, CARB (last visited Oct. 25, 2021), https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/arb-offset-credit-issuance. *See also* Danny Cullenward & Dallas Burtraw, *Draft IEMAC Report Offsets Chapter*, at 2 (Jan. 11, 2022), https://calepa.ca.gov/wp-content/uploads/sites/6/2022/01/2022_01_13_IEMAC_Report_carbon_offsets_chapter_a-1.pdf.

225 Cap-and-Trade Regulations, 17 C.C.R § 95973(a)(3).

226 *Id.* § 95980(a).

227 *Id.* § 95854(b).

228 *See* AB 398, 2017-2018 Leg. (Cal. 2017); *see also* Cap-and-Trade Regulations, 17 C.C.R § 95854(e). *See generally Direct Environmental Benefits in the State* (*DEBS*), CARB (last visited Apr. 18, 2022), https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/direct-environmental-benefits.

229 Cap-and-Trade Regulations, 17 C.C.R § 95970(a)(1).

230 *See generally US Forest Projects – June 25, 2015*, CARB (last visited Apr. 18, 2022), https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/compliance-offset-protocols/us-forest-projects/2015; and CARB, Compliance Offset Protocol US Forest Projects 132 (June 25, 2015), https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/protocols/usforest/forestprotocol2015.pdf.

California's Compliance Offset Program has been one of the most criticized elements California's GHG ETS, and these critiques – including with respect to permanence, especially in light of climate change-induced extreme wildfires, leakage, and whether reductions are real – are discussed further in § IV.D.4, below.

6 | Monitoring, reporting, and verification (MRV) requirements for the GHG ETS

California's GHG reporting requirements predate the GHG ETS. The Mandatory Greenhouse Gas Reporting Regulation (MRR) was originally approved in 2007, as part of the suite of policies mandated by AB 32.[231] It was substantially revised in 2010 to better support the cap-and-trade program, which CARB was then in the process of developing, and has been periodically revised since.[232] Because MRR serves multiple policy purposes, this report only discusses the portions that are most relevant to the GHG ETS.

All entities covered by the GHG ETS have to report their emissions through MRR.[233] The reports are required annually.[234] Each sector, and many subsectors in industrial manufacturing, have specific requirements for how they measure and report their individual GHG emissions.[235] Reporting is required at the facility level and must include both fuel burned and GHG emissions from any other processes at the facility.[236] Fuel suppliers must report both the amount of GHGs their operations emit directly and the GHGs that would be emitted if all the fuel that they supplied to California purchasers were burned.[237] Facilities are required to report a variety of emissions sources beyond fuel consumed to generate energies, including those from venting, flaring, equipment leaks, acid-gas removal and dehydration of gas or petroleum, and blowdowns of equipment.[238] Emissions are generally calculated by metering vented gas, high-volume sampling, or standardized calculations from related measurements.[239]

MRR reports must be verified by an accredited third-party provider.[240] In the first year of a compliance period, the provider must conduct a "full verification"[241] including review of the reporting documents, data checks, on-site sampling, and at least one site visit.[242] In subsequent years, a verifier may perform "less intensive verification" requiring only document review and data checks.[243] Covered entities must switch verifiers at least once every six years and may not use the previous verifier for at least three years after switching.[244]

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231 *See generally* Cal. Health & Safety Code § 38530 (West).

232 *See* CARB, Mandatory Greenhouse Gas Reporting Regulation (last visited Oct. 25, 2021), https://ww2.arb.ca.gov/mrr-regulation.

233 Cap-and-Trade Regulations, 17 C.C.R. § 95850(a).

234 MRR, 17 C.C.R. § 95103(e).

235 *See generally id.* §§ 95110-95124, 95153. Many of the measuring requirements are harmonized with the federal GHG monitoring requirements at 40 C.F.R. Pt. 75.

236 *See generally* MRR, 17 C.C.R. § 95153.

237 *Id.* § 95121(a). Downstream suppliers are not required to report emissions from an upstream California source, to avoid double-counting. *Id.* § 95121(a)(2).

238 *Id.* § 95152(b)-(j).

239 *See generally id.* § 95153, which includes specific requirements for calculating GHG emissions from petroleum and natural gas systems.

240 *Id.* § 95103(f); *see also generally id.* §§ 95132-95133 (accreditation and conflict-of-interest requirements).

241 *Id.* § 95130(a)(1).

242 *See generally id.* § 95131(b)(3)-(8).

243 *Id.* § 95130(a)(1); *see also id.* § 95102 (definition of "Less intensive verification").

244 *Id.* § 95130(a)(2)-(3).

Offset projects must also comply with certain monitoring and reporting requirements.[245] Monitoring requirements are specified in the applicable Compliance Offset Protocol, though entities may apply in limited circumstances to use techniques developed after the relevant protocol was issued.[246] As with emissions reporting, offset reports must generally be submitted each year[247] and must be verified by a third party, though sequestration offsets require verification only once every six years.[248] The verification requirements are similar to the verification requirements for MRR and require projects to retain the same verifier for no more than six years in any nine-year period.[249]

If an entity is found to have underreported its emissions (and therefore to have undersubmitted allowances for compliance) by more than 5%, it is required to surrender additional allowances to make up for the deficit beyond 5% of the allowances it already surrendered for that period.[250] In other words, for underreporting below this 5% threshold, "the entity is not required to take any further action."[251]

7 | Allowance trading and banking

A covered entity with excess allowances may either trade them to another covered entity or retain (or "bank") them for use in future years. Generally speaking, allowance trades may be done freely, but must be between entities registered with CARB.[252] There is also a futures and options market for carbon allowances, which is conducted on exchanges such as the Intercontinental Exchange.[253] CARB conducts market surveillance, together with a third party, Monitoring Analytics, to monitor trading within the market and auctions.[254] Additionally, the federal Commodity Futures Trading Commission regulates the Intercontinental Exchange,[255] and therefore trade in allowances futures. CARB also coordinates with the California Independent System Operator, which governs the wholesale energy market in California, and the Federal Energy Regulatory Commission, which regulates US energy trading and supply.

The number of allowances that can be banked and rolled over to the next compliance period is subject to a holding limit based on the annual allowance budget for the vintage year to which the allowances belong.[256] All allowances that an entity holds from previous budget years are aggregated together with the allowances for the current budget year and subject to the same holding limit.[257] If an entity holds allowances for future years (for example, allowances purchased at an advance auction), however, these are subject to a separate holding limit for each year.[258] The holding limit for

245 Cap-and-Trade Regulations, 17 C.C.R. § 95970(a)(5); *see generally id.* § 95976.

246 *Id.* § 95976(a)-(c), (g).

247 *Id.* § 95976(d) (reports must be submitted each "Reporting Period"); *id.* § 95802 ("Reporting Period" defined as 12 consecutive months in most cases).

248 *Id.* § 95977(b)-(c).

249 *See generally id.* § 95977.1(a), (b)(3)(D)-(L).

250 *Id.* § 95858(a)-(b).

251 *Id.* § 95858(a).

252 *See generally id.* § 95921. Trades for the purpose of market manipulation, fraud, or made under false pretenses are not permitted. *Id.* § 95921(f)(2).

253 *See All Futures, Options, OTC Products & Physicals*, Intercontinental Exchange (ICE) (last visited Oct. 25, 2021), https://www.theice.com/products/?filter=california%20carbon%20allowance.

254 *Market Monitoring*, CARB (last visited Aug. 8, 2021), https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/market-monitoring.

255 *ICE Futures US: Regulation*, ICE (last visited Oct. 25, 2021), https://www.theice.com/futures-us/regulation.

256 Cap-and-Trade Regulations, 17 C.C.R. § 95856.

257 *Id.* § 95920(d)(1).

258 *Id.* § 95920(e).

2021 allowances is 9.895 $MMTCO_2e$; under the current budget schedule, the holding limit declines by about 0.335 $MMTCO_2e$ each year until 2030, and then by about 0.168 $MMTCO_2e$ each year until 2050.[259]

Banking was included as part of ETS design to enable recognition of early reductions and to provide firms with greater flexibility in long-term compliance planning. Critics have pointed to the role of banking in exacerbating allowance surpluses that in turn suppress allowance prices.

8 | Accountability and Regular Evaluation

An important part of any new and complex system is continual review to ensure that integrity is maintained and ambition is maximized. Such review can occur as part of California's Scoping Plan process, which is the state's legislatively-required climate change action plan that must be updated at least every five years. Part of that role in California's cap-and-trade program is served by the Independent Emissions Market Advisory Committee (IEMAC), which publishes regular reports on the performance of the cap-and-trade program. More general oversight is provided by the Legislative Analyst's Office (LAO), which reviews the actions of the state's administrative agencies, including CARB's management of the cap-and-trade program.

a | IEMAC

IEMAC was established in 2017, as part of the changes made to the cap-and-trade program under AB 398. The commission has five expert members: three appointed by the governor and one each appointed by the State Senate and State Assembly, which are the two houses of California's legislative branch.[260] Thus, IEMAC primarily consists of representatives of the administration, which will presumably support CARB's position, but will also always include representatives of the legislature, which authorized the cap-and-trade program and has authority to require changes to it. An observer position is reserved for a representative of the LAO.[261]

IEMAC's primary role is to produce annual reports and hold public meetings on "the environmental and economic performance" of the cap-and-trade program.[262] IEMAC uses these reports to isolate a few key issues and recommend changes to CARB regulations for each issue.[263] IEMAC's first report, in 2018, was also submitted directly to CARB and considered as part of CARB's development of regulations to comply with AB 398.[264]

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259 Specifically, the holding limit for each year is 2.5% of that year's budget plus 1.875 $MMTCO_2e$. *Id.* § 95920(d)(1), (e).

260 Cal. Health & Safety Code § 38591.2(b)(1)(A) (West). Members must be "experts on emissions trading market design," *id.*, with "academic, nonprofit, and other relevant backgrounds" and without conflicts of interest, *id.* § 38591.2(b)(2).

261 *Id.* § 38591.2(b)(1)(B).

262 *Id.* § 38591.2(c).

263 *See, e.g.*, Indep. Emissions Market Advisory Comm. 2020 Report, *supra* note 157 (making recommendations for each of six items reviewed).

264 *See Comment 43 for Cap and Trade 2018*, CARB (lasted visited Apr. 11, 2022), https://www.arb.ca.gov/lispub/comm/bccomdisp.php?listname=ct2018&comment_num=47&virt_num=43 (IEMAC's submittal of the 2018 report); CARB, Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Responses: Public Hearing to Consider the Amendments to the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms (2018), https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/capandtrade18/ct18fsor.pdf?_ga=2.131692361.73140785.1642018425-1158618940.1627694642 (document summarizing all received comments and CARB's responses, including many references to IEMAC's 2018 report).

b | LAO

The LAO has the general responsibility of reviewing the state administrative agencies' implementation of laws passed by the state legislature. Although the LAO is not assigned any particular role in the cap-and-trade program, its recommendations are seriously considered because of its longstanding role in California policymaking, expertise, and connection with the legislature. The LAO does not generally make policy recommendations, but does forecast the impact of various policy choices.

The LAO has produced a number of influential reports on the cap-and-trade program. Its assessment of the likely oversupply of allowances formed the basis for CARB's own prediction of allowance oversupply in its AB 398 rulemaking.[265] A related report noted the possibility that banked allowances could allow facilities to emit far more GHGs than expected in the late 2020s, potentially causing California to miss its 2030 emissions target;[266] that study is regularly referenced in reporting on the cap-and-trade program.[267] The LAO also reports on the budget for the GGRF, most recently alerting the legislature to the greatly increased allowance prices at the November 2021 auction, and proposing alternative revenue predictions based on the price increase.[268]

C | Key moments in the development of California's GHG ETS

Because fuel suppliers were given an additional two years to phase-in compliance with the GHG ETS, the market expanded substantially in 2015.[269] The result was an increase in coverage to include about 77% of the state's overall GHG emissions and a corresponding increase in the cap on emissions.[270]

In 2017, the California legislature passed AB 398, which guaranteed the ETS would remain in place until 2030 and made several changes to the program.[271] Most notably, AB 398:

- Eliminated previously required reductions in free industrial allocations;
- Added the requirement that CARB set a hard price ceiling for compliance instruments;
- Reduced the maximum amount of offset credits entities can use, from 8% prior to 2021, to 4% for emissions from 2021-25, which will increase to 6% for emissions from 2026-30, and specified that starting with 2021 emissions, no more than one half of the offsets limit may be sourced from projects that do not provide direct environmental benefits in the state;
- Set new priorities for the use of auction proceeds; and
- Enacted the ban on (or preempted) local air-pollution districts' regulation of CO_2 for facilities within the cap-and-trade program.

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265 *See* CARB, Initial Statement of Reasons: Proposed Amendments to the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation Appx. D, at 10 (2018), https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/capandtrade18/ct18398.pdf?_ga=2.55603309.73140785.1642018425-1158618940.1627694642 (citing letter from Legislative Analyst's Office (LAO) to AM Cristina Garcia (June 26, 2017), *available at* https://lao.ca.gov/letters/2017/Garcia-cap-and-trade-062617.pdf).

266 LAO, Cap-and-Trade Extension: Issues for Legislative Oversight 6–9 (2017), https://lao.ca.gov/reports/2017/3719/cap-trade-extension-121217.pdf.

267 *See, e.g.*, David Roberts, *California's Cap-and-Trade System May be Too Weak to Do Its Job*, Vox (Dec. 13, 2018), https://www.vox.com/energy-and-environment/2018/12/12/18090844/california-climate-cap-and-trade-jerry-brown; Julie Cart, *Checking the Math on Cap and Trade, Some Experts Say It's Not Adding Up*, CalMatters (May 22, 2018), https://calmatters.org/environment/2018/05/checking-the-math-on-cap-and-trade-some-experts-say-its-not-adding-up/; Rachel Becker, *California Says It Will Review Cap-and-Trade amid Growing Criticism*, CalMatters (Feb. 18, 2021), https://www.kqed.org/science/1972789/california-says-it-will-review-cap-and-trade-amid-growing-criticism (quoting LAO representative discussing same finding).

268 LAO, Cap-And-Trade Auction Update and GGRF Projections 1–3 (2021), https://lao.ca.gov/reports/2021/4480/cap-and-trade-120621.pdf. This was also picked up by news media. *See, e.g.*, Sameea Kamal, *The California Legislature is Back: What to Expect in 2022*, CalMatters (Jan. 3, 2022), https://calmatters.org/politics/2022/01/california-legislature-what-to-expect-in-2022/.

269 *See* Cap-and-Trade Regulations, 17 C.C.R. § 95851(b).

270 *See supra* § IV.B.2.

271 For a general summary of which elements of the ETS were introduced by AB 398, *see* Ctr. for Climate & Energy Solutions, Summary of California's Extension of Its Cap-and-Trade Program (2017), https://www.c2es.org/wp-content/uploads/2017/09/summary-californias-extension-its-cap-trade-program.pdf.

CARB subsequently adopted several regulatory changes in 2018 reflecting the requirements of AB 398. These included the creation of both a price ceiling and two price containment points, which would trigger releases of reserve credits short of the price ceiling.[272]

The evolution of the Western Climate Initiative is also an important part of the GHG ETS's history. California has been cooperating with other jurisdictions on a cap-and-trade policy since 2007, when the original WCI was formed with five US states. They were quickly joined by two additional states and four Canadian provinces (Québec, Ontario, Manitoba, and British Columbia).[273] When California formalized its ETS in 2011, however, all US states except California left the WCI, citing concerns with implementing a cap-and-trade program.[274] California and Québec implemented their own ETS programs in 2012 and 2013, respectively, and then linked the two programs in 2014.[275] Ontario briefly joined in 2018, linking its ETS market with California and Québec in January but then eliminating its ETS market entirely in October.[276] Finally, Nova Scotia joined the WCI in 2018 as part of its ETS development[277] and has since implemented its ETS, although it is not linked to the California or Québec ETS programs.[278]

D | Assessment of the GHG ETS's efficacy

The central concern of critics of California's GHG ETS is that the system has generated only modest emissions reductions over the last eight years. Observers have criticized liberal free allowance allocations that have accumulated over time. What's more, emissions reductions achieved may primarily have been the result of other policies, such as the renewable portfolio standard in the electricity sector. The program has also generated debates over the quality of offsets, environmental justice, and the risks associated with regulatory preemption. The ETS has nonetheless helped to ensure that an economy-wide price signal is in place, produced substantial revenue for climate- and environment-oriented projects, and helped to establish a comprehensive system for monitoring, reporting, and recordkeeping of GHG emissions.

This section attempts to summarize existing debates about the environmental efficacy of California's GHG ETS. We acknowledge that there are sharp disagreements on some of the points discussed below and do not purport to come to a definitive conclusion on them here. We raise these critiques to highlight the types of issues that have arisen in ETS design and implementation, and to suggest that other jurisdictions should carefully consider these issues in their own ETS design.

272 *See generally* CARB, Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Responses, Agenda Item No. 18-10-7, at 6–8 (2018), *available at* https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/capandtrade18/ct18fsor.pdf.

273 *See* WCI, Design Recommendations for the WCI Regional Cap-and-Trade Program 3 (rev. 2009), https://wcitestbucket.s3.us-east-2.amazonaws.com/amazon-s3-bucket/documents/en/wci-program-design-archive/WCI-DesignRecommendations-20090313-EN.pdf.

274 *Six US states leave the Western Climate Initiative* S&P Global Commodity Insights (Nov. 18, 2011), https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/111811-six-us-states-leave-the-western-climate-initiative; Lane Powell, *The Western Climate Initiative Is Dead, Long Live the WCI*, Lexology (Nov. 23, 2011), https://www.lexology.com/library/detail.aspx?g=16aa30c5-63ab-406c-a3f7-100b3eaae557.

275 WCI, Participating Jurisdictions Overview (rev. 2021), https://wcitestbucket.s3.us-east-2.amazonaws.com/amazon-s3-bucket/participatingjurisdiction-comparativetable-en.pdf.

276 *Program Linkage*, CARB (last visited Apr. 11, 2022), https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/program-linkage.

277 *Nova Scotia Joins Western Climate Initiative Inc.*, Nova Scotia (May 14, 2018), https://novascotia.ca/news/release/?id=20180514001.

278 WCI, Participating Jurisdictions Overview (rev. 2021).

1 | California's portfolio of climate policies drove an overall decrease in GHG emissions, but the GHG ETS does not appear to have played a major role in this success.

The portfolio of climate policies implemented as part of AB 32[279] has had a substantial impact on California's carbon emissions: California met its goal of reducing emissions by about 15% compared to a "business as usual" scenario,[280] and researchers have found that the suite of AB 32 policies have been effective in reducing emissions.[281]

During the period that the ETS was in effect, statewide GHG emissions reductions came almost entirely from the electricity sector. Emissions in the transportation and industrial sectors increased somewhat during this period.[282] It is not clear, however, how much of this reduction is due to the GHG ETS, as opposed to the other policies begun at around the same time. The California Legislative Analyst's Office (LAO) attempted to review the efficacy of the GHG ETS in 2020, but was unable to find any relevant empirical research. It did find, "[b]ased on conversations with stakeholders and researchers," that the ETS's "effect on electricity sector emissions is generally thought to have been relatively modest compared to other policies." [283]

Other policies, such as California's renewable portfolio standard, are thought to have been a "significant driver" of emissions reductions.[284] The state enacted its renewable portfolio standard in 2002, requiring the power sector to use renewable power for 20% of its retail sales by 2017.[285] In 2015, the program was expanded to a 50% requirement by 2030;[286] the 2030 target was increased to 60% in 2018.[287] This has led to a relatively steady decrease in total GHG emissions and GHG intensity of California's electricity supply since 2002, beginning well before the ETS was in place.[288]

This dynamic is consistent with the idea of the ETS as a "backstop" to the rest of the AB 32 policies.[289] If

279 A summary of the major elements of this portfolio is maintained by the Center for Law, Energy & the Environment at University of California, Berkeley School of Law. *California Climate Policy Dashboard*, Berkeley L. (last visited Apr. 11, 2022), https://www.law.berkeley.edu/research/clee/research/climate/climate-policy-dashboard/.

280 *See*, *e.g.*, *Latest State Greenhouse Gas Inventory Shows Emissions Continue to Drop Below 2020 Target,* CARB (2021), https://ww2.arb.ca.gov/news/latest-state-greenhouse-gas-inventory-shows-emissions-continue-drop-below-2020-target.

281 *See, e.g.,* Geoff Martin & Eri Saikawa, *Effectiveness of State Climate And Energy Policies in Reducing Power-Sector CO_2 Emissions*, 7 Nature Climate Change 912 (2017), https://www.nature.com/articles/s41558-017-0001-0.pdf?origin=ppub.

282 All data from CARB, 2000-2019 GHG Emissions Trends Report Data Sheet, Figure 3 (2021), https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2019/2000_2019_ghg_inventory_trends_figures.xlsx; *see also* CARB, California Greenhouse Gas Emissions for 2000 to 2019, at 3 (2021), https://ww2.arb.ca.gov/sites/default/files/classic/cc/ghg_inventory_trends_00-19.pdf.

283 LAO, Assessing California's Climate Policies – Electricity Generation 19 (2020), https://lao.ca.gov/reports/2020/4131/climate-policies-electricity-010320.pdf.

284 *Id.* at 12–13.

285 SB 1078, 2001-2002 Leg. (Cal. 2002).

286 SB 350, 2015-2016 Leg. (Cal. 2015).

287 SB 100, 2017-2018 Leg. (Cal. 2018).

288 *See* CARB, California Greenhouse Gas Emissions for 2000 to 2019, at 13–14 (2021).

289 *See*, *e.g.*, Elec. Power Rsch. Inst., Exploring the Interaction Between California's Greenhouse Gas Emissions Cap-and-Trade Program and Complementary Emissions Reduction Policies 1–7 (2013) ("The cap-and-trade program incorporates a fixed emissions cap which serves as a backstop for" other climate policies.). CARB's own analyses have avoided the term, but generally refer to the ETS as a means of ensuring that climate targets are met, rather than a standalone program. *E.g.*, CARB, First Update to the Climate Change Scoping Plan, at ES4 (2014) (ETS "will ensure that California remains on track to continually reduce emissions and meet the 2020 limit."); CARB, California's 2017 Climate Change Scoping Plan 25 (2017), https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf (placing the ETS last in a list of climate policies as a means to "ensure the State's 2030 target is achieved"). CARB, *Draft 2022 Scoping Plan Update* 89 (2022), https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf ("[T]he greater the actual reductions from non-Cap-and-Trade Program measures are, the less reliant the GHG reduction program will be on the need for Cap-and-Trade to 'fill the gap' to meet the state's 2030 reduction target.").

California failed to reduce GHG emissions sufficiently to meet its 2020 target, the price of allowances may have been driven upward sufficiently to give the covered sectors incentive to reduce emissions. But since statewide emissions dropped quickly, the supply of credits remained high relative to demand, and prices stayed near the price floor. As a result, the ETS has generated a relatively low carbon price for most of its existence.

2 | The GHG ETS has had a persistent surplus of allowances.

Perhaps the most common critique of the GHG ETS is that it suffers from excessive allowances that have in turn kept allowance prices low.[290] Several observers consider the ETS to have been oversupplied with allowances through 2016.[291] More recent empirical data is hard to obtain, but the consistently low price of allowances from 2017 to mid-2021 provides reason to suspect that there was still oversupply for that period.[292] However, prices have spiked over the last several auctions, from August 2021 to May 2022, and the current-auction settlement price is, as of May, at a record high of $30.85.[293] It is too early to tell whether the latest auctions are an anomaly or the beginning of a trend, but the early surpluses and availability of banking may continue to drag down prices and may threaten California's 2030 targets.[294]

One reason for oversupply is the low initial ambition of the program. Although important, the reduction that the GHG ETS was meant to deliver by 2020 was relatively modest: 23 $MMTCO_2e$/year, or about 4.5% of the annual emissions in the "business as usual" projection for 2020.[295] As described above, substantial emissions reductions in the electricity sector, likely from other regulatory programs, led to substantial surpluses of allowances within the system.

The GHG ETS's banking provisions also feed into this issue. The banking provisions are generous: In 2021, entities may bank almost 10 $MMTCO_2e$. This is equal to or more than a full compliance period worth of allowances for all but a handful of the highest emitters.[296] Therefore, even though the program ambition is somewhat greater from 2021 onward, the prior surplus may weigh on the efficacy of the program going forward. Most notably, the California Legislative Analyst's Office, a governmental agency that provides policy analysis to the state government, has projected that excess allowances could lead to missing California's annual emissions target in 2030 by a substantial amount.[297]

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290 *See, e.g.*, Chris Busch, Oversupply Grows in the Western Climate Initiative Carbon Market (2017), https://energyinnovation.org/wp-content/uploads/2018/02/WCI-oversupply-grows-February-update.pdf; Danny Cullenward & Andy Coghlan, *Structural Oversupply and Credibility in California's Carbon Market*, 29(5) Elec. J. 7 (2016); LAO, Cap-and-Trade Extension: Issues for Legislative Oversight 8–9 (2017).

291 *Id.*; *see also* Env't Comm'r Ont., Ontario's Climate Act: From Plan to Progress – Appendix G: Technical Aspects of Oversupply in the WCI Market 2–4 (2018), https://www.auditor.on.ca/en/content/reporttopics/envother/env17_other/From-Plan-to-Progress-Appendix-G.pdf.

292 The price during this period stayed within $2 (or 12%) of the price floor, and was equal to the price floor in February 2017 and in May and August 2020. CARB, Summary of California-Québec Joint Auction Settlement Prices and Results (2022) (settlement prices); *Auction Notices and Reports*, CARB (last visited Apr. 18, 2022) https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/auction-information/auction-notices-and-reports (page linking to auction notices with the price floors for each auction).

293 CARB, Summary of California-Québec Joint Auction Settlement Prices and Results (2022). Interestingly, the advance-auction settlement price has been much more volatile during this period: it also increased sharply in August and November 2021, but crashed back down to the price floor in the February 2022 auction before jumping up again in May. *Id.*

294 LAO, Cap-and-Trade Extension: Issues for Legislative Oversight (2017), https://lao.ca.gov/Publications/Report/3719. Importantly, this does not necessarily mean that more GHGs could be emitted over the course of the program than were allowed for, just that emissions that were budgeted for earlier years may be released in later years. But this nuance does not matter for California's targets, since they are expressed in terms of an annual rate.

295 CARB, First Update to the Climate Change Scoping Plan: Building on the Framework 93 (2014).

296 In the 2015-2017 compliance period, only 13 entities, 4% of all entities, had more than 10 $MMTCO_2e$ in emissions. The mean entity emissions for the period were about 3.2 $MMTCO_2e$, and, because most entities are small emitters, the median was only about 0.2 $MMTCO_2e$. *See* CARB, *2015-2017 Compliance Report* (2020), https://www.arb.ca.gov/cc/capandtrade/2015-2017compliancereport.xlsx.

297 LAO, Cap-and-Trade Extension: Issues for Legislative Oversight 8–9 (2017). The LAO appears to assume that all banked allowances will be used by 2030, meaning that emissions would sharply decline after 2030, since no banked allowances would be available. But the overall problem remains: overallocation in the early years, plus banking, will make later caps less stringent. CARB has responded to these critiques at length. *See* CARB, *BR 18-51 Cap-and-Trade Allowance Report* (2022), https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/Allowance%20Report_Res018_51.pdf; CARB, Cap-and-Trade Program: Frequently Asked Questions (2021), https://ww2.arb.ca.gov/sites/default/files/2021-05/nc-FAQ_CT_Jan2021.pdf.

CARB has offered responses to criticisms of allowance oversupply. In a February 2022 document, CARB argued that existing ETS design is appropriate for meeting California's 2030 GHG target.[298] This follows on CARB's 2018 analysis, which found that "the currently established caps ... would support a steadily increasing carbon price signal to prompt the needed actions to reduce GHG emissions," and "no changes to allowance supply or banking rules were required at the time."[299] We note that CARB currently plans to report to the California legislature at the end of 2023 "giving a status of the allowance supply with any suggestions on Legislative changes to ensure the number of allowances is appropriate to help the state achieve its 2030 target."[300]

We remain concerned that substantial allowance surpluses are an indicator of insufficient environmental ambition. Careful consideration of cap stringency is essential in a period where virtually all analyses indicate that more aggressive near-term climate action is needed.

3 | Free allocations under the GHG ETS could likely be reduced without causing emissions leakage.

The free allocations provided to industrial manufacturing have been criticized as excessive.[301] These allowances are intended to prevent production from moving out of state to avoid the cost of complying with the GHG ETS. They were initially accompanied by a detailed assessment of the risk of each individual industry shifting production in this way, with subsidies reduced for the industries least likely to leave.[302] Those variations have since been removed due to legislatively mandated design changes through AB 398, however, and now nearly all industries receive the full leakage assistance factor within the calculation of their allowance allocation.

It is possible that free allocations could be reduced without inducing leakage. Take refineries, for example. Refineries receive the largest share of industry allowances.[303] Observers have questioned whether any free allocations are needed at all to prevent leakage from refineries, since initial estimates suggested that it would cost refineries $60/MTCO$_2$e to move production out of state, and allowance prices have been far lower than that.[304]

4 | GHG ETS offset rules may not be sufficiently stringent

Under California's cap-and-trade program, a California emitting facility can use offsets from GHG reduction or elimination in other projects to fulfill a small percentage of the facility's compliance obligation. The state's offset program is meant to help with cost-containment, achieve reductions in non-covered sectors, and offer a vehicle for climate diplomacy with other states/regions.

Offsets theoretically reduce global GHG emissions by the same amount as GHG mitigation would

298 *See* CARB, *BR 18-51 Cap-and-Trade Allowance Report* (2022). https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/Allowance%20Report_Reso18_51.pdf (response produced at the direction of the Board).

299 *Id.* at 8–9.

300 *Id.* at 7.

301 *See, e.g.*, Indep. Emissions Market Advisory Comm. 2021 Report, *supra* note 34, at 40–41.

302 CARB, Proposed Regulation to Implement the California Cap-and-Trade Program: Initial Statement of Reasons Appx. J, at J-21 to J-23 (2010).

303 *Allowance Allocation*, CARB, *supra* note 165.

304 Indep. Emissions Market Advisory Comm. 2020 Report, *supra* note 157, at 11–13. The report notes that refineries' break-even price for leaving the state was expected to be $50/ton, or $60 in 2020 dollars, *id.* at 12; the highest price recorded for the GHG ETS at auction was $23.30. There is an upward trend in these prices since mid-2020, so they may continue to climb, but, on the other hand, the ceiling price of $65/ton in 2020 is not much higher than the estimated break-even point, and the price-containment measures in place make reaching that level unlikely, at least in the near future.

at the facility. But the offset protocols may not guarantee that this is so. For example, one scholar has argued that the protocol for non-urban forestry offset projects, which account for the vast majority of offset credits generated thus far,[305] assumes that all the carbon sequestration from a 100-year project occurs immediately.[306] She further argues that this allows covered facilities to trade reductions far in the future, which are less valuable, for allowances in the present; that the future emissions reductions are uncertain because of variability in the effectiveness of sequestering carbon in forests as they age; and that the leakage rate is likely higher than the protocol allows.[307] This scholar and her coauthors have suggested that the concept of one-to-one trades for emissions is fundamentally flawed, and that offsets should instead be considered a limited incentive program for firms to invest in emissions reductions in lieu of reducing emissions themselves.[308]

Offset rules meant to address concerns about offset permanence and durability have come under critique as well. For example, California's cap-and-trade program requires the creation of a buffer pool to account for disturbances of forest sequestration projects, such as those due to wildfires.[309] Specifically, a portion of offset credits issued to a forest offset project must be placed into a "Forest Buffer Account."[310] The amount a particular project must place into the buffer is dependent on the project's reversal risk, which CARB determines based on financial, management, social, and natural disturbance factors.[311] When an unintentional reversal like the burning of a forest occurs, the project operator must notify CARB and the project registry within 30 days and provide an estimate of remaining carbon stocks in the project within 23 months.[312] CARB will thereafter retire credits from the buffer to account for the loss.[313] This system works much like an insurance policy for reversals.[314] But as such wildfires grow more frequent and more intense, the credits in the buffer pool may not be enough to account for the losses. Although the last few years have had California's worst wildfire seasons to date, the almost two-year delay in calculating the lost carbon otherwise contained in forest offset projects makes it difficult to tell how fast the buffer pool is depleting. CARB intends to further assess the issue of offset quality in the context of wildfires and other concerns during the late summer of 2022, highlighting again the need for an iterative and reform-minded approach to key elements of ETS and offset design.

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305 CARB, ARB Offset Credit Issuance Table (2021), https://ww3.arb.ca.gov/cc/capandtrade/offsets/issuance/arboc_issuance.xlsx (174 million of the 204 million credits issued have been for non-urban forest projects).

306 Barbara Haya, Policy Brief: The California Air Resources Board's US Forest Offset Protocol Underestimates Leakage 1 (May 7, 2019), https://gspp.berkeley.edu/assets/uploads/research/pdf/Policy_Brief-US_Forest_Projects-Leakage-Haya_4.pdf. For CARB's response to Haya's critiques regarding anti-leakage measures and the temporal mismatch issue, *see* CARB, US Forest Offset Projects 19–24 (May 30, 2019), https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/offsets/overview.pdf (stating that the Haya brief "misrepresents how leakage is accounted for in the Protocol").

307 *Id.* Dr. Haya recommends crediting projects with the actual amount of sequestration achieved each year, rather than granting all sequestration credits immediately, which would result in an 82% decrease in the offset credits issued under the protocol.

308 Barbara Haya et al., *Managing Uncertainty in Carbon Offsets: Insights from California's Standardized Approach*, 20 Climate Pol'y 1112 (2019). For CARB's response to some of these critiques, *see* CARB, California's Compliance Offset Program (Oct. 27, 2021), https://ww2.arb.ca.gov/sites/default/files/2021-10/nc-forest_offset_faq_20211027.pdf.

309 17 Cap-and-Trade Regulations, § 95983. *See*, Emily Pontecorvo & Shannon Osaka, *California Is Banking on Forests to Reduce Emissions. What Happens When They Go Up in Smoke?* Grist (Oct. 27, 2021), https://grist.org/wildfires/california-forests-carbon-offsets-reduce-emissions/; *see also* William Anderegg et al., Letter from Group of Concerned Scientists to Gavin McCabe, Chair of Compliance Offset Protocol Task Force (Nov. 5, 2020), https://www.arb.ca.gov/lists/com-attach/18-ab398offsetreport-ws-VjVTNFAjBTQAWVA2.pdf (citing the fact that 2020 has shattered California fire records and arguing the forest buffer pool contributions from project likely needs substantial increase rather than decrease).

310 17 Cap-and-Trade Regulations, § 95983(a).

311 CARB, Compliance Offset Protocol US Forest Projects 132 (June 25, 2015).

312 17 Cap-and-Trade Regulations, § 95983(b).

313 *Id.* CARB also determines whether the reversal was unintentional, as opposed to intentional, reversals which follows different procedures. *Id.* § 95983(c).

314 For a condensed explanation of the process, *see*, Brook J. Detterman & Kirstin K. Gruver, *Wildfires Burn Carbon Offsets* Nat'l L. Rev. (Sept. 22, 2020), https://www.natlawreview.com/article/wildfires-burn-carbon-offsets.

Offsets raise other issues as well. To the extent that offsets are out-of-state, Californians do not receive the co-benefits of GHG emissions reductions, such as air pollution reduction.[315] Even in-state offsets can reduce public health co-benefits, for example, where non-urban forestry projects take the place of industrial emissions reductions in urban areas. Offsets can also exacerbate allowance oversupply as they are direct substitutes for allowances in the ETS.

AB 398 attempts to address these concerns by limiting the use and location of offset projects. It reduced the cap on offsets from 8% to 4% of an entity's total compliance obligation through 2025, though it will raise that cap to 6% in 2026 through 2030.[316] It also required that no more than one half of a firm's quantitative usage limit may be sourced from projects that do not provide direct environmental benefits in the state. This is defined in the regulation as a project that improves air or water quality in California, and CARB has interpreted this to include any project that is located within California, as well as outside projects that reduce GHG emissions or have another environmental benefit to the state.[317]

As mentioned above, California's Compliance Offset Program has been one of the most criticized elements California's GHG ETS, and the program continues to be subject to debate and efforts at reform. The complexity of the protocols and the uncertainties associated with ensuring offset integrity raise the prospect of non-additional crediting or over-crediting. We note that these debates remain unresolved in California, a jurisdiction with very high administrative capacity and a strong tradition of transparency and public oversight (from civil society groups, academia, research organizations, and media). We would expect these issues to be even more challenging in jurisdictions with deficiencies in any of these areas.

5 | Auctions have generated revenue for environmental projects.

The revenues from allowance auctions go to the GGRF, which funds a variety of programs aimed at further GHG reductions. This has brought in $19.2 billion as of March 2022.[318]

The GGRF system also promised to ensure that a substantial quantity of these funds would go to people and areas that were low-income, bore disproportionate pollution burdens, or were otherwise vulnerable. The record on these expenditures is unclear. Roughly half of GGRF funds that have been implemented thus far have gone to projects benefiting "low-income" households or located in and benefiting "disadvantaged communities" or "low-income" census tracts.[319] However, a recent examination of expenditures by the GGRF on projects in Orange County indicated that funding there tended to go to regional projects that provided most of their benefits to non-disadvantaged areas.[320] Similarly, the definition of "low-income" is quite broad and could include households and census tracts that earn twice the state median income or more.[321]

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315 *See, e.g.,* Lara Cushing et al., *Carbon trading, Co-Pollutants, and Environmental Equity: Evidence from California's Cap-and-Trade Program (2011–2015)*, PLOS Med. (July 10, 2018), https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002604; Robert Sanders, *California's Cap-and-Trade air Quality Benefits Go Mostly out of State*, Berkeley News (July 10, 2018), https://news.berkeley.edu/2018/07/10/californias-cap-and-trade-air-quality-benefits-go-mostly-out-of-state/.

316 Cap-and-Trade Regulations, 17 C.C.R. § 95854.

317 *Id.* § 95989(a).

318 CARB, Summary of Proceeds to California and Consigning Entities 1 (last updated Mar. 2022), *supra* note 215.

319 Cal. Climate Inv., 2021 Annual Report, at iii (2021), http://ww2.arb.ca.gov/sites/default/files/auction-proceeds/2021_cci_annual_report.pdf.

320 Kim Serrano, Greenhouse Gas Reduction Fund Investments in and around Orange County 1–2 (2017), https://communityresilience.uci.edu/wp-content/uploads/2018/02/UCI-OC-GGRF-Report-FINAL-1.pdf.

321 *See supra* note 213.

6 | Preemption of local regulation appears to have stopped at least one initiative to reduce GHG emissions

As part of AB 398, California prohibited local air districts from imposing any additional GHG reductions on facilities covered by the GHG ETS.[322] These districts ordinarily have authority to regulate air pollution within their regional jurisdictions, in order to implement state and federal air-pollution statutes. It is generally difficult to tell what regulations might have happened without this provision, but at least one district, the Bay Area Air Quality Management District (BAAQMD), which regulates air quality in San Francisco and the surrounding area, did stop a rulemaking process that would have imposed restrictions on CO_2 emissions from oil and gas plants.[323] Whether AB 398 actually would have barred BAAQMD's rule – which limited the growth of CO_2 emissions rather than reducing emissions from their current point – was disputed.[324] Nevertheless, the BAAQMD cited the new law, and no other reason, in its decision to abandon the regulation.[325]

Preemption is not per se problematic, and proponents of preemption have argued that it prevents piecemeal regulation at the local level. Yet, multiple levels of regulatory authority can allow for local innovation and some level of regulatory redundancy can make regulatory capture more difficult.

More generally, we highlight this case as an example of how political compromises can potentially render climate action more difficult. Harmful subsidies and excessive complexity that obscures actual performance are other examples of problems that arise in ETS design.

7 | Studies have produced conflicting results as to the environmental justice impacts of the GHG ETS.

Pollution sources and other environmental hazards in California are disproportionately located in areas with lower incomes and higher percentages of non-White residents.[326] While GHGs do not generally cause local harms, the process of reducing GHGs could also reduce other pollutants by, for example, reducing the total amount of fuel burned at a facility or leading to air-filtration systems that reduce co-pollutants as well as GHGs. However, the ETS approach allows for greater unevenness in emissions reductions, since no individual facility will be required to reduce its emissions. This creates the possibility that inequitable pollution burdens will persist or even increase.

Evidence is sparse and mixed on the equity impacts of the GHG ETS, however. One study found that many facilities covered by the ETS increased both GHG and co-pollutant emissions between 2013 and 2015, and that those facilities tended to be located near neighborhoods with higher percentages of people of color and people in poverty.[327] A contrasting study analyzing pollutant dispersal found

322 Cal. Health & Safety Code § 38594(b)-(c) (West).

323 *Regulation 12 Rule 16: Petroleum Refining Greenhouse Gas Emissions Limits*, BAAQMD (updated 2019), https://www.baaqmd.gov/rules-and-compliance/rules/regulation-12-rule-16-petroleum-refining-greenhouse-gas-emissions-limits.

324 For example, several members of the California legislature wrote the BAAQMD to say that the proposed rule would not have violated AB 398. Letter from Sen. Skinner, AM Wicks, and Sen. Wiener to the Board of Directors of the BAAQMD (Dec. 18, 2018), *available at* https://www.sierraclub.org/sites/www.sierraclub.org/files/sce-authors/u1054/Legislators%20to%20BAAQMD%20Letter%2012.18.18.pdf.

325 BAAQMD, *Regulation 12 Rule 16: Petroleum Refining Greenhouse Gas Emissions Limits* (updated 2019), https://www.baaqmd.gov/rules-and-compliance/rules/regulation-12-rule-16-petroleum-refining-greenhouse-gas-emissions-limits.

326 *See, e.g.*, Lara Cushing et al., *Racial/Ethnic Disparities in Cumulative Environmental Health Impacts in California: Evidence from a Statewide Environmental Justice Screening Tool* (*CalEnviroScreen 1.1*), 105 Am. J. Pub. Health 2341 (2015).

327 Lara Cushing et al., *Carbon Trading, Co-Pollutants, And Environmental Equity: Evidence from California's Cap-and-Trade Program* (*2011-2015*), 15(7) PLOS Med. e1002604 (2018).

that the GHG ETS reduced the average gap in pollution burden between areas designated by as "disadvantaged" and others.[328]

8 | There may be leakage in the market for California electricity.

One problem that California's GHG ETS faces as a subnational trading program is that it is part of an electric grid that is larger than the market itself. Since electricity itself is source-independent, energy suppliers with access to a mix of energy sources can simply state that the electricity from low-GHG sources is going to their California purchasers and that from high-GHG sources is going to other purchasers outside of the ETS, a phenomenon known as "resource shuffling."[329] Resource shuffling is prohibited by AB 32 and the GHG ETS implementing regulations, but certain transactions are specifically exempted from the regulatory definition of the practice.[330] One researcher identified several contracts that appear to show resource shuffling occurring, in the form of California utilities divesting from coal plants that continue operating but selling their power to non-California purchasers.[331]

328 Danae Hernandez-Cortes & Kyle C. Meng, *Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market* (Nat.l Bureau Econ. Rsch., Working Paper, 2021), https://www.nber.org/system/files/working_papers/w27205/w27205.pdf.

329 *See, e.g.*, Severin Borenstein et al., *Report of the Market Simulation Group on Competitive Supply/Demand Balance in the California Allowance Market and the Potential for Market Manipulation* 12–13 (2014), *available at* http://www.ourenergypolicy.org/wp-content/uploads/2014/07/HAAS.pdf; *see also* Cap-and-Trade Regulations, 17 C.C.R. § 95802.

330 Cap-and-Trade Regulations, 17 C.C.R. § 95852(b)(2).

331 Danny Cullenward, *Leakage in California's Carbon Market*, 27(9) Elec. J. 36 (2014). It is worth noting that at least one of these plants, the Reid Gardner facility in Nevada, stopped operations a few years after the divestment. Cal. Energy Comm'n, Tracking Process 9 (2018), https://www.energy.ca.gov/sites/default/files/2019-12/declining_reliance_coal_ada.pdf. For more recent CARB analysis finding leakage, but no resource shuffling, *see* CARB, Review of Potential for Resource Shuffling in the Electricity Sector (Feb, 2020), (https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/guidance/resource_shuffling_faq.pdf.

V | LESSONS LEARNED

What are the key lessons to be drawn from this review of California's two major emissions trading systems? The strongest proponents of carbon pricing have argued that market approaches will achieve emissions reductions at much lower cost. Debates over carbon pricing have mirrored broader (and more ideological) conversations about the relative merits of government and market interventions in the economy and otherwise.

In practice, emissions trading systems have generated relatively modest emissions reductions and often-maligned command-and-control regulations have been critical in achieving environmental objectives. We believe that the complexity of emissions trading systems and the enthusiasm of trading proponents for the theoretical benefits of the tool have obscured these relative weaknesses.

To be sure, emissions trading systems have produced benefits. They have helped to build monitoring capacity and firm awareness of carbon emissions. Where auctions are involved, they have generated substantial revenue that can be used to support environmental and social programs and build political support for environmental policies.

Our point here is that the discussion over emissions trading must be more honest about these limits and the *actual* benefits to date in order to properly situate carbon pricing within a broader regulatory scheme for climate change. A franker dialogue about emissions trading will also offer a clearer path to improving the heretofore disappointing environmental performance of emissions trading systems. By all accounts, emissions trading is set to expand globally, whether in regulatory trading programs as seen in California, the EU, and China, or in voluntary offset programs. It is beyond time to engage in a more robust dialogue on genuine pathways to greater market integrity.

These observations led us, in Chapter One, to emphasize three high-level, overarching recommendations: (1) to engage in continuous improvement – reflecting the reality that no emissions trading system is without flaws; (2) to do no harm (and to seek to eliminate design features that create perverse incentives); and (3) to take a portfolio approach that maximizes environmental efficacy.

Here, we elaborate on a few more specific observations and recommendations drawn from our critical analysis of California's two major emissions trading systems.

A | ETS programs have not proven to be the main drivers of emissions reductions

The foremost lesson of California's experience is that ETS programs should not be relied upon to reduce emissions on their own. The ultimate failure of the RECLAIM program to deliver the reductions required by law is an important example here.[332]

California regulators learned from the RECLAIM experience in constructing the GHG ETS. That program was conceived and structured as a "backstop" to the overall AB 32 program: Its primary function was to increase carbon prices if other regulatory measures failed, raise revenue to fund GHG-reduction projects, and provide a modest amount of downward pressure on emissions.[333] It appears to have functioned well in this sense; prices have remained low, but the price floor has

332 *See supra* §§ III.D.2-3.

333 *See supra* § IV.D.1.

ensured that there is some cost to emitting GHGs, and that the auction generates some revenue for other climate projects. As of this writing, CARB is considering the relative role of the carbon ETS in California's overall climate change planning process (known as the Scoping Plan process) and CARB has predicted that the ETS will play a less significant role between now and 2030.[334]

The flip side of this lesson is a warning: ETS mechanisms can swallow up other regulatory approaches (see RECLAIM), by replacing other mechanisms in policymaking discussions, or by preempting other measures, as happened with AB 398, which eliminated local regulation even as it extended the GHG ETS.[335] Policymakers should be careful not to allow for such expansion at the cost of other mechanisms, since an ETS will not likely function as well when it is not paired with other programs.

B | Emissions trading systems are often established with relatively lax environmental requirements; strengthening ambition later on is difficult

Regulators often commence ETS programs with relatively lax allowance budgets to garner political support and facilitate learning and engagement with a new regulatory approach. Generous banking rules exacerbate this laxness in later years. It can be politically difficult to eliminate allowance surpluses and increase environmental stringency down the road.

The GHG ETS is a case in point. Initial overallocation and generous banking rules have kept allowance prices low there.[336] And the negotiations to extend the cap-and-trade program from 2020 to 2030 resulted in compromises (such as the expansion of leakage protections for industrial facilities, and preemption of local regulation) that arguably limit the environmental ambition of the program.

RECLAIM was commenced with generous allowance allocations that resulted in limited initial pressure on firms to mitigate emissions. Industry lobbying subsequently blocked legally-required cap reductions. RECLAIM did not allow banking, a design element that has been criticized in the GHG ETS. The experience of RECLAIM in this regard shows both the benefits and the costs of removing banking as an option: Initial overallocation in the RECLAIM market was not exacerbated by banking, but later on market participants had no buffer to rely on when allocations declined, triggering a price spike and eventually requiring substantial program reforms.[337] The smoothing out role of banking was not available to RECLAIM participants.

C | Regulatory capture creates particular problems under ETS systems

The phenomenon of regulatory capture – where regulated industries are able, through political influence and resource mobilization, to control their regulators – is not unique to emissions markets. However, emissions markets create particular problems. One of the most important is that, by tying together all entities in a given market, an ETS makes the ambition of the whole program subject to the most influential sector.

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334 CARB, Draft 2022 Scoping Plan Update 90 (2022), https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf (noting that CARB's latest modeling shows "an approximate 27 percent reduction in the role of the Cap-and-Trade Program in 2030 compared to what was included in the 2017 Scoping Plan," and that that uncertainty remains).

335 *See supra* § IV.D.7.

336 *See supra* § IV.D.2. We reiterate that allowance surpluses and low allowance prices in the GHG context could be seen as reflecting the ETS' backstop role. That is, other policies have done substantial work toward meeting state targets and so the ETS has not been needed.

337 *See supra* § III.D.2.

In both the RECLAIM and the GHG ETS cases, industry-friendly decisions have weakened the program. In RECLAIM, the overallocation that pervaded the program was likely due to the influence of refinery owners. This was most obvious in the 2015 NO_x "shave," which led to SCAQMD overruling its own staff to weaken a planned reduction in RECLAIM credits.[338] In the GHG ETS, this can be seen both in the initial decision to provide free allocations to industrial manufacturing, based on an intricate assignment of "leakage risk," and then to abandon that concept entirely and maximize free allocations for all industries.[339] In the case of RECLAIM, the overallocation led to a decrease in the overall level of reductions in the program, since the emissions budget was simply the sum of individual allocations. In the GHG ETS, the free allocations may not have increased the emissions budget, but can blunt the intended pricing incentive on firms to invest in emissions reductions. Free allocations also reduce funds available to the GGRF.

The various regulatory pathologies described in this report (overallocation, preemption, low-cost compliance with relatively modest incentives for emissions reduction) help explain why industry has tended to support emissions trading/pricing mechanisms over command-and-control measures.[340] Our admonition to "do no harm" is a response to the very real risks of carbon pricing mechanisms serving as a merely symbolic form of regulation.

D | Offset quality must be carefully regulated

The use of offsets in California's GHG ETS has generated intense debates over whether such projects represent emissions reductions that are *real, quantifiable, permanent, verifiable, enforceable, and additional* to what is required by law and to what would otherwise occur in a conservative business-as-usual scenario.[341] At the same time, California has arguably among the most comprehensive rules on offsets in the world, including the requirement to conform to specific "Compliance Offset Protocols" issued by CARB.

The California experience is instructive for highlighting debates over offset quality, and possible responses to issues raised.

E | Emissions trading has generated sharp disputes over environmental justice in California

California's emissions trading systems have generated sharp debates about environmental justice, although the empirical research on the economic and racial impacts of using market mechanisms is mixed for both the RECLAIM and GHG ETS programs.[342] Emissions trading can also create procedural inequities, as the public has no right to comment on or intervene in firm decisions about how to comply with emissions trading rules. People who live nearby ETS facilities have less say in regulating their environment than if such facilities were subject to, say, the administrative law requirements associated with permit issuances under the Clean Air Act.

338 *See supra* § III.C.

339 *See supra* § IV.B.3.

340 Timothy Cama, *API Supports Carbon Pricing, but Its Allies Remain Skeptical*, E&E Daily (Aug. 12, 2021), https://www.eenews.net/articles/api-supports-carbon-pricing-but-its-allies-remain-skeptical/.

341 *See supra* § IV.D.3.

342 *See supra* §§ III.D.4, IV.D.7.

While not directly addressing the issue, the GHG ETS sought to support people with disproportionate pollutant burdens by earmarking a certain amount of funds from the GGRF.[343] It is unclear to what extent this directly benefits the populations that are harmed by the facilities that the ETS regulates; the program is based on CalEPA's assessment of people with pollution burden generally, and to a lesser extent on household or area income relative to the county in which they are located. Still, it is important to continually strive toward evening out pollutant burdens, and programs like the GGRF earmarking should be considered in other market-style programs.

343 *See supra* § IV.D.4.

CHAPTER THREE
RECOMMENDATIONS FOR CHINA

I | INTRODUCTION

China launched its national carbon emissions trading system in July 2021. The system under current design is a tradeable performance standard (TPS) with multiple benchmark categories. Although the system became, in an instant, the largest emissions trading system in the world by covered emissions – nearly three times larger than the EU ETS and 14 times larger than California's carbon ETS – it is worth clarifying how a TPS-based design and the other features of the Chinese system differ from the traditional cap-and-trade systems utilized in the EU and California.

This Chapter provides a basic overview of the current design of China's national carbon ETS and seeks to clarify the implications of its current design, drawing on a range of existing research and our own analysis. As in our assessment of the California emissions trading systems, we comment on the Chinese national ETS with respect to its environmental ambition and integrity, as well as opportunities created or missed for building political support, fiscal resources, administrative/regulatory capacity, and environmental justice. We conclude with a series of recommendations for ETS reform.

Commentary about China's national ETS to date has often focused on metrics such as the size of the market, firm compliance rates, volume of allowances traded, and allowance prices. Some of these may be a rough proxy for environmental ambition (e.g., allowance prices), but others point to activity level within the ETS without any indication of actual environmental impact. This Chapter seeks to focus more squarely on likely implications of the ETS for decarbonization. In short, we believe that without substantial reforms, China's national carbon ETS will only have a limited impact on carbon emissions and some design elements may actually slow the transition from fossil fuels to clean energy.

The question of environmental ambition and integrity has taken on a particular urgency with President Xi Jinping's announcement of the 2030 peaking and 2060 carbon neutrality targets. Given the ambition of these targets, China cannot afford to invest substantial resources and effort into a system that functions on its own terms without producing serious emissions reductions. Based on our conversations with Chinese researchers, we are aware of continual efforts to reform the system and hope that this report may contribute to that effort.

II | OVERVIEW OF CHINA'S NATIONAL CARBON EMISSIONS TRADING SYSTEM

A | Background

China's national carbon ETS, which was announced in 2017 and officially commenced trading in June 2021, was many years in the making. Chinese authorities announced plans to develop carbon emissions trading systems in 2011.[344] Eight ETS pilots launched between 2013-16 and continue in operation as of this writing.[345] China's past experience with the Clean Development Mechanism under the Kyoto Protocol and sulfur dioxide (SO_2) emissions trading pilots in the early 2000s also informed the development of the national carbon ETS.[346]

The plans to develop carbon emissions trading were meant to support implementation of China's 12th Five-Year Plan (2011-15), which had incorporated a binding target of reducing carbon intensity 40-45% by 2020 compared to 2005 levels. This carbon intensity target had first been announced in advance of the UN COP15 meeting at Copenhagen in 2009. At that time, primary responsibility for climate change policy and ETS development resided within China's National Development and Reform Commission (NDRC), the country's main economic planning agency. That authority was transferred to the Ministry of Ecology & Environment (MEE), the enlarged and strengthened environmental agency created in 2018 to replace the Ministry of Environmental Protection (MEP).

B | Design

At its launch in June 2021, China's national carbon ETS covered 2,225 firms in the electricity sector that emit 26,000 tons or more of CO_2 annually. In all, this accounted for 4.5 GT of CO_2 emissions in 2020 – 40% of China's overall CO_2 emissions. ETS coverage is limited to three categories of coal-fired plants, as well as natural gas facilities. It does not include non-fossil sources of electricity production, such as hydropower, solar, wind, nuclear, or other electricity producers. Chinese authorities have announced that the system coverage would eventually expand to include buildings, iron and steel, non-ferrous metal processing, petroleum refining, chemicals, pulp and paper, and aviation.[347]

The registry for the national ETS is based in Hubei Province.[348] The exchange system is based in Shanghai.[349] The trading platform for allowances related to voluntary carbon reductions (China Certified Emission Reductions or CCERs) is based in Beijing.[350]

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344 12th Five-Year Plan (2011-2015) for National Economic and Social Development (中华人民共和国国民经济和社会发展第十二个五年规划纲要), (Mar. 16, 2011), http://www.gov.cn/2011lh/content_1825838.htm ("We will... gradually create a carbon emissions trading system."); *translated at* https://policy.asiapacificenergy.org/node/37. *See also* 国家发展改革委办公厅关于开展碳排放权交易试点工作的通知: 发改办气候[2011]2601号 (Oct. 29, 2011), http://www.ncsc.org.cn/SY/tpfqjy/202003/t20200319_769725.shtml (calling for trading pilots in Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei, and Shenzhen); 国务院 "十二五"控制温室气体排放工作方案 (Dec. 1, 2011) (探索建立碳排放交易市场), http://www.gov.cn/zwgk/2012-01/13/content_2043645.htm; 国务院关于印发能源发展"十二五"规划的通知 (Jan. 1, 2013), http://www.gov.cn/zwgk/2013-01/23/content_2318554.htm; 习近平在气候变化巴黎大会开幕式上的讲话(全文)(Nov. 11, 2015), http://www.xinhuanet.com//world/2015-12/01/c_1117309642.htm; 国务院《"十三五"控制温室气体排放工作方案》(Oct. 27, 2016) (calling for national ETS development) http://www.gov.cn/zhengce/content/2016-11/04/content_5128619.htm.

345 The pilots are in Shenzhen (Jun. 2013), Beijing (Nov. 2013), Shanghai (Nov. 2013), Guangdong (Dec. 2013), Tianjin (Dec. 2013), Hubei (Apr. 2014), Chongqing (June 2014), and Fujian (Sept. 2016). Launch date in parentheses.

346 *See, e.g.*, Michael Wara, *Measuring the Clean Development Mechanism's Performance and Potential*, 55 UCLA L. Rev. 1759 (2009); Jintian Yang & Jeremy Schreifels, Implementing SO_2 Emissions Trading in China (2003), https://www.oecd.org/env/cc/2957744.pdf.

347 生态环境部办公厅《关于加强企业温室气体排放报告管理相关工作的通知》(Mar. 29, 2021), https://www.mee.gov.cn/xxgk2018/xxgk/xxgk05/202103/t20210330_826728.html; 赵英民 (MEE Vice President) at State Council Policy Briefing on July 14, 2021, http://www.gov.cn/xinwen/2021zccfh/30/index.htm; 生态环境部《对十三届全国人大四次会议第9145号建议的答复》 (Sept. 18, 2021), https://www.mee.gov.cn/xxgk2018/xxgk/xxgk13/202112/t20211206_963196_wh.html.

348 生态环境部《关于发布<碳排放权登记管理规则(试行)><碳排放权交易管理规则(试行)>和<碳排放权结算管理规则(试行)>的公告》(May 17, 2021), https://www.mee.gov.cn/xxgk2018/xxgk/xxgk01/202105/t20210519_833574.html.

349 *Id.*

350 *The Status of China's Voluntary Carbon Market*, Env't Def. Fund (July 24, 2020), https://www.edf.org/climate/status-chinas-voluntary-carbon-market.

C | Tradable Performance Standard

The most salient design feature of China's national carbon ETS is its use of a tradable performance standard (TPS), rather than a traditional cap-and-trade design.[351] A TPS design, which incentivizes firms to meet carbon intensity performance benchmarks, is consistent with the overarching carbon intensity targets set forth in China's Five-Year Plans and its climate change pledges at the international level. But it will not likely be an appropriate design as China shifts toward the achievement of carbon peaking by 2030 and the dramatic reductions needed to achieve carbon neutrality by 2060.

Under a TPS, firms receive allowances based on the amount of production multiplied by an intensity benchmark. A firm that can produce at a carbon intensity more efficient than the benchmark will receive a surplus of credits that can be sold on the market for value. Some have called this an "implicit output subsidy" in that each unit of production would earn the firm a surplus of allowances with economic value.[352] A less efficient firm that did not meet the applicable benchmark would in turn face a penalty for each unit of production because it would need to purchase additional allowances to comply with the benchmark level. In this way, the system contains both a "subsidy" and a "tax" component.

A TPS creates an incentive to meet or exceed the performance benchmark, as there are penalties for failure to meet the efficiency benchmark and the ability to sell credits generated through performance that exceeds benchmark levels. Intensity-based performance standards, however, do not create an incentive to limit aggregate emissions. The TPS-based system is therefore not only "rate-based," but also "output-based." China's TPS-based emissions trading system is analogous to the US approach to improving automobile fuel efficiency through Corporate Average Fuel Economy (CAFE) standards. CAFE standards create no incentive to reduce the sale of internal combustion engine automobiles or aggregate vehicle miles traveled. Likewise, China's TPS-based ETS sets no cap on power sector carbon emissions but creates incentives to divert more electricity production to more efficient power plants.

While many descriptions of the Chinese ETS discuss a "cap" or "cap-setting," there is in fact no firm cap or upper limit on emissions under a TPS-based system. Firms receive a pre-allocation based on a formula that incorporates (i) electricity production multiplied by (ii) the applicable benchmark multiplied by (iii) various correction factors for load factor, cooling mode (water vs. air cooling), and the relative share of heating.[353] The load factor correction factor essentially offers more allowances to firms operating below 85% capacity.[354] This correction factor will likely be broadly applicable as China's coal-fired power plants have an average utilization rate of less than 50%. The cooling mode correction factor provides firms who use air cooling (less water intensive) with an allowance adjustment of 1.05 (as compared to 1 for water cooling).[355] Firms then must go through ex-post adjustments to "true up" the final allocation of allowances based on actual production and adjustments based on correction factors.

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351 Tradable performance standards are commonly referred to as "rate-based," whereas cap-and-trade systems are often termed "mass-based."

352 Lawrence Goulder et al., *China's Unconventional Nationwide CO_2 Emissions Trading System: The Wide-Ranging Impacts of an Implicit Output Subsidy*, Res. for Future (2020), https://www.rff.org/publications/working-papers/chinas-unconventional-nationwide-co2-emissions-trading-system/.

353 *See* MEE, 2019-2020年全国碳排放权交易配额总量设定与分配实施方案(发电行业)11 (Dec. 30, 2020), https://www.mee.gov.cn/xxgk2018/xxgk/xxgk03/202012/W020201230736907121045.pdf.

354 *Id.* at 12.

355 *Id.* at 11.

All allowances are currently allocated for free under the present design, although the use of auctions is under discussion. Allowance auctioning would provide a substantial source of funds that could be used to promote environmental or social (just transition, stranded asset) goals.

D | Multiple Benchmarks

China's national ETS currently uses 4 benchmark categories: conventional coal-fired generators above 300 MW, conventional coal-fired generators below 300 MW, unconventional coal-fired generators, and gas-fired generators (see Table 1). The multiple benchmarks serve to shield less efficient generators from the effects of a single, uniform standard, and to allow these less efficient plants time to transition. In other words, plants are compared to best-in-class of similar types of plants, rather than among all types of electricity producers.

The initial compliance obligations for the ETS cover 2019 and 2020 emissions and are limited in various ways. Natural gas plants are only required to submit allowances up to the amount of their free allocation. In other words, there is no penalty for less efficient gas plants, but gas plants operating more efficiently than the benchmark receive the surplus/subsidy, which can be sold on the market. Less efficient coal-fired plants within the ETS have their compliance obligations capped at 120% of free allocations given. According to commentators, this set-up is meant to favor natural gas plants and limit compliance burden for natural gas and coal-fired plants.

At the same time, the structure creates limited incentives for fuel switching, either from coal to natural gas or from fossil to non-fossil sources of electricity production. For example, the creation of a separate benchmark category for natural gas plants (as opposed to using a single benchmark closer to the performance level of less carbon-intensive natural gas plants) lessens the potential penalty against coal-fired power plants and only encourages natural gas through the benchmarks implicit output subsidy (which more efficient coal-fired power plants also receive). It is an open empirical question as to whether the relative amounts of subsidy here lead to any fuel switching. A 2021 study from the IEA and Tsinghua (described in greater detail below) finds almost no coal-to-gas switching under current design, even assuming gradually tightened benchmarks.[356] Rather, the impact of the ETS comes from improved coal technology efficiency, switching from unabated coal to coal with carbon capture & sequestration, and some other technology efficiency improvements.

Anecdotal evidence illustrates the sort of windfall subsidy that firms can receive under existing design. Zhongshan Jiaman, a natural gas subsidiary of the state-owned China National Offshore Oil Corporation (CNOOC) based in Guangdong, received 150,000 surplus allowances for 2021.[357] CNOOC and Zhongshan announced that it used 100,000 allowances as collateral to obtain preferential interest rates on two loans totaling 500 million RMB from China Construction Bank, saving the firms 3 million RMB ($471,000) in financing costs. Query whether this level of subsidy is appropriate for a firm that emits over 2.1 MMTCO$_2$e per year. The fuel switching incentive could be strengthened by reducing the "overallocation" of allowances to coal-fired power plants. Fuel switching to non-fossil sources could be further encouraged by reducing the subsidy to natural gas and increasing support for non-fossil sources.

356 IEA & Tsinghua Univ., *supra* note 24, at 11.

357 Stian Reklev & Jiefei Liu, *China's CNOOC Reaps Windfall Profits from ETS Natural Gas Arrangements*, Carbon Pulse (Jan. 10, 2022), https://carbon-pulse.com/147999/.

By comparison, the Clean Power Plan under US law (though never eventually implemented) utilized a rate-based performance standard set at the level of emissions for natural gas plants, creating a disincentive for electricity production from coal-fired power plants. Coal-fired plants could only meet the performance standard with carbon capture & sequestration, or else would need to purchase allowances on the market. The shift from coal to natural gas has been an important abatement strategy in the EU and the US. China is more reliant on coal and does not have the same access to affordable natural gas as in the US, but the comparison is nonetheless useful for highlighting a more environmentally ambitious approach that China could take.

In contrast, the Chinese ETS creates a disincentive for fuel switching from fossil to non-fossil sources of electricity, such as hydropower, wind, solar, or nuclear, as those sources are not covered under the ETS. A firm would receive a subsidy per unit of output for utilizing an efficient (beyond benchmark) coal-fired plant, but would receive nothing under the ETS for switching to a non-fossil source. Such fuel switching will need to be handled through other policies, such as renewable portfolio standards or subsidies for non-fossil energy development. Various policies – such as switching from energy consumption caps to carbon emissions caps (as proposed during the 2022 National People's Congress meeting) – should be considered to create greater incentives for clean energy deployment.

As IEA analysis has pointed out, the multiple benchmark design also creates the possibility of perverse incentives at the margins. A more efficient conventional coal facility under 300 MW that received an implicit output subsidy could be price-preferred to a below-benchmark plant above 300 MW that was subject to a penalty for production.

TABLE 1
China's National Carbon ETS Benchmarks

Type of Generator	Electricity Supply Benchmark (tons of CO_2/GJ)	Heating Supply Benchmark (tons of CO_2/GJ)
Conventional coal above 300 MW	0.877	0.126
Conventional coal below 300 MW	0.979	0.126
Unconventional coal	1.146	0.126
Natural gas	0.392	0.059

E | Offsets

Up to 5% of a firm's compliance obligation may be satisfied through offsets, or certified voluntary emission reductions outside of the trading system. These include forestry carbon sink projects, methane reduction initiatives, renewable energy projects, and the like. This system will require consideration of offset quality (are the emissions real and additional?), durability (what happens when an offset project is destroyed, say, through forest fires?), and double-counting (can an offset count for ETS purposes *and* as a carbon reduction in the jurisdiction of origin?).

Official offset credits or CCERs may be used for compliance in the national ETS and the eight subnational pilots.[358] Authorities had halted CCER project registration and issuance in March 2017, but observers expect registration to commence again in 2022.

As CCER markets expand, much more work will be needed to ensure the integrity of emissions reductions represented by these offsets.

F | Monitoring, Reporting, and Verification

Current ETS rules authorize a so-called "double random, one public" (双随机, 一公开) approach to MRV, which involves randomly matching third-party emissions verifiers with covered firms (the "double random") and disclosing results to the public (the "one public"). Coal-fired power plants are encouraged to measure their emissions. Applicable rules apply a high default emissions factor to firms that do not measure their emissions or coal carbon content.[359]

G | Enforcement

The administrative rules set forth a variety of penalties for undesirable behavior. The rules authorize fines of RMB 20,000 to 30,000 for non-compliance, along with a deduction of any shortfall from the next year's allocation.[360] False reporting or concealing of emissions results may result in a fine of RMB 10,000 to 30,000.[361] The State Council regulations seek to impose higher levels of fines for these behaviors.[362] Other provisions set forth penalties for emissions verification organization collusion with firms, and punishments for bureaucrats and firms in annual performance reviews for failure to comply with ETS rules.[363]

H | Other Governance Objectives

China's national carbon ETS is meant to support emissions reduction goals and such environmental performance will necessarily be balanced against other policy goals, such as economic growth, job creation, distributional justice, cost-effectiveness, and energy security. It is worth noting that market measures will play a different role in the Chinese context than they have in the US or the EU. In the Chinese regulatory space, a major concern has been excessive reliance on "administrative measures" and the tendency towards "one-size-fits-all" regulatory solutions. In China's more top-down, state-dominated system, the debate is not so much about government or markets, but whether market measures can serve to improve state performance. The creation of an ETS also creates an opportunity for Chinese regulators to develop regulatory capacity, particularly in monitoring, reporting, and verification; to strengthen regulatory tools, such as using pollution permits to strengthen regulation of carbon and traditional pollutants; and to clarify the specific regulatory and implementation roles

358 Newsletter, Refinitiv Commodities Rsch., China Coal Plants Likely Face Considerably Stricter Benchmarks in ETS in 2022, under the New Coal Retrofitting Rules by State Planner (Dec. 21, 2021) (on file with author).

359 IEA, China's Emission Trading Scheme: Designing Efficient Allowance Allocation (June 2020), https://www.iea.org/reports/chinas-emissions-trading-scheme.

360 MEE Administrative Measures for Carbon Emission Trading (trial) art. 40 (eff. Feb. 1, 2021).

361 *Id.* art. 39.

362 State Council Interim Regulation for the Management of Carbon Emissions Trading (draft published Mar. 30, 2021) arts. 24-25, https://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/202103/W020210330371577301435.pdf (proposing a 100,000 RMB to 500,000 RMB fine for non-compliance, and a 50,000 RMB to 200,000 RMB fine for false reporting).

363 MEE Administrative Measures for Carbon Emission Trading (trial) arts. 37-41 (eff. Feb. 1, 2021).

of the different levels of government (central, provincial, municipal). The Chinese offset market appears poised to expand, especially in light of the finalization of the Paris Agreement Article 6 rulebook on carbon markets, and this enhanced governance capacity will be important to improving the integrity of such offsets.

I | Key Milestones & Legal Authorities

2011	Announcement of subnational emissions trading pilots
2013-2016	Launch of subnational ETS pilots
Dec. 2014	NDRC Interim Measures on National ETS
Dec. 2017	Official "launch" of national ETS; commencement of national ETS development
Dec. 2017	NDRC Work Plan for the Construction of the National ETS (Power Sector)
Sept. 2019	2019 Electricity Sector Major Emitting Units (incl. self-use, combined heat and power) Carbon Dioxide Emissions Quota Allocation Implementation Plan (draft) 2019
Dec. 2020	Administrative Measures for Carbon Emission Trading (trial) (eff. Feb. 1, 2021)
Dec. 2020	2019-2020 National Carbon Emissions Trading Total Quota Setting and Allocation Implementation Plan (Power Sector)
Dec. 2020	Major Emitting Units Name List for 2019-2020 National Emissions Trading System Quota Management
Mar. 2021	MEE Guidelines on Enterprise Greenhouse Gas Emissions Accounting and Reporting – Power Generation Facilities
Mar. 2021	MEE Guidelines for Enterprise Greenhouse Gas Verification (trial)
May 2021	MEE Administrative Measures for the Registration, Trading, and Settlement of the National Carbon Emission Rights (trial)

TABLE 2
Key Design Elements of China's National Carbon ETS and California's Statewide Carbon ETS

	China national carbon ETS	California statewide carbon ETS
Covered Emissions	Over 4,000 MMTCO$_2$e (40% of overall) in 2021[364]	320.8 MMTCO$_2$e (75% of overall) in 2021[365]
Sectors	Power (other sectors to come – buildings, iron and steel, non-ferrous metal processing, petroleum refining, chemicals, pulp and paper, aviation)	Power, industry, transportation fuels
No. of Entities	2,225	approx. 500
Inclusion Threshold	26,000 tons CO$_2$e per yr	25,000 metric tons of CO$_2$e per yr
Cap	No cap on absolute emissions, multiple intensity-based benchmarks (4 benchmarks - conventional coal plants below 300 MW, conventional coal plants above 300 MW, unconventional coal, natural gas)	Declining cap 13.4 MMTCO$_2$e to 200.5 MMTCO$_2$e in 2030
Allowance Auctioning	100% free allocation (auctioning under consideration)	Free allocation to industrial facilities for leakage prevention; free allocation to electricity and natural gas utilities with consignment requirements; and auctioning (47% free allocation 2020)
Revenue & Use of Proceeds	None (under consideration along with auctions)	$19.2B since beginning of program, $3.99B in 2021, to the GGRF
Banking and Borrowing	Unclear (although the lack of official guidance has led entities to expect the allowances to be bankable)	Banking allowed subject to holding limits, no borrowing
Offsets	5% limit	4% limit (2021-25); 6% limit (2026-30)
Price	58.55RMB/tCO$_2$ ($9.20) (as of April 1, 2022)	$30.85/MTCO$_2$e (auction settlement price in May 2022)
Trading Participants	Compliance entities (considering inclusion of institutions/individuals)	Compliance entities, institutions/ individuals

364 ICAP, Emissions Trading Worldwide: Status Report 2021, *supra* note 21, at 109.

365 *Id.* at 64.

J | Early Program Assessment

This section seeks to clarify the implications of China's ETS design for environmental ambition and integrity. Carbon peaking and neutrality goals will require dramatic reductions in greenhouse gas emissions and the expansion of carbon capture/sinks. To what extent will the Chinese ETS promote these goals? Modeling efforts suggest that the impact of the ETS on decarbonization will be relatively modest. Based on our own internal analysis, we highlight the features of the system that tend to limit environmental performance.

A 2021 study by the International Energy Agency and Tsinghua University researchers found relatively modest impacts on CO_2 emissions from electricity generation through the ETS. The ETS would reduce emissions by 12% as compared to a No-Carbon-Pricing Scenario in 2035.[366] In this scenario, CO_2 emissions from electricity generation gradually decrease after 2025, but are still higher than 2020 levels in 2035. This amounts to 570 million metric tons of CO_2, which is 136% of California's total CO_2 emissions in 2019.[367] Under this scenario, power sector emissions remain above 4,000 MMTCO_2e in 2035 with only 25 years more to reach carbon neutrality in 2060.

The reductions in this scenario would be achieved primarily through shifting electricity production toward more efficient ultra-supercritical coal-fired power plants, and by expanding the deployment of carbon capture, utilization, and storage (CCUS). It would do little to encourage fuel-switching away from coal. Note that even this level of impact assumes several reforms that are by no means certain, including gradually tightening benchmarks and the use of economic (least cost) dispatch for the electricity grid after 2025.

The addition of auctioning would impose greater cost on coal- and gas-powered plants and accelerate emissions reductions, including through greater fuel switching to non-fossil technologies and natural gas.[368] Such a move would reduce emissions an additional 1% (about 500 Mt CO_2) in 2035, allow electricity system CO_2 emissions to fall below 2020 levels by 2035, and generate substantial revenue (up to $99 billion in 2035 by IEA/Tsinghua estimates).

The IEA/Tsinghua study is in line with several concerns and conclusions raised by our analysis.

- **Ambition.** Current ETS design is modest in environmental ambition, encouraging efficiency improvements in different categories of coal and gas plants, but creating little incentive for fuel switching. The ETS would also encourage the development of carbon capture, utilization & sequestration (CCUS), although additional policies would be needed to support CCUS development.

- **Adverse Incentives.** The implicit output subsidy inherent in the TPS-based ETS design may incentivize further construction of more efficient (ultra-supercritical) coal-fired power plants and contribute to greater GHG emissions and stranded assets problems in the near future.

366 IEA & Tsinghua Univ., *supra* note 24, at 10-11. The No-Carbon-Pricing Scenario incorporates "no specific policies to control CO_2 emissions (*i.e.*, neither an ETS nor command-and-control policies such as emissions caps or energy consumption standards)". *Id.* at 9. The modeling here isolates the effect of the ETS as compared to no CO_2 emissions policies and does not offer a comparison among CO_2 regulatory measures. The IEA and Tsinghua University released a second report on Chinese emissions trading as this report went to press. We do not consider the analysis in that second report here. *See* IEA & Tsinghua Univ., Enhancing China's ETS for Carbon Neutrality: Focus on Power Sector (2022), https://www.iea.org/reports/enhancing-chinas-ets-for-carbon-neutrality-focus-on-power-sector.

367 *Current California GHG Emission Inventory Data*, CARB (last visited Apr. 11, 2022), https://ww2.arb.ca.gov/ghg-inventory-data.

368 IEA & Tsinghua Univ., *supra* note 24, at 14-15. The ETS Auctioning Scenario assumes that auctions are adjusted in 2025 (10% of allowances auctioned, then 30% in 2030 and 50% in 2035). *Id.* at 10.

- **Auctions.** The reduction of free allowances and the auctioning of some portion of allowances to covered entities would raise the effective carbon cost faced by emitters, improve incentives to fuel switch to lower- or no-carbon fuels, and generate substantial revenue that can be used for environmental, economic, or social projects, building political stakeholder support for climate policy.[369]

K | Preliminary Data on the First ETS Compliance Period

The first compliance period for the Chinese ETS closed on December 31, 2021 with 99.5% of the 2,162 covered companies meeting their compliance deadlines.[370] Between ETS launch on July 16, 2021 and December 31, 2021, 179 million allowances traded on the market with the vast majority transacting in December (135.5 million). The total value of trades was 7.6671 billion RMB ($1.2 billion). The market price on the last day of 2021 was 54.22 RMB and the weighted average price of allowances during 2021 was 43.85 RMB.

The environmental ministry did not disclose how many permits were allocated for 2019 and 2020, but analysts have estimated an overallocation of 160-184 million allowances per year.[371] Use of carbon offsets (China's Certified Emissions Reductions or CCERs) are believed to have contributed to the surplus as 32.73 million tonnes of CCERs were surrendered for compliance purposes.[372] Although earlier reports had predicted allowance benchmark tightening of 4-5%, a January 2022 environmental ministry proposal offered possible reductions in the range of 0.5%, 0.8% or 1% below 2020 levels for 2021 emissions.[373]

Reports suggest that much of the oversupply is not sold at market, with companies holding allowances for future compliance/planning purposes and in anticipation of higher future prices. The five large state-owned power companies have apparently been reluctant to sell and are using allowance surpluses as part of an internal company accounting. That is, allowance surpluses from more efficient coal-fired power plants could be used to subsidize less efficient plants within a power company's portfolio.

369 At the same time, under the assumptions of the model fuel switching remains relatively modest by 2035. "Compared with free allowance allocation, auctioning would double gas-fired generation in 2035 and increase generation from wind (by 10%) and solar (by over 40%)." *Id.* at 14.

370 Stian Reklev, *CN Markets: Most Chinese Companies Meet ETS Deadline Amid Late Price Spike*, Carbon Pulse (Jan. 4, 2022), https://carbon-pulse.com/147588/.

371 Jiefei Liu & Stian Reklev, *Analysts Tip China ETS to Face Permit Shortage as Tighter Settings Loom*, Carbon Pulse (Dec. 22, 2021), https://carbon-pulse.com/147333/; Jiefei Liu & Stian Reklev, *Analysts See Room for Rising Prices in China ETS*, Carbon Pulse (Jan. 10, 2022), https://carbon-pulse.com/147976/.

372 Newsletter, Refinitiv Commodities Rsch., Media Advisory: China National Carbon Market Finished Debut Year 2021 with Upbeat Results (Jan. 4, 2022) (on file with author).

373 *Ministry Proposes Minor Cut in China ETS Allocation*, Carbon Pulse (Jan. 6, 2022), https://carbon-pulse.com/147749/.

III | RECOMMENDATIONS

This report has emphasized the need for greater environmental ambition and integrity of emissions reductions, as well as the expansion of economic and political resources in support of climate change policy. We emphasize continuous reform, careful attention to adverse consequences of system design (doing no harm), and a commitment to a broad-based portfolio approach to climate regulation to ensure implementation in practice.

As for specific reforms, Chinese policymakers will need to consider, among other things: a cap on emissions, elimination of multiple categories of performance benchmarks, and auctioning of allowances to strengthen the environmental effects of the ETS. Revenues from auctioning could be used to mitigate economic impact of the ETS. A regular process for reviewing climate ambition – such as through climate planning updates processes such as California's mandated Scoping Plan updates every five years, an independent advisory commission like California's Independent Emissions Market Advisory Committee, or public hearing processes – can help to ensure that weaknesses in design do not persist.

An assessment of China's national ETS also highlights the need for reform in other parts of China's regulatory system. For example, China must limit the continued approval and development of coal-fired power plants, and the effectiveness of carbon trading in the power sector will depend on reforms to grid dispatch policies and greater cross-province grid integration.

ETS Reforms

- Tighten benchmarks and reduce the number of benchmarks, make the trajectory clear well in advance (visibility, certainty, management and investment decisions);
- Move from tradeable performance standard (rate-based) to absolute cap (mass-based) with declining limits over time;
- Move to auctioning, reduce free allocations;
- Reform the system to create incentives for fuel switching (to non-fossil fuels);
- Create an environmental and/or social fund for auction proceeds (for environmental projects, economic and jobs transition);
- Strengthen protocols for offset integrity;
- Optimize banking policies (to reduce negative impact on ambition);
- Create a continually updating/increasing price floor;
- Monitoring, reporting, verification, including transparency aimed at accountability and improved performance, process-specific emissions formulas, etc.;
- Carefully expand market coverage to maintain ambition and integrity;
- Further research on role of derivatives and financial instruments in carbon markets;
- Be cautious about adverse policy compromises.

Other Reforms

- Grid reforms – improve dispatch (least cost/economic dispatch), regional integration, resource flexibility;
- Prohibit new coal power plants;
- Use ETS to provide subsidy for non-fossil energy development;
- Coordinate with other policies.

BIBLIOGRAPHY

Anderegg, W., et al. (2020, November 5). Letter to Gavin McCabe. https://www.arb.ca.gov/lists/com-attach/18-ab398offsetreport-ws-VjVTNFAjBTQAWVA2.pdf.

Anderson, R.C. & Morgenstern, R.D. (2011, June 15). Marginal Abatement Cost Estimates for Non-CO2 Greenhouse Gases: Lessons from RECLAIM, *Climate Policy*, 9(1), 40. https://doi.org/10.3763/cpol.2008.0398.

Bay Area Air Quality Management District (BAAQMD). (2019, August 9). *Regulation 12 Rule 16: Petroleum Refining Greenhouse Gas Emissions Limits*. https://www.baaqmd.gov/rules-and-compliance/rules/regulation-12-rule-16-petroleum-refining-greenhouse-gas-emissions-limits.

Becker, R. (2021, February 18). California Says It Will Review Cap-and-Trade Amid Growing Criticism, *CalMatters*. https://www.kqed.org/science/1972789/california-says-it-will-review-cap-and-trade-amid-growing-criticism.

Berkeley Law. *California Climate Policy Dashboard*. https://www.law.berkeley.edu/research/clee/research/climate/climate-policy-dashboard/.

Borenstein, S., et al. (2014, July). Report of the Market Simulation Group on Competitive Supply/Demand Balance in the California Allowance Market and the Potential for Market Manipulation, *Energy Institute at Haas*. http://www.ourenergypolicy.org/wp-content/uploads/2014/07/HAAS.pdf.

Boyd, W. (2021, June 2). The Poverty of Theory: Public Problems, Instrument Choice, and the Climate Emergency, *Columbia Journal of Environmental Law*, 46(2), 399. https://journals.library.columbia.edu/index.php/cjel/article/view/8401/4300.

Burtraw, D., et al., (2020, December 30). A*nnual Report of the Independent Emissions Market Advisory Committee*. https://calepa.ca.gov/wp-content/uploads/sites/6/2021/01/2020-ANNUAL-REPORT-OF-THE-INDEPENDENT-EMISSIONS-MARKET-ADVISORY-COMMITTEE_FINAL_a.pdf.

Busch, C. (2017, December). Oversupply Grows in the Western Climate Initiative Carbon Market, *Energy Innovation: Policy and Technology LLC*. https://energyinnovation.org/wp-content/uploads/2018/02/WCI-oversupply-grows-February-update.pdf.

California Air Resources Board (CARB). (2010, December 16). *Cap and Trade 2010*. https://ww3.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm.

CARB. (2010). *Proposed Regulation to Implement the California Cap-and-Trade Program: Initial Statement of Reasons Appendix J*. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/capandtrade10/capv4appj.pdf.

CARB. (2010). *Proposed Regulation to Implement the California Cap-and-Trade Program: Initial Statement of Reasons Appendix K*. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/capandtrade10/capv4appk.pdf.

CARB. (2011, October). *California's Cap-and-Trade Program: Final Statement of Reasons*. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/capandtrade10/fsor.pdf.

CARB. (2011, December 22). *Cap and Trade 2010*. https://ww3.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm.

CARB. (2012). *Final Regulation Order: Subchapter 10 Climate Change, Article 5, Sections 95800 to 96023*. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2010/capandtrade10/finalrevfro.pdf?_ga=2.188658344.1298492686.1637032871-1158618940.1627694642.

CARB. (2013). *Final Regulaton [sic] Order California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms*. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2013/capandtrade13/ctreg.pdf?_ga=2.17800889.1298492686.1637032871-1158618940.1627694642.

CARB. (2014). *First Update to the Climate Change Scoping Plan*. https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf.

CARB. (2015, June 25). *Compliance Offset Protocol US Forest Projects*. https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/protocols/usforest/forestprotocol2015.pdf.

CARB. (2015, September 2). *Overview of ARB Emissions Trading Program*. https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/guidance/cap_trade_overview.pdf.

CARB. (2017, November). *California's 2017 Climate Change Scoping Plan*. https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf.

CARB. (2018, September 4). *Initial Statement of Reasons: Proposed Amendments to the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation Appx. D*. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/capandtrade18/ct18398.pdf?_ga=2.65568110.1719232368.1634231775-1158618940.1627694642#page=7.

CARB. (2018, September 28). *AB 32 Global Warming Solutions Act of 2006*. https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006.

CARB. (2018, December 13). *Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Responses: Public Hearing to Consider the Amendments to the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms*. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/capandtrade18/ct18fsor.pdf?_ga=2.131692361.73140785.1642018425-1158618940.1627694642.

CARB. (2019, March 29). *Proposed Amendments to the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation*. https://ww2.arb.ca.gov/rulemaking/2018/california-cap-greenhouse-gas-emissions-and-market-based-compliance-mechanisms.

CARB. (2019, May 30). *US Forest Offset Projects*. https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/offsets/overview.pdf.

CARB. (2020, February). *Cap-and-Trade Program: Summary of 2013-2018 Electrical Distribution Utility Allocated Allowance Value Usage*. https://ww2.arb.ca.gov/sites/default/files/classic//cc/capandtrade/allowanceallocation/edu2013-2018useofvaluereport.pdf.

CARB. (2020, February). *Review of Potential for Resource Shuffling in the Electricity Sector*. https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/guidance/resource_shuffling_faq.pdf.

CARB. (2020). *2015-2017 Compliance Report*. https://www.arb.ca.gov/cc/capandtrade/2015-2017compliancereport.xlsx.

CARB. (2020). *Data used to generate figures in the California Greenhouse Gas Emissions for 2000 to 2019 - Trends of Emissions and Other Indicators report*. https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2019/2000_2019_ghg_inventory_trends_figures.xlsx.

CARB. (2020, December 4). *Cap-and-Trade Program Vintage 2021 Allowance Allocation Summary*. https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/v2021allocation.pdf?_ga=2.229837404.1361840485.1634867930-1158618940.1627694642.

CARB. (2021). *2000-2019 GHG Emissions Trends Report Data*. https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2019/2000_2019_ghg_inventory_trends_figures.xlsx.

CARB. (2021). *ARB Offset Credit Issuance Table*. https://ww3.arb.ca.gov/cc/capandtrade/offsets/issuance/arboc_issuance.xlsx.

CARB. (2021) *Cap-and-Trade Program: Frequently Asked Questions*. https://ww2.arb.ca.gov/sites/default/files/2021-05/nc-FAQ_CT_Jan2021.pdf.

CARB. (2021, February). *Cap-and-Trade Program Summary of 2013-2019 Electrical Distribution Utility Allocated Allowance Value Usage*. https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/edu_2013to2019useofvaluereport.pdf.

CARB. (2021, February). *Cap-and-Trade Program Summary of 2015-2019 Natural Gas Supplier Allocated Allowance Value Usage*. https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/ngs_2015to2019useofvaluereport.pdf.

CARB. (2021, May). *Identification of Low-Income Communities under AB 1550 Methodology and Documentation for Maps*. https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/kml/ab1550_maps_documentation.pdf.

CARB. (2021, July 28). *California Greenhouse Gas Emissions for 2000 to 2019*. https://ww2.arb.ca.gov/sites/default/files/classic/cc/ghg_inventory_trends_00-19.pdf.

CARB. (2021, July 28). *Latest State Greenhouse Gas Inventory Shows Emissions Continue to Drop Below 2020 Target*. https://ww2.arb.ca.gov/news/latest-state-greenhouse-gas-inventory-shows-emissions-continue-drop-below-2020-target.

CARB. (2021, August). *California Climate Investments 2021 Mid-Year Data Update*. https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/cci_2021mydu_cumulativeoutcomessummarytable.pdf.

CARB. (2021, Oct. 27). *California's Compliance Offset Program*. https://ww2.arb.ca.gov/sites/default/files/2021-10/nc-forest_offset_faq_20211027.pdf.

CARB. (2021, December 1). *California Cap-and-Trade Program and Québec Cap-and-Trade System 2022 Annual Auction Reserve Price Notice*. https://ww2.arb.ca.gov/sites/default/files/2021-12/nc-2022_annual_reserve_price_notice_joint_auction.pdf.

CARB. (2021, December 3). *Cap-and-Trade Program Vintage 2022 Allowance Allocation Summary*. https://ww2.arb.ca.gov/sites/default/files/2021-12/nc-v2022%20Public%20Allocation%20Summary.pdf.

CARB. (2022). *Scoping Plan Update*. https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf.

CARB. (2022, February). *California Cap-And-Trade Program Summary of California-Quebec Joint Auction Settlement Prices and Results*. https://ww2.arb.ca.gov/sites/default/files/2020-08/results_summary.pdf.

CARB. (2022, March). *California Cap-And-Trade Program Summary of Proceeds to California and Consigning Entities*. https://ww2.arb.ca.gov/sites/default/files/2020-09/proceeds_summary.pdf.

CARB. (2022, March 16). *California and Québec Carbon Allowance Prices*. http://ww2.arb.ca.gov/sites/default/files/cap-and-trade/carbonallowanceprices.pdf.

CARB. (2022, April 1). *2000–2019 GHG Emissions Trends Report Data*. https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/2000_2019_ghg_inventory_trends_figures_04-01.xlsx.

CARB. *Allowance Allocation*. https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/allowance-allocation.

CARB. *Auction Notices and Reports*. https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/auction-information/auction-notices-and-reports.

CARB. *Current California GHG Emission Inventory Data*. https://ww2.arb.ca.gov/ghg-inventory-data.

CARB. *Compliance Offset Program*. https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program.

CARB. *Direct Environmental Benefits in the State* (*DEBS*). https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/direct-environmental-benefits.

CARB. *Mandatory Greenhouse Gas Reporting Regulation*. http://file.lacounty.gov/SDSInter/lac/1033324_PRAContacts.pdf.

CARB. *Market Monitoring*. https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/market-monitoring.

CARB. *Pricing Ceiling Information*. https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/cost-containment-information/price-ceiling-information.

CARB. *Problem Linkage*. https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/program-linkage.

CARB. *Submit Public Comments to CARB*. https://ww2.arb.ca.gov/applications/public-comments.

CARB. *US Forest Projects – June 25, 2015*. https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/compliance-offset-protocols/us-forest-projects/2015.

California Climate Investments (CCI). (2020, March). *Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds*. https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/2020_cci_annual_report.pdf.

CCI. (2021, April). *Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds*. http://ww2.arb.ca.gov/sites/default/files/auction-proceeds/2021_cci_annual_report.pdf.

California Department of Housing and Community Development. (2021, December). *Revised State Income Limits for 2021*. https://www.hcd.ca.gov/grants-funding/income-limits/state-and-federal-income-limits/docs/income-limits-2021.pdf.

California Energy Commission. (2018, October). *Tracking Progress*. https://www.energy.ca.gov/sites/default/files/2019-12/declining_reliance_coal_ada.pdf.

California Environmental Protection Agency. (2017, April). *Designation of Disadvantaged Communities Pursuant to Senate Bill 535 (De León)*. https://calepa.ca.gov/wp-content/uploads/sites/6/2017/04/SB-535-Designation-Final.pdf.

(California) Legislative Analyst's Office (LAO). (2017, June 26). Letter to the Honorable Cristina Garcia. https://lao.ca.gov/letters/2017/Garcia-cap-and-trade-062617.pdf.

LAO. (2017, December). *Cap-and-Trade Extension: Issues for Legislative Oversight*. https://lao.ca.gov/reports/2017/3719/cap-trade-extension-121217.pdf.

LAO. (2020, January). *Assessing California's Climate Policies – Electricity Generation*. https://lao.ca.gov/reports/2020/4131/climate-policies-electricity-010320.pdf.

LAO. (2021, December). *Cap-And-Trade Auction Update and GGRF Projections*. https://lao.ca.gov/reports/2021/4480/cap-and-trade-120621.pdf.

Cama, T. (2021, August 12). API Supports Carbon Pricing, but Its Allies Remain Skeptical, *E&E News*. https://www.eenews.net/articles/api-supports-carbon-pricing-but-its-allies-remain-skeptical/.

Cart, J. (2018, May 22). Checking the Math on Cap and Trade, Some Experts Say It's Not Adding Up, *CalMatters*. https://calmatters.org/environment/2018/05/checking-the-math-on-cap-and-trade-some-experts-say-its-not-adding-up/.

Carbon Pricing Leadership Coalition. (2017). *Report of the High-Level Commission on Carbon Prices*. https://www.carbonpricingleadership.org/report-of-the-heghlevel-commission-on-carbon-prices.

Carbon Pulse. (2022, January 6). Ministry Proposes Minor Cut in China ETS Allocation. https://carbon-pulse.com/147749/.

Carlson, C., et al. (2000). Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?, *Journal of Political Economy*, 108(6), 1292. https://www.econ.umd.edu/sites/www.econ.umd.edu/files/pubs/jc44.pdf.

Center for Climate and Energy Solutions. (2017, August). Summary of California's Extension of Its Cap-And-Trade Program, *Center for Climate and Energy Solutions*. https://www.c2es.org/wp-content/uploads/2017/09/summary-californias-extension-its-cap-trade-program.pdf.

Chestney, N. (2021, April 20). EU carbon price hits record high above 45 euros a tonne, *Reuters*. https://www.reuters.com/business/energy/eu-carbon-price-hits-record-high-above-45-euros-tonne-2021-04-20/.

(China) Ministry of Ecology and Environment (MEE). (2019, September). 2019 Electricity Sector Major Emitting Units (incl. self-use, combined heat and power) Carbon Dioxide Emissions Quota Allocation Implementation Plan (draft) (2019年发电行业重点排放单位(含自备电厂, 热电联产) 二氧化碳排放配额分配实施方案(试算版)). https://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/201909/W020190930789281533906.pdf.

MEE. (2020, December). Administrative Measures for Carbon Emission Trading (trial) (碳排放权交易管理办法(试行)). https://www.mee.gov.cn/xxgk2018/xxgk/xxgk02/202101/t20210105_816131.html.

MEE. (2020, December). 2019-2020 National Carbon Emissions Trading Total Quota Setting and Allocation Implementation Plan (Power Sector) (comment draft) (2019-2020年全国碳排放权交易配额总量设定与分配实施方案(发电行业)(征求意见稿)).

MEE. (2020, December). Major Emitting Units Name List for 2019-2020 National Emissions Trading System Quota Management (纳入2019-2020年全国碳排放权交易配额管理的重点排放单位名单). https://www.mee.gov.cn/xxgk2018/xxgk/xxgk03/202012/W020201230736907682380.pdf.

MEE. (2021, March 29). MEE Guidelines for Enterprise Greenhouse Gas Verification (trial) (企业温室气体排放报告核查指南(试行)). https://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/202103/t20210329_826480.html.

MEE. (2021, March 29). Notice on Strengthening Tasks Relating to Reporting and Management of Greenhouse Gas Emission of Enterprises (关于加强企业温室气体排放报告管理相关工作的通知 环办气候〔2021〕9号). https://www.mee.gov.cn/xxgk2018/xxgk/xxgk05/202103/t20210330_826728.html.

MEE. (2021, May 17). Notice on Issuing Administrative Measures for the Registration, Trading, and Settlement of the National Carbon Emission Rights (关于发布《碳排放权登记管理规则(试行)》《碳排放权交易管理规则(试行)》和《碳排放权结算管理规则(试行)》的公告). https://www.mee.gov.cn/xxgk2018/xxgk/xxgk01/202105/t20210519_833574.html.

MEE. (2021, September 18). Response to the No.9145 Suggestion on the Fourth Session of the 13th National People's Congress (对十三届全国人大四次会议第9145号建议的答复). https://www.mee.gov.cn/xxgk2018/xxgk/xxgk13/202112/t20211206_963196_wh.html.

(China) National Center for Climate Change Strategy and International Cooperation (NCSC). (2011, October 29). Notice by NDRC on Commencing Subnational Emissions Trading Pilots (国家发展改革委办公厅关于开展碳排放权交易试点工作的通知 发改办气候 [2011] 2601号). http://www.ncsc.org.cn/SY/tpfqjy/202003/t20200319_769725.shtml.

(China) National Development and Reform Commission (NDRC). (2014, December 10). Interim Measures on National ETS (碳排放权交易管理暂行办法 中华人民共和国国家发展和改革委员会令 第17号). http://www.gov.cn/gongbao/content/2015/content_2818456.htm.

NDRC. (2017, December 18). NDRC Work Plan for the Construction of the National ETS (Power Sector) (国家发展改革委关于印发《全国碳排放权交易市场建设方案(发电行业)》的通知 发改气候规〔2017〕2191号). https://www.ndrc.gov.cn/xxgk/zcfb/ghxwj/201712/t20171220_960930.html?code=&state=123.

(China) State Council (SC). (2011, December 1). State Council's Notice on Issuing "12th Five-Year" Work Plan of Controlling Greenhouse Gas Emission (国务院关于印发"十二五"控制温室气体排放工作方案的通知 国发〔2011〕41号). http://www.gov.cn/zwgk/2012-01/13/content_2043645.htm.

SC. (2013, January 1). State Council's Notice on Issuing "12th Five-Year" Work Plan of Energy Development (国务院关于印发能源发展"十二五"规划的通知 国发〔2013〕2号). http://www.gov.cn/zwgk/2013-01/23/content_2318554.htm.

SC. (2016, October 27). State Council's Notice on Issuing "13th Five-Year" Work Plan of Controlling Greenhouse Gas Emission (国务院关于印发"十三五"控制温室气体排放工作方案的通知 国发〔2016〕61号). http://www.gov.cn/zhengce/content/2016-11/04/content_5128619.htm.

SC. (2021, July 14). State Council's Routine Policy Briefing (国务院政策例行吹风会). http://www.gov.cn/xinwen/2021zccfh/30/index.htm.

CPUC. (2015, October). *Decision Adopting Procedures Necessary for Natural Gas Corporations to Comply with the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms (Cap-and-Trade Program)*. http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M155/K330/155330024.PDF.

CPUC. (2020, February). *Cap-and-Trade Program Summary of 2013-2018 Electrical Distribution Utility Allocated Allowance Value Usage*. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M040/K631/40631611.pdf.

CPUC. (2020, March). *Decision Establishing Building Decarbonization Pilot Programs*. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF.

Cullenward, D. (2014, November). Leakage in California's Carbon Market, *Electricity Journal*, 27(9), 36. https://www.sciencedirect.com/science/article/abs/pii/S1040619014002164.

Cullenward, D. & Coghlan, A. (2016, June). Structural Oversupply and Credibility in California's Carbon Market, *The Electricity Journal*, 29(5), 7. https://www.sciencedirect.com/science/article/abs/pii/S1040619016300707.

Cullenward, D. & Victor, D. (2020, December) Making Climate Policy Work, *Polity*.

Cushing, L., et al. (2015, October 9). Racial/Ethnic Disparities in Cumulative Environmental Health Impacts in California: Evidence from a Statewide Environmental Justice Screening Tool (CalEnviroScreen 1.1), *American Journal of Public Health*, 105(11), 2341. https://ajph.aphapublications.org/doi/10.2105/AJPH.2015.302643?url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org&rfr_dat=cr_pub++0pubmed.

Cushing, L., et al. (2018, July 10). Carbon Trading, Co-Pollutants, And Environmental Equity: Evidence from California's Cap-and-Trade Program (2011-2015), *PLOS Medicine*, 15(7). https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002604.

Detterman, B.J. & Gruver, K.K. (2020, September 22). Wildfires Burn Carbon Offsets, *National Law Review*. https://www.natlawreview.com/article/wildfires-burn-carbon-offsets.

Dlouhy, J.A. & Kaufman, L. (2021, March 4). How the Oil Lobby Learned to Love Carbon Taxes, *Bloomberg Green*. https://www.bloomberg.com/news/articles/2021-03-04/how-the-oil-lobby-learned-to-love-carbon-taxes.

Drury, R.T., et al. (1999). Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy, *Duke Environmental Law & Policy Forum*, 9(2), 231. https://scholarship.law.duke.edu/delpf/vol9/iss2/5.

Eden, A., et al. (2018, July 16). *Benefits of Emissions Trading: Taking Stock of the Impacts of Emissions Trading Systems Worldwide, International Carbon Action Partnership (ICAP)*. https://icapcarbonaction.com/en/publications/benefits-emissions-trading-taking-stock-impacts-ets-worldwide.

Environmental Defense Fund. (2020, July 24). *The Status of China's Voluntary Carbon Market*. https://www.edf.org/climate/status-chinas-voluntary-carbon-market.

Electric Power Research Institute. (2013, April). *Exploring the Interaction Between California's Greenhouse Gas Emissions Cap-and-Trade Program and Complementary Emissions Reduction Policies Background Paper*. https://eea.epri.com/pdf/ghg-offset-policy-dialogue/workshop14/EPRI-IETA-Joint-Symposium_Complementary-Policies_041613__Background-Paper_FinalPosted.pdf.

Environmental Commissioner of Ontario. (2018). *Ontario's Climate Act: From Plan to Progress – Appendix G: Technical Aspects of Oversupply In The WCI Market*. https://www.auditor.on.ca/en/content/reporttopics/envother/env17_other/From-Plan-to-Progress-Appendix-G.pdf.

European Commission. *European Climate Law.* https://ec.europa.eu/clima/eu-action/european-green-deal/european-climate-law_en.

Evans, S., et al. (2021, November 15). *COP26: Key Outcomes Agreed at the UN Climate Talks in Glasgow.* https://www.carbonbrief.org/cop26-key-outcomes-agreed-at-the-un-climate-talks-in-glasgow.

Fowlie, M., Holland, S.P. & Mansur, E.T. (2012). What Do Emissions Markets Deliver and to Whom? Evidence from Southern California's NO_x Trading Program, *American Economic Review*, 102(2), 965. https://faculty.tuck.dartmouth.edu/images/uploads/faculty/erin-mansur/mansur_emissions_markets.pdf.

Gorman, H.S. & Solomon, B.D. (2002, July). The Origins and Practice of Emissions Trading, *Journal of Policy History*, 14(3), 293. https://doi.org/10.1353/jph.2002.0015.

Goulder, L.H., Long, X., Lu, J. & Morgenstern, R.D. (2020, January 14). China's Unconventional Nationwide CO_2 Emissions Trading System: The Wide-Ranging Impacts of an Implicit Output Subsidy, *Resources for the Future*. https://www.rff.org/publications/working-papers/chinas-unconventional-nationwide-co2-emissions-trading-system/.

Grainger, C. & Ruangmas, T. (2018, November). Who Wins from Emissions Trading? Evidence from California, *Environmental & Resource Economics*, 71(3), 703.

Green, J.F. (2021, March 24). Does Carbon Pricing Reduce Emissions? A Review of Ex-Post Analyses, *Environmental Research Letters*, 16(4). https://iopscience.iop.org/article/10.1088/1748-9326/abdae9.

Haya, B. (2019, May 7). Policy Brief: The California Air Resources Board's US Forest Offset Protocol Underestimates Leakage, *Berkeley Public Policy*. https://gspp.berkeley.edu/assets/uploads/research/pdf/Policy_Brief-US_Forest_Projects-Leakage-Haya_4.pdf.

Haya, B., et al. (2020, June 29). Managing Uncertainty in Carbon Offsets: Insights from California's Standardized Approach, *Climate Policy*, 20(9), 1112. https://gspp.berkeley.edu/assets/uploads/research/pdf/Policy_Brief-US_Forest_Projects-Leakage-Haya_4.pdf.

Hernandez-Cortes, D. & Meng, K.C. (2020, May). Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market, *National Bureau of Economic Research Working Paper*. https://www.nber.org/system/files/working_papers/w27205/w27205.pdf.

Independent Emissions Market Advisory Committee (IEMAC). (2020, December 30). *2020 Annual Report of the Independent Emissions Market Advisory Committee*. https://calepa.ca.gov/wp-content/uploads/sites/6/2021/01/2020-ANNUAL-REPORT-OF-THE-INDEPENDENT-EMISSIONS-MARKET-ADVISORY-COMMITTEE_FINAL_a.pdf.

IEMAC. (2022, January 20). *2021 Annual Report of The Independent Emissions Market Advisory Committee*. https://calepa.ca.gov/wp-content/uploads/sites/6/2022/01/2021-IEMAC-Annual-Report.a.pdf.

Intercontinental Exchange (IEC). *All Futures, Options, OTC Products & Physicals*. https://www.theice.com/products/?filter=california%20carbon%20allowance.

ICE. *ICE Futures US: Regulation*. https://www.theice.com/futures-us/regulation.

ICAP. (2021, March 29). *Emissions Trading Worldwide: 2021 ICAP Status Report*. https://icapcarbonaction.com/en/publications/emissions-trading-worldwide-icap-status-report-2021.

ICAP. (2022, March 29). *Emissions Trading Worldwide: 2022 ICAP Status Report*. https://icapcarbonaction.com/en/publications/emissions-trading-worldwide-2022-icap-status-report.

International Energy Agency. (2020, June). *China's Emission Trading Scheme: Designing Efficient Allowance Allocation*. https://www.iea.org/reports/chinas-emissions-trading-scheme.

International Energy Agency & Tsinghua University. (2021, April). *The Role of China's ETS in Power Sector Decarbonisation*. https://www.iea.org/reports/the-role-of-chinas-ets-in-power-sector-decarbonisation.

Intergovernmental Panel on Climate Change (IPCC). (2018). *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. https://www.ipcc.ch/sr15/.

Jenkins, J.D. (2014, June). Political Economy Constraints on Carbon Pricing Policies: What are the Implications for Economic Efficiency, Environmental Efficacy, and Climate Policy Design, *Energy Policy,* 69(C), 467. https://www.sciencedirect.com/science/article/abs/pii/S0301421514000901.

Jenkins, J.D. & Karplus, V.J. (2016, April). Carbon pricing under binding political constraints, *United Nations University World Institute for Development Economics Research*. https://www.wider.unu.edu/sites/default/files/wp2016-44.pdf.

Jin, M., et al. (2016). Analysis of the Current Status and Problems of the Carbon Emission Trading Pilots in China, *Environmental Protection Science.,* 42(3), 134.

Kamal, S. (2022, January 3). The California Legislature is Back: What to Expect in 2022, *CalMatters*. https://calmatters.org/politics/2022/01/california-legislature-what-to-expect-in-2022/.

Keohane, N.O. (2003, October 13). What Did the Market Buy? Cost Savings under the US Tradeable Permits Program for Sulfur Dioxide, *Yale Center for Environmental Law and Policy Working Paper*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=465320.

Kerr, S. & Newell, R.G. (2018, August 9). Policy-Induced Technology Adoption: Evidence from the US Lead Phasedown, *Controlling Automobile Air Pollution*, *Virginia McConnell*.

Lejano, R.P. & Hirose, R. (2005, August). Testing the Assumptions Behind Emissions Trading in Non-market Goods: The RECLAIM Program in Southern California, *Environmental Science & Policy*, 8(4), 367. https://www.sciencedirect.com/science/article/abs/pii/S1462901105000559.

Liu, J. & Reklev, S. (2021, December 22). Analysts Tip China ETS to Face Permit Shortage as Tighter Settings Loom, *Carbon Pulse*. https://carbon-pulse.com/147333/.

Liu, J. & Reklev. S., (Jan. 10, 2022). Analysts See Room for Rising Prices in China ETS, *Carbon Pulse*. https://carbon-pulse.com/147976/.

Liu, X., et al. (2018). Study on EU ETS MRV System and the Enlightenments for China, *Forum of Science and Technology in China,* 8, 164.

Mann, M.E. (2021, January 12). The New Climate War: The Fight to Take Back Our Planet, *PublicAffairs*.

Mansur, E.T. & Sheriff, G. (2019, March). Do Pollution Markets Harm Low Income and Minority Communities? Ranking Emissions Distributions Generated by California's RECLAIM Program*, National Bureau of Economic Research*. https://www.nber.org/system/files/working_papers/w25666/w25666.pdf.

Martin, G. & Saikawa, E. (2017, December). Effectiveness of State Climate and Energy Policies in Reducing Power-Sector CO_2 Emissions, *Nature Climate Change*, 7, 912. https://www.nature.com/articles/s41558-017-0001-0.pdf?origin=ppub.

Mildernberger, M. (2020, February). Carbon Captured: How Business and Labor Control Climate Politics, *MIT Press*.

Meckling, J. (2011, August). Carbon Coalitions: Business, Climate Politics, and the Rise of Emissions Trading, *MIT Press*.

National People's Congress of the People's Republic of China (NPC). (2011, March 16). 12th Five-Year Plan (2011-2015) for National Economic and Social Development (中华人民共和国国民经济和社会发展第十二个五年规划纲要). http://www.gov.cn/2011lh/content_1825838.htm.

NewClimate Institute. (2020, October 22). *Navigating the Nuances of Net-zero Targets*. https://newclimate.org/2020/10/22/navigating-the-nuances-of-net-zero-targets/.

Newell, R.G. & Rogers, K. (2003, June). The US Experience with the Phasedown of Lead in Gasoline, *Resources for the Future*. https://web.mit.edu/ckolstad/www/Newell.pdf.

Nova Scotia. (2018, May 14). *Nova Scotia Joins Western Climate Initiative Inc*. https://novascotia.ca/news/release/?id=20180514001.

Pan, J. (2016). Construction, Challenges and Market Expansion of Emission Trading System, *Chinese Journal of Population, Resources and Environment*, 26(8), 1.

Pontecorvo, E. & Osaka, S. (2021, October 27). California Is Banking on Forests to Reduce Emissions. What Happens When They Go Up in Smoke?, *Grist*. https://grist.org/wildfires/california-forests-carbon-offsets-reduce-emissions/.

Powell, L. (2011, November 23). The Western Climate Initiative is dead, long live the WCI, *Lexology*. https://www.lexology.com/library/detail.aspx?g=16aa30c5-63ab-406c-a3f7-100b3eaae557.

Rabe, B.G., (2018). Can We Price Carbon? *MIT Press*.

Refinitiv Commodities Research. (2020, December 1). *China Coal Plants Likely Face Considerably Stricter Benchmarks in ETS in 2022, under the New Coal Retrofitting Rules by State Planner*.

Refinitiv Commodities Research. (2022, January 4). *Media Advisory: China National Carbon Market Finished Debut Year 2021 with Upbeat Results*.

Reklev, S. (2022, January 4). CN Markets: Most Chinese Companies Meet ETS Deadline Amid Late Price Spike, *Carbon Pulse*. https://carbon-pulse.com/147588/.

Reklev, S. & Liu, J. (2022, January 10). China's CNOOC Reaps Windfall Profits from ETS Natural Gas Arrangements, *Carbon Pulse*. https://carbon-pulse.com/147999/.

Reklev, S. & Liu, J. (2022, January 10). *Analysts See Room for Rising Prices in China ETS, Carbon Pulse*. https://carbon-pulse.com/147976/.

Roberts, D. (2018, December 13). California's Cap-and-Trade System May be Too Weak to Do Its Job, *Vox*. https://www.vox.com/energy-and-environment/2018/12/12/18090844/california-climate-cap-and-trade-jerry-brown.

Sanders R. (2018). California's Cap-and-Trade air Quality Benefits go Mostly out of State, *Berkeley News*. https://news.berkeley.edu/2018/07/10/californias-cap-and-trade-air-quality-benefits-go-mostly-out-of-state/.

Schmalensee, R. & Stavins, R.N. (2013). The SO_2 Allowance Trading System: The Ironic History of a Grand Policy Experiment, *Journal of Economic Perspectives,* 27(1), 103. https://www.aeaweb.org/articles?id=10.1257/jep.27.1.103.

South Coast Air Quality Management District (SCAQMD). (1994, January 31). *RECLAIM: Program Summary EX-17 to EX-18*. https://www.aqmd.gov/docs/default-source/reclaim/reclaim_program_summary.pdf.

SCAQMD. (1996, January 16). *First Annual RECLAIM Program Audit Report*. http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/1994-reclaim-report.pdf?sfvrsn=6.

SCAQMD. (2001, March 16). *Annual RECLAIM Audit Report for 1999 Compliance Year.* http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/1999-reclaim-report.pdf?sfvrsn=8.

SCAQMD. (2002, March 1). *Annual RECLAIM Audit Report for 2000 Compliance Year*. https://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2000-reclaim-report.pdf?sfvrsn=8.

SCAQMD. (2003, March 7). *Annual RECLAIM Audit Report for the 2001 Compliance Year*. http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2001-reclaim-report.pdf?sfvrsn=8.

SCAQMD. (2004, April 2). *Annual RECLAIM Audit Report for the 2002 Compliance Year*. http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2002-reclaim-report.pdf?sfvrsn=8.

SCAQMD. (2005, March 4). *Annual RECLAIM Audit Report for 2003 Compliance Year*. http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2003-reclaim-report.pdf?sfvrsn=8.

SCAQMD. (2006, March 3). *Annual RECLAIM Audit Report for the 2004 Compliance Year*. http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2004-reclaim-report.pdf?sfvrsn=8.

SCAQMD. (2007, March 2). *Annual RECLAIM Audit Report for 2005 Compliance Year*. http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2005-reclaim-report.pdf?sfvrsn=8.

SCAQMD. (2007, June). *Over a Dozen Years of RECLAIM Implementation: Key Lessons Learned Part I – RECLAIM Design*. http://www.aqmd.gov/docs/default-source/reclaim/policy-paper/policy-paper-part-1.pdf.

SCAQMD. (2007, June). *Over a Dozen Years of RECLAIM Implementation: Key Lessons Learned Part II – RECLAM Implementation.* http://www.aqmd.gov/docs/default-source/reclaim/policy-paper/policy-paper-part-2.pdf.

SCAQMD. (2007, June). *Over a Dozen Years of RECLAIM Implementation: Key Lessons Learned Part III – Conclusions and Recommendations.* http://www.aqmd.gov/docs/default-source/reclaim/policy-paper/policy-paper-part-3.pdf?sfvrsn=4.

SCAQMD. (2013, March 1). *Annual RECLAIM Audit Report for 2011 Compliance Year*. http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2011-reclaim-report.pdf?sfvrsn=9.

SCAQMD. (2015, December 4). Materials for Dec. 4, 2015 Board Meeting, Agenda No. 30, Proposed Amendments to NO_x RECLAIM Program (Regulation XX). http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2015/2015-dec4-030.pdf?sfvrsn=9.

SCAQMD. (2016, January 8). *Governing Board Monthly Meeting – Dec. 4, 2015 and Dec. 11, 2015*. http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2016/2016-jan8-001.pdf?sfvrsn=7.

SCAQMD. (2016, July). *Preliminary Draft Staff Report: Proposed Amendments to Regulation XX*. https://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/regxx/noxreclaim_pdsr_072216.pdf?sfvrsn=2.

SCAQMD, (2016, September 6). Draft Staff Report: Proposed Amendments to Regulation XX – Regional Clean Air Incentives Market. http://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/regxx/2-regxx-dsr-final.pdf?sfvrsn=2.

SAQMD. (2018, March). *RECLAIM Transition Plan Version 1.0*. http://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/regxx/draft-transition-plan-version1-final.pdf?sfvrsn=6.

SCAQMD. (2020, December). *RECLAIM Transition Plan Version 2.0*. http://www.scaqmd.gov/docs/default-source/rule-book/Proposed-Rules/regx111/reclaim-transition-plan-draft-version-2-0.pdf?sfvrsn=6.

SCAQMD. (2021, March 5). *Annual RECLAIM Audit Report for 2019 Compliance Year*. http://www.aqmd.gov/docs/default-source/reclaim/reclaim-annual-report/2019-reclaim-report.pdf?sfvrsn=6.

SCAQMD. *Permitting Public Notices*. https://www.aqmd.gov/nav/about/public-notices/permitting-public-notices.

SCAQMD. *RECLAIM Transition*. http://www.aqmd.gov/home/rules-compliance/reclaim-transition.

SCAQMD. *REgional Clean Air Incentives Market* (*RECLAIM*). http://www.aqmd.gov/home/programs/business/about-reclaim.

Skinner, N., Wicks, B., & Wiener, S. (2018, December 18). Letter to Chair Hudson of BAAQMD. https://www.sierraclub.org/sites/www.sierraclub.org/files/sce-authors/u1054/Legislators%20to%20BAAQMD%20Letter%2012.18.18.pdf.

Serrano, K. (2017, December). *Greenhouse Gas Reduction Fund Investments in and around Orange County, University of California Irvine Community Resilience Projects*. https://communityresilience.uci.edu/wp-content/uploads/2018/02/UCI-OC-GGRF-Report-FINAL-1.pdf.

S&P Global Commodity Insights. (2011, November 18). *Six US States Leave the Western Climate Initiative*. https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/111811-six-us-states-leave-the-western-climate-initiative.

United States. (2021, April 15). *The United States' Nationally Determined Contribution*. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20States%20of%20America%20First/United%20States%20NDC%20April%2021%202021%20Final.pdf.

(US) Census Bureau. *Glossary*. https://www.census.gov/programs-surveys/geography/about/glossary.html#par_textimage_13/.

(US) Environmental Protection Agency (EPA).(2002, November). *An Evaluation of the South Coast Air Quality Management District's Regional Clean Air Incentives Market – Lessons in Environmental Markets and Innovation*. https://www3.epa.gov/region9/air/reclaim/reclaim-report.pdf.

EPA. (2006). *An Overview of the Regional Clean Air Incentives Market*. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.187.7379&rep=rep1&type=pdf#:~:text=Emissions%20have%20been%20reduced%20under,and%20perpetuating%20complexity%20and%20uncertainty.

EPA. *California Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants*. https://www3.epa.gov/airquality/greenbook/anayo_ca.html.

(US) Federal Energy Regulation Commission. (2003). *Final Report on Price Manipulation in Western Markets*. https://elibrary.ferc.gov/eLibrary/idmws/common/opennat.asp?fileid=9666688.

Verified Petition. (2019, March 6). *Communities for a Better Envt. v. S. Coast Air Quality Mgmt. Dist.*, No. BS161399 (Superior Court County of Los Angeles). https://earthjustice.org/sites/default/files/files/2016-0309-Verified-Petition.pdf.

Wara, M. (2008, January 22). Measuring the Clean Development Mechanism's Performance and Potential, *UCLA Law Review*, 55(6), 1759. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1086242.

Western Climate Initiative, Inc. (WCI). (2009, March 13). Design Recommendations for the WCI Regional Cap-and-Trade Program. https://wcitestbucket.s3.us-east-2.amazonaws.com/amazon-s3-bucket/documents/en/wci-program-design-archive/WCI-DesignRecommendations-20090313-EN.pdf.

WCI, CARB, & Québec's ministère de l'Environnment et de la Lutte contre les changements climatiques (MELCC). (2020, May 28). *California Cap-and-Trade Program, and Québec Cap-and-Trade System May 2020 Auction #23 Summary Results Report*. https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/auction/may-2020/summary_results_report.pdf.

WCI, CARB, & MELCC. (2021, August 25). *California Cap-and-Trade Program, and Québec Cap-and-Trade System August 2021 Joint Auction #28 Summary Results Report*. https://ww2.arb.ca.gov/sites/default/files/2021-08/nc-aug_2021_summary_results_report_0.pdf.

WCI. (2022, April 11). *Participating Jurisdictions Overview*. https://wcitestbucket.s3.us-east-2.amazonaws.com/amazon-s3-bucket/participatingjurisdiction-comparativetable-en.pdf.

White House. (2021, January 21). *Executive Order on Tackling the Climate Crisis at Home and Abroad*. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/?utm_source=link.

World Bank. (2022, April 6). *Carbon Pricing Dashboard*. https://carbonpricingdashboard.worldbank.org/map_data.

Wu, C. (2017). Links in International ETS Markets and Lessons for China, *Dong Yue Tribune*, 38(5), 111.

Xue, Y. (2022, January 2). China to remain renewable energy leader with strong capacity growth in 2022, despite subsidies phase-out, *South China Morning Post*. https://www.scmp.com/business/china-business/article/3161732/china-remain-renewable-energy-leader-strong-capacity-growth.

Xinhuanet. (2015, December 1). Speech of Xi Jinping at the opening of COP 21 (full text) (习近平在气候变化巴黎大会开幕式上的讲话(全文)). http://www.xinhuanet.com//world/2015-12/01/c_1117309642.htm.

Yang. J. & Schreifels, J. (2003, March). Implementing SO_2 Emissions in China, *Organisation for Economic Co-operation and Development*. https://www.oecd.org/env/cc/2957744.pdf.

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