RFF REPORT

Companion Policies under Capped Systems and Implications for Efficiency—The North American Experience and Lessons in the EU Context

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Executive Summary

Carbon pricing regimes are often preceded and accompanied by companion policies, which can include regulatory standards, subsidies, and additional carbon pricing policies. While carbon pricing programs hold the advantage of identifying least-cost means of reducing carbon emissions, non-price based companion policies provide other advantages, such as addressing other externalities besides the social cost of carbon emissions, targeting specific technologies, addressing impacts on disadvantaged communities, and providing additional incentives for behavioral changes when carbon prices are too low to adequately do so. Companion policies therefore do play an important role in meeting climate goals, but some inefficiencies are expected when carbon pricing and companion policies interact.

The two North American carbon pricing programs we discuss, the Regional Greenhouse Gas Initiative (RGGI) and the Western Climate Initiative (WCI), are cap-and-trade programs composed of individual states and provinces that pursue their own climate objectives and policies in addition to participating in emissions trading. RGGI affects the electricity sector in nine eastern US states, and virtually all allowances are auctioned in this program. The WCI is an economy-wide program covering California, Quebec and Ontario, where most allowance are auctioned. The companion policies in those jurisdictions are challenged by the waterbed effect, in which emissions reductions by one facility in a capped system are offset by increased emissions by another facility, leaving total emissions unchanged at least in the short run. Both trading programs reduce the waterbed effect by implementing a price floor in allowance auctions, below which emissions allowances are not sold. RGGI also plans to adopt an Emissions Containment Reserve (ECR), an additional price step above the price floor, applying to about 10 percent of allowances that will not sell at prices below this level. The auction price floors have been binding in both programs, and subsequently prices have risen off the price floor. These mechanisms cause the supply of allowances to decrease in response to lower demand, allowing the trading programs to capture some of the emissions reductions from companion policies through price suppression, but also maintain the buoyancy of the programs by supporting the price despite lack of allowance scarcity and guarantee a stream of revenue for programs supported by auction revenue.

Companion policies have been fundamental to the design of the RGGI and WCI programs. In RGGI, most auction revenues are invested in energy efficiency, which by design pushes down electricity demand and allowance prices. In this context, the price floor and ECR provide guardrails for the allowance price path. In California, the largest jurisdiction in the WCI, over 80 percent of emissions reductions under the cap are attributable to regulatory measures. California estimates that these measures have a cost per ton of avoided carbon emissions that is greater than the cap-and-trade allowance price. However, these companion policies achieve essential ancillary benefits such as air quality improvements and investments in low carbon infrastructure. An important part of California's policy is the focus of companion policies and spending of auction revenues to address emissions outcomes in disadvantaged communities.

The European Union's Emissions Trading System (ETS) faces the same challenge from the waterbed effect. The EU and its member states have pursued companion policies that reduce emissions at specific facilities in their jurisdictions but do not affect the volume of emissions allowances in the market. This effect contributes to the large surplus of allowances and the low allowance price that the EU ETS market has experienced over the

past years. The EU has hence adopted a mechanism called a Market Stability Reserve (MSR), in which allowances are temporarily withheld from auction based on the number of (surplus) allowances in circulation. Beginning in 2023, when the MSR reaches a certain volume, some allowances can be permanently cancelled. This mechanism provides some responsiveness of allowance supply to reduced demand. We find through our modeling of MSR outcomes from 2018-2030 that the waterbed effect is diminished but still exists to some extent. We also find that additional emissions reductions have a greater impact on allowance supply the sooner they are taken.

Our analysis of the North American and European Union cap-and-trade experiences provide a number of insights that are useful to Sweden in achieving its commitment to reach net-zero greenhouse gas emissions by 2045. We outline the primary insights below:

- Both price-based and non-price based companion policies hold advantages. While price-based policies are likely to achieve least-cost emissions reductions in the short term, non-price based policies can improve political viability, reduce leakage, address environmental justice concerns, and may be essential in driving the energy transformation required to meet long-run climate goals.
- Due to the EU ETS reform to introduce the Market Stability Reserve with a cancelation mechanism, the waterbed effect is diminished. Additional emissions reductions by Sweden and other member states will not be fully effective in reducing overall emissions, but some portion of those reductions are likely to lead to cancelled allowances.
- Additional emissions reductions resulting from companion policies are likely to have a greater effect on cancellation the earlier they are achieved. We estimate that an additional unit of reduced emissions in 2018 will lead to 0.88 units of cancelled allowances by 2030, while an additional reduced emission in 2024 will lead to only 0.47 units of cancelled allowances by 2030.
- Sweden may consider the unilateral cancellation of allowances. This option would be more effective if implemented in conjunction with a coalition of member states and its usefulness would be greater if the cancellation of allowances from the MSR were lower than expected.
- Extending and strengthening Sweden's carbon tax would accelerate Sweden's decarbonization. If the rate of cancellation of the allowances from the MSR is low, creating a stronger waterbed effect, Sweden could improve the efficacy of its reductions by directing some tax or auction revenue to purchase emissions allowances and hold them out of the market for possible future cancellation. They would continue to be counted towards the total number of allowances in circulation (TNAC) and thus contribute to the MSR cancellation mechanism, and Sweden could consider permanently canceling them in the future.
- In the EU ETS, a price floor or Emissions Containment Reserve with permanent cancellation of allowances would reduce the waterbed effect. Advocacy by Sweden for these mechanisms in the EU ETS, or the implementation of these mechanisms by a large coalition of ETS member states, would improve the overall effectiveness of emissions reductions through companion policies.

1. Introduction

When it comes to addressing climate change, carbon pricing policies are considered by many to be the gold standard due to their economic efficiency. Carbon pricing policies exist in the form of cap-and-trade programs in a number of jurisdictions, including the European Union; the Western Climate Initiative (WCI) that links California, Quebec and Ontario; and the Regional Greenhouse Gas Initiative (RGGI) in the northeastern and mid-Atlantic US. Some of these jurisdictions and others also have in place, or are considering, a carbon emissions tax. However, carbon pricing is not the only form of climate-related policy in these jurisdictions; it is typically preceded by and coexists with a number of other policies, referred to as companion policies. Climate-related companion policies commonly include regulatory standards and technology-specific subsidies. Further, sometimes carbon taxes exist as companion policies to cap and trade, as in a few sectors in Sweden.

Carbon pricing policies tend to have an economic efficiency advantage because they give compliance entities the flexibility and incentive to identify least-cost means of carbon mitigation. In cap-and-trade programs, compliance entities must obtain allowances for each unit of carbon dioxide they emit, and can sell allowances if they are able to reduce emissions at a lower cost, or purchase allowances if they face a higher cost of emissions mitigation. This stands in contrast to prescriptive policies, which do not give compliance entities the opportunity to identify least-cost mitigation measures and tend to cost more per unit of reduced emissions.

However, there are a number of reasons why non-price based policies are more prevalent and almost always exist alongside pricing policies. The first reason is political—policies such as energy technology standards and subsidies have greater political viability, at least in part because the price signal is less evident. They often create new opportunities for emerging industries, which in turn create new constituencies that may become advocates for more stringent environmental policies or green energy (Meckling et al. 2016; Pahle et al. 2017). Their political viability makes them favorable candidates to precede price-based regimes, because they can facilitate shifting toward use of less carbon-intense technologies. This makes any subsequent policies less costly and thus more politically viable.

Companion policies have economic justifications as well. While carbon prices address the externalities from carbon emissions, companion policies can address other externalities such as conventional air pollution, or barriers to technological innovation that may inhibit the shift to a low-carbon economy. Economists have acknowledged that when multiple externalities exist, there is a justified role for the use of multiple policy instruments (Bennear and Stavins 2007, Goulder and Parry 2008). For example, subsidies for technology research and development can help overcome barriers to technological innovation that slow down the deployment of renewable energy technologies.

Carbon prices in the existing cap-and-trade programs are also too low from a social standpoint if measured against estimates of the social cost of carbon and, on their own, would fail to trigger the levels of research, innovation and investment in mitigation measures that are deemed necessary. Again, political viability plays a role by rendering it difficult to establish a stringent enough cap such that carbon prices can reach an economically efficient level. A high carbon price in only one region would subject jurisdictions in that region to potential leakage of economic activity to other regions that do not regulate carbon. Hence, in the presence of modest carbon prices, companion policies play a critical role in achieving long-run climate goals. Companion policies that target technology and infrastructure can impact long-run decision-making processes that may not be responsive to low carbon prices (Burtraw 2016).

When price-based policies take the form of cap and trade, the overlap with companion policies complicates the policy environment and has the potential to undermine climate goals by driving modest carbon prices down even further. This occurs when companion policies cause emissions reductions from some of the same emissions sources that are covered by the emissions cap, thereby reducing the demand for emissions allowances and leading to a lower price. In some trading programs, lower than expected allowance prices have undermined confidence in carbon pricing as a tool for achieving emissions reductions. Further, with an emissions cap in place, the actions taken by companion policies may result in a net zero impact on emissions. This occurs because, with a cap in place, emissions reductions at one source enable emissions increases at another source, resulting in the so-called "waterbed effect."

The interaction of a carbon tax and cap and trade in the same jurisdiction can also result in lower prices in the cap-and-trade program and erase the contribution of emissions reductions that are achieved because of the carbon tax. In Sweden and some other European countries, carbon taxes affect a subset of compliance entities that are also covered by the EU Emissions Trading System (ETS).

Through the Swedish Climate Act of 2017, which was supported by a large majority of political parties, Sweden is committed to reduce territorial emissions by at least 85 percent as compared to the year 1990 and reach net-zero greenhouse gas emissions by 2045.[1] The lack of stringency in the EU ETS poses a dilemma for Sweden. To reach its objectives Sweden's emissions need to be reduced on average by at least 5 percent per year,[2] which is faster than the current pace in the EU, and many of these reductions need to occur in sectors that are also covered by the EU ETS. However, if additional policies are implemented in the ETS-covered sectors in Sweden, the waterbed effect could shift emissions to other EU member states, undermining the legitimacy of the Swedish policies and increasing costs to no use.

In this report, we discuss the mechanisms of companion (overlapping) policies, describe the experiences in North America and the European Union with cap and trade and companion policies, and suggest a conceptual framework to address the complications raised by companion policies. Careful program design can help moderate the potential adverse interaction between carbon pricing and companion policies, or between cap and trade at a regional level and country-level policies like carbon taxes in Sweden. The North American cap-and-trade programs offer one approach, which involves the use of a minimum price(s) in the auction for emissions allowances. Recently, the EU ETS has adopted reforms that provide another approach to address the issue, including a modification of the Market Stability Reserve (MSR) that adjusts the quantity of allowances in circulation. We describe these approaches and discuss lessons for the Swedish context.

[1] https://www.riksdagen.se/sv/dokument-lagar/arende/betankande/ett-klimatpolitiskt-ramverk-for-sverige_H401MJU24

[2] https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6782-3.pdf?pid=21185

2. Mechanisms of Overlapping Policies

Carbon pricing policies involve placing a per-unit price on carbon dioxide emissions. Carbon prices can be imposed in the form of a per-unit emission tax, or by introducing scarcity through an emissions cap. Because the emissions cap approach is the one taken at the EU level, we focus most of our discussion on the interactions of companion policies with cap and trade. Under cap and trade, entities that are required to comply with the cap either purchase or receive freely allocated emissions allowances, and compliance entities can trade allowances amongst one another. The market for emissions allowances enables an equilibrium carbon price to emerge, representing the marginal cost of emissions reductions that compliance entities face. A robust and transparent trading market identifies the least-cost means of emissions reduction.

The function and effectiveness of cap-and-trade programs are complicated by companion policies, which often precede and exist alongside carbon pricing. Companion policies like technology standards and subsidies also drive down emissions, but they tend to have greater costs per unit of emissions reductions. Inefficiencies can be expected when cap-and-trade programs are accompanied by companion policies because generally, an emissions cap not only serves as a maximum level of emissions but also as a minimum level – that is, the emissions cap determines the actual level of emissions that will occur. Consequently, emissions reductions that are achieved by companion policies reduce the scarcity of allowances in the carbon market and drive down emissions allowance prices, while likely resulting in a net-zero impact on emissions, at least in the short run. In the long run, the lower allowance price in the carbon market may trigger administrative reforms and a tightening of the cap, but the prospect of future changes in the emissions cap introduces additional uncertainty that can undermine confidence in the carbon market.

The emissions reductions from companion policies, as mentioned above, often come at a higher cost than the marginal cost of reductions achieved by the trading program, so companion policies may push down allowance prices but actually increase overall costs without creating additional emissions reductions. This type of inefficiency is expected in a static framework, according to economic theory, but it may be less of a concern when considered in a dynamic setting. Companion policies have the potential to drive faster introduction of new technologies and behavioral changes than would be achieved by a modest carbon price alone, both because carbon prices are often too low and because companion policies can address barriers to new technologies that even an optimal carbon price cannot. This process might enable greater emissions reductions over time; but the waterbed effect, if not addressed, erases emissions reductions in the short term, presenting a serious challenge to climate policy.

3. The North American Experience

Two regional cap-and-trade programs operate in North America. Both programs were preceded by and continue to co-exist with numerous regulatory policies that promote energy efficiency, renewable energy, transportation policies and other measures that we characterize as companion policies. See Table 1 for an overview of general RGGI, WCI, and EU ETS program characteristics.

TABLE 1. CAP-AND-TRADE PROGRAM CHARACTERISTICS

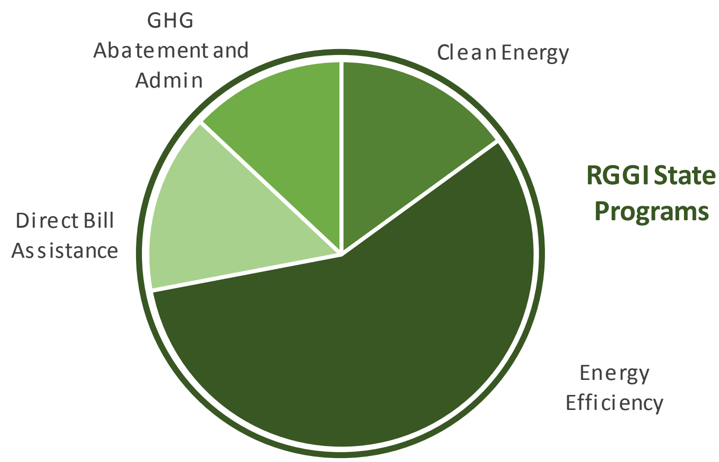
Program	Year of implementation	Allowance price, 2017	Share of emissions covered	Share of allowances auctioned	Price containment mechanism(s)	Cost containment mechanism
RGGI	2009	$3	20%	93%	Price floor, Emissions Containment Reserve	Cost Containment Reserve
WCI	2013	$14	85%	80%	Price floor	Price Containment Reserve; Offsets
EU ETS	2005	€ 5	45%	57%	Market Stability Reserve	Market Stability Reserve; Offsets (until 2019)

3.1. The Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative cap-and-trade program among nine northeastern and mid-Atlantic states, and was the first price-based carbon emissions reduction program in the US when it became effective in 2009. The program is expected to expand to two additional states in the near future. RGGI regulates CO_2 emissions from electric power plants with a capacity of 25 megawatts or greater. Each state in RGGI runs its own CO_2 Budget Trading Program, and most allowances are distributed through a region-wide auction and can be traded among all compliance entities in the RGGI region.

RGGI states invest the allowance auction proceeds into energy and consumer programs. Nearly sixty percent of RGGI investments have been dedicated to energy efficiency programs, with the remainder going to clean and renewable energy, greenhouse gas abatement, and direct electricity bill assistance (see Figure 1). RGGI, Inc. estimates that these programs vary in their cost effectiveness for reducing carbon emissions. RGGI states' 2015 investments in energy efficiency programs are estimated to have cost $85 per short ton CO_2 (equivalent to 0.9 metric tons) reduced over the lifetime of the programs. Investments in clean and renewable energy in 2015 have an estimated cost of $44 per short ton reduced CO_2, and investments in greenhouse gas abatement programs cost $26 per short ton reduced CO_2 (RGGI 2017). The remarkable aspect of these investments is they explicitly lead to a reduction in the allowance price by reducing the demand for emissions allowances. They are, however, subject to the waterbed effect and thus the RGGI trading program requires additional mechanisms to help these investments achieve additional emissions reductions.

FIGURE 1. INITIAL DISTRIBUTION OF ALLOWANCE VALUE, RGGI



Note: This figure shows distribution of allowances for 2008–2014. Auctions began in 2008 and compliance began in 2009. State set-aside allowances and all allowances unsold at auction are not included.
Source: RGGI, Inc. 2014 Proceeds Report.

RGGI states also have many companion policies aimed at the environmental performance of the electricity sector, and in some cases, directly regulate carbon emissions from sources that are also covered by the regional cap. One example is the states' own energy technology policies, including Renewable Portfolio Standards (RPS) that require utilities to include a certain amount of renewable electricity as a share of total electricity consumption in the state. In addition, some states have specified carbon targets. The state of Massachusetts has a legislative goal that has been upheld in the courts and that has introduced important requirements on the state to reduce its emissions. One part of its efforts is an emissions cap on electricity generators in the state. However, those generators are also covered by the RGGI cap; consequently, one might expect 100 percent emissions leakage to generators in other RGGI states. Other states and county governments have similar requirements or goals as Massachusetts.

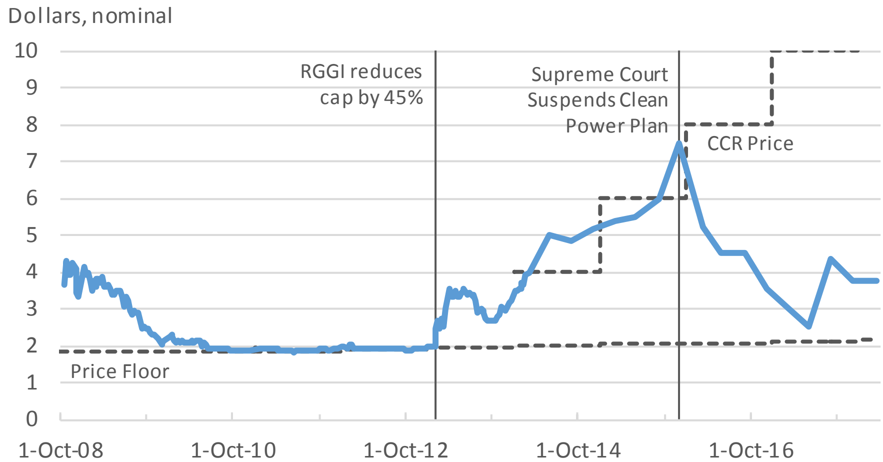
To varying degrees, these programs and policies reduce CO_2 emissions in the respective jurisdiction, which drives down demand for emissions allowances and thus reduces compliance costs and allowance prices in the region. The RGGI program design includes mechanisms to capture the benefits of low cap-and-trade compliance costs. RGGI uses a price floor ("reserve price") in the allowance auction, which is a minimum price below which no allowances will sell. The price floor was set at $2.15 per ton in 2017 and rises by 2.5 percent per year. In 2010, the auction price fell to the floor, and stayed at the floor for eleven consecutive quarterly auctions before prices recovered due to changes in the program introducing greater scarcity (see Figure 2). The inclusion of a price floor has proved to be a key element of RGGI's success, as it has provided buoyancy to the program when there was limited allowance scarcity and maintained a stream of auction revenue that has been invested in related programs. In principle, any unsold allowances are retained by the auction authority and can be auctioned again or states can choose to retire them permanently at the end of each three-year control period. In practice, the states have chosen to permanently cancel (retire) all the allowances that did not sell because the price floor was binding in those eleven auctions, and the expectation is that this will continue to be standard practice. The RGGI program also has included two interim adjustments to the emissions cap by reducing the issuance of new allowances, to account for a substantial accumulation of privately-held banked allowances.

It is interesting to note that RGGI also includes a cost containment reserve (CCR) that is intended to prevent prices from rising too quickly. The CCR contains allowances that can enter the program only if the auction price reaches a specified level. As illustrated in Figure 2, this reserve has been tapped twice.

RGGI's newest design innovation is the Emissions Containment Reserve (ECR), a price step that is introduced into the allowance auction. A certain number of allowances will not sell for a price below this price step. Beginning in 2020, approximately 10 percent of allowances will not sell if the price is below the ECR price step of $6 per ton, and those allowances will be permanently cancelled. The ECR price step occurs above the price floor, which applies to all the remaining allowances and below which no allowances will sell. The ECR's function is to make the supply of allowances more responsive to the allowance price and to prevent the price from falling too quickly. It operates in symmetric fashion to the CCR, which prevents prices from rising too quickly. Consequently, the regional trading program can capitalize on low allowance prices (driven in part by the suite of companion policies in various jurisdictions) to achieve additional emissions reductions beyond the original cap.

The ECR component in the RGGI market design helps reconcile the regional emissions cap and the advantages that come from cooperation in climate policy at the regional level, with the efforts of individual jurisdictions that may reflect greater levels of ambition and pave the way for the introduction of new technologies. The price floor and the ECR introduce a new attribute to carbon markets in which the supply of emissions allowances responds to the market price. This price-based approach translates some of the reduction in allowance demand into reduced emissions, although some is realized through reduced prices. In this sense, the price-based approach of a price floor or ECR is similar to the quantity-based approach of the MSR, as both provide a similar sharing of effects between emissions reductions and price suppression. An advantage of the price-based approach is that the effect is observed immediately and is easier to predict than the MSR. Although a price-responsive supply schedule is unfamiliar in previous emissions cap-and-trade programs, it is a universal feature in other commodity markets. For example, when the price of natural gas declines, less natural gas enters the market. When the supply of allowances adjusts to the price, the market equilibrium is achieved more quickly and the price is less volatile, providing a better price signal to investors (Burtraw et al. 2018).

FIGURE 2. RGGI CO_2 ALLOWANCE PRICES



Note: Auction prices are used where market prices are not available.
Sources: Thomas Reuters; RGGI

3.2. The Western Climate Initiative: California, Quebec and Ontario

California employs a cap-and-trade program as one of a number of strategies employed to reach its greenhouse gas emission reduction goals. The trading program began in 2012, and linked with Quebec in 2014 and Ontario in 2018. The California cap-and-trade program applies not only to large electric power plants, but to all fossil fuel combustion including large industrial plants and fuel distributors (for heating and transportation), covering about 85 percent of all greenhouse gas emissions in the state. California, Quebec and Ontario have comparable climate goals. California recently extended the goals of its landmark climate legislation, and plans to reduce emissions 40 percent from 2020 levels by 2030. Quebec and Ontario have set comparable targets of about 37 percent below 1990 levels by 2030.

California's cap-and-trade program makes up only a portion of the state's climate change policy efforts. A number of regulatory standards and measures preceded and coexist with carbon trading. For example, California, like many states, employs a renewable portfolio standard. The target of 33 percent energy from renewables by 2020 has already been met, and the next target is 50 percent by 2030. The California Air Resources Board (ARB) estimates that the cost in 2030 of the RPS will be $175 per metric ton of reduced greenhouse gas emissions (CARB 2017). California also has a low-carbon fuel standard that targets a 10 percent reduction in fuel carbon intensity by 2020, and an 18 percent reduction in fuel carbon intensity by 2030, with an estimated cost in 2030 of $150 per metric ton of reduced emissions. California also has a number of other measures, some of which affect sources also covered by the cap-and-trade program and others targeting emissions reduction opportunities outside the market.

Every five years, California develops a Scoping Plan that specifies policies the state has in place and new ones the state will employ to meet its emissions reduction goals. The first and second Scoping Plans, which describe efforts to drive emissions back to 1990 levels by 2020, identify regulatory standards and measures that are sufficient to achieve over 80 percent of that emissions reduction target (CARB 2008, CARB 2014). Hence, according to the first and second Scoping Plans, cap and trade is responsible for fewer than 20 percent of the required emissions reductions. Cap and trade, however, has played a key role in the policy portfolio by improving its overall cost-effectiveness, ensuring that the emissions target is met, and providing program funding through auction revenues.

Looking forward, California's most recent emissions target requires emissions to fall to 40 percent below the 1990 level (2020 level) by 2030. The third Scoping Plan identifies regulatory standards and measures sufficient to achieve just 60 percent of this more stringent goal (CARB 2017). Hence, California expects cap and trade to play a growing role in emissions reductions, accounting for the remaining 40 percent of reduced emissions between 2020 and 2030.

Quebec and Ontario also count cap and trade as the foundation for a large suite of climate policies. These policies, similarly to those in California, have great variation in their cost effectiveness. In Ontario for example, some actions, such as increasing the availability and use of low-carbon transportation fuels, have estimated costs as low as $20 per ton of emissions reduction (Ontario 2016). Others, such as improving energy efficiency in homes, schools and hospitals, have estimated costs ranging from $225 to $425 per ton of emissions reduction.

In California, energy-intensive, trade-exposed industries receive free allocation, constituting about 15 percent of total allowances. In contrast, in the current phase of the EU ETS (2013-2020), 43 percent of the allowances are allocated freely. The difference in free allocation between EU and California can in part be explained by differences in industrial structure and trade exposed industries.[3] There are for instance no blast furnace steel works in California. Additionally, the EU ETS applies only to the power and industrial sectors while California cap and trade applies economy-wide; thus, free allocation constitutes more than 15 percent of total power and industrial sector allowances in California. Over 80 percent of emissions allowances are distributed through auctions in California, and a portion of the auction revenues flow into program-related spending on mitigation and climate change adaptation (see Figure 3).

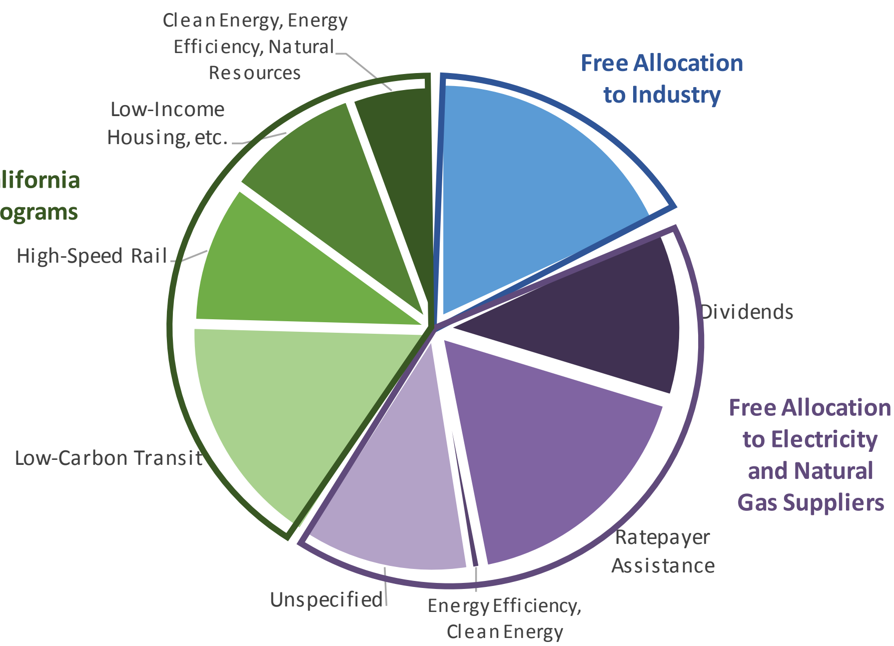
The cost of meeting the emissions cap, represented by the cap-and-trade allowance price, has been far lower than the costs of the regulatory programs described above. The allowance price is currently about $15 per metric ton of CO_2. However, regulatory programs provide other advantages beyond cost effectiveness. While the total costs are generally higher than under carbon pricing, they are in many cases borne by producers and are less likely to be visible to consumers in product prices in the short run. This can result, for example, when product prices in California are determined by markets that extend outside the state. Smaller changes in product prices are particularly advantageous in "first mover" jurisdictions like California that are vulnerable to leakage, as they protect the state against competition from neighboring states and other countries that do not price carbon. They also can improve the political sustainability of climate policy. Non-pricing programs also may have dynamic advantages. While the low carbon price is insufficient to meet California's long-term emissions goals, regulatory standards and measures can help drive carbon-reducing investments and innovation that may increase the feasibility of more stringent measures in the future, both within California and beyond.

The design of California's cap-and-trade program includes provisions that allow for the state's regulatory companion policies to drive

3 https://www.arb.ca.gov/regact/2010/capandtrade10/capv4appk.pdf

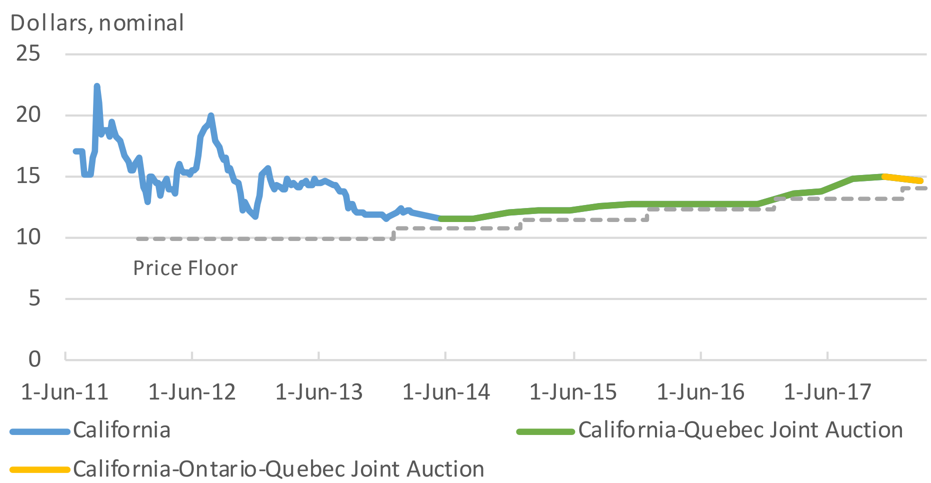
down emissions without damaging the efficiency or legitimacy of the cap-and-trade program. As in RGGI, the trading program has a price floor—a reserve price below which no allowances can be auctioned. California's allowance reserve price was set at $10 per ton in 2012 and each year rises by 5 percent plus an inflation adjustment. The reserve price was binding for five consecutive quarterly auctions before prices rose above the floor in 2017 (see Figure 4). The price floor, like in RGGI, ensures a minimum cost of compliance and also helps maintain a stream of auction revenues that are used for program-related spending.

FIGURE 3. INITIAL DISTRIBUTION OF ALLOWANCE VALUE, CALIFORNIA



Note: This figure shows distribution of allowances for 2013–2020. Allowances held in reserve (not issued) are not included.
Source: California ARB

FIGURE 4. CALIFORNIA AND QUEBEC CO_2 ALLOWANCE PRICES



Note: Auction prices are used where market prices are not available.
Source: Thomson Reuters; California ARB; Quebec MDDELCC

Currently in the program, allowances that are not sold when the reserve price is binding are held out of the market until the auction price is above the price floor for two consecutive auctions, after which they are slowly reintroduced to the program. California also has a price containment reserve, which is a bank of allowances that become available if the allowance price rises to an unreasonably high level. In 2017, these additional allowances would have been available at price steps of $50.69, $57.04 and $63.37 (CARB 2016). Legislation enacted in 2017 that extends the cap-and-trade program until 2030 continues the use of a price floor and a price containment reserve.[4] Starting in 2021 allowances that are not sold at the price floor for more than 24 months will be transferred to the price containment reserve. In addition, the program will maintain price steps introducing additional allowances if the price rises to very high levels, and will adopt a hard price ceiling at a third price step at which an unlimited supply of additional allowances would be sold. The price levels for these additional allowances are not set yet but are expected to be at or above the current price steps in the price containment reserve. [5]

As California extends its cap-and-trade program through 2030, it has a large bank of allowances that have not been used, suggesting that the associated emissions have not occurred. The surplus of allowances means that emissions have been falling faster than expected; however, going forward the large bank of allowances could reduce compliance costs and reduce incentives to undertake emissions mitigation measures. Although the cumulative emissions in the next decade will be no more than the number of available allowances, some advocates are concerned that the volume of banked allowances means that the cap-and-trade program might have actual emissions in 2030 that are above the state's emission target of 40 percent reductions from 2020 levels by 2030. California's Air Resources Board has a number of options to address this situation, including adjusting the bank by permanently retiring a portion of the unused allowances or moving them into the price containment reserve.

3.3. Cost-Effectiveness of Companion Policies

Just as the two North American trading programs pose challenges for states that implement companion policies in their own jurisdictions; a similar challenge exists for Sweden as a member state within the EU ETS. Sweden's goal of reaching net-zero greenhouse gas emissions by 2045 necessitates the implementation of more stringent companion policies, including Sweden's carbon tax and likely others. Reporting of costs in the North American programs provide estimates on the cost effectiveness, or cost per unit of emissions reduction, of various companion policies, presented in Table 2. The cost per unit of emissions reductions estimates of all companion policies listed are greater than the current allowance prices in the cap-and-trade programs, which represent the marginal cost of reducing emissions: approximately $4 in RGGI and $15 in California.

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[4] Assembly Bill 398; https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB398.
https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB398

[5] California's Air Resources Board is developing regulations to implement the legislation, and have initially proposed two price steps and a hard price ceiling, at which an unlimited supply of allowances would potentially be available. The price ceiling proposed in a recent discussion paper would be between $81.90 and $150 (2015 dollars) per metric ton (CARB 2018).

TABLE 2. COST-EFFECTIVENESS OF COMPANION POLICIES

RGGI		California	
Measure	Dollars per Avoided Ton of CO_2	Measure	Dollars per Avoided Ton of GHG
		50 Percent Renewable Portfolio Standard	\$100 to \$200
Energy Efficiency	\$85	Clean Fuels and Technology for Mobile Sources and Freight	<\$50
Clean and Renewable Energy	\$44	18 percent Carbon Intensity Reduction Target for Low Carbon Fuel Standard	\$100 to \$200
GHG Abatement	\$26	Short-Lived Climate Pollutant Strategy	\$25

Notes: RGGI cost effectiveness estimates are based on the cost of programs in 2015 and their associated lifetime CO2 savings. California cost effectiveness estimates are based on total 2021-2030 program costs and 2021-2030 GHG savings.
Sources: RGGI 2015 Proceeds Report, California ARB Third Scoping Plan.

The cost effectiveness estimates of these companion policies have limited usefulness to the Swedish experience because they take into account only the benefits from greenhouse gas emissions reductions and ignore other ancillary benefits beyond their cost effectiveness in directly producing carbon emissions reductions. Companion policies have a range of ancillary benefits that provide important justification for their role, including improving political viability, overcoming barriers to technological change, and addressing environmental justice concerns. In Sweden, there also may be a number of justifications for the role of various companion policies. Putting such ancillary justifications aside and looking narrowly at the cost effectiveness of various options for implementing companion policies, the implementation of price-based companion policies such as carbon taxes or cap-and-trade programs in Sweden is likely to provide the most cost-effective direct emissions reductions. However, it may be that Sweden cannot achieve deep decarbonization in industries such as steel and cement based on carbon pricing alone.

4. Heterogeneous Sub-Targets in a Cap-and-Trade System

Integrating a number of jurisdictions into a linked cap-and-trade system generates a number of benefits, including improving political viability, increasing market liquidity and reducing volatility due to an expanded portfolio of emissions reduction options, and improving administrative operations (Burtraw et al. 2013, Flachsland et al. 2009). Linking different jurisdictions into a unified cap-and-trade framework also creates complications that require consideration in program design.

In the EU ETS, RGGI, and the Western Climate Initiative, all jurisdictions within these trading systems are able to set their own emissions reduction targets, as long as they are at least as strong as their federation requirements for the EU, US and Canada, and these jurisdictions can create companion policies to help reach those targets. In Europe and North America, a number of jurisdictions have passed or are working to pass legislation to strengthen their individual climate targets. In some cases, this causes heterogeneity in the ambition of jurisdictional climate policy efforts within regional and international cap-and-trade regimes.

States in the RGGI region have particularly high variation in their climate policies and emissions reduction goals. Massachusetts, New York, and Maryland stand out as states that have recently undertaken particularly ambitious climate initiatives. Massachusetts finalized new electricity sector regulations in 2017 that set a Clean Energy Standard and establish a within-state cap-and-trade program for carbon emissions from electricity generation, meant to reduce emissions from the covered facilities by 80 percent between 2018 and 2050. New York signed a Clean Energy Standard in 2016 requiring 50 percent of the state's electricity to come from wind and solar by 2030. Maryland recently signed into law the Greenhouse Gas Emissions Reduction Act of 2016, which calls for a 40 percent reduction in greenhouse gas emissions by 2030.

These state-level policy efforts affect electricity generation sources that are also compliance entities in the RGGI framework. As a result, any additional emissions reductions that occur at those facilities reduce demand for allowances and put downward pressure on allowance prices. Without mechanisms in the trading program to address these complications, the state-level policies could have a net-zero effect on total emissions reductions in the RGGI region. Additionally, there could be expanded possibilities for leakage within the region, since the more carbon-intensive facilities in the RGGI states with less stringent climate policies could benefit from the lower allowance prices and increase generation. RGGI's price floor and ECR mechanisms help to mitigate these effects, which could otherwise undermine the efforts by certain states within RGGI to undertake more ambitious climate efforts. The price-responsive supply of allowances supports the market price of allowances and reduces the total supply of allowances to help capture the positive effects of individual states' actions.

Extending cap-and-trade programs across jurisdictions provides a number of benefits, but the integration of heterogeneous jurisdictions into a single framework creates challenges that must be addressed through trading program design. This consideration is particularly important as jurisdictions seek to increase the ambition of their climate goals, and as regional programs pursue initiatives to broaden the scope of their trading markets.

5. The European Union Experience

The EU Emissions Trading System launched in 2005 and is the world's largest carbon market, now linking with Switzerland and covering emissions from the power sector and industrial sources in 31 countries. The EU ETS has had multiple reforms aimed in large part at addressing persistent low allowance prices that have been substantially less than were envisioned by planners, and less than models indicate are necessary to achieve long-term goals for a decarbonization of the energy sector. These reforms have reduced the supply of allowances and delayed ("backloaded") the issuance of a substantial portion of allowances. Until the present, however, prices have remained low, as illustrated in Figure 5.

Several factors contribute to the low allowance price in the EU ETS, including the economic recession, which reduced the demand for allowances, and the availability of Clean Development Mechanism allowances through Phase 2, which introduced additional low-cost emissions credits. Falling costs for renewables technologies also played a role. Another important factor has been the role of companion policies including the EU's 2020 climate and energy package that set 20 percent targets for expanded renewables and energy efficiency by 2020, in addition to the greenhouse gas reduction goal. Individual member states have taken additional unilateral action. The phase-out of coal in some countries helped to reduce demand for allowances, although this effect has been somewhat offset by the phase-out of nuclear. Especially visible was Germany's Feed-In Tariff for renewable energy, which is credited with having contributed to a decline in the price of wind and solar energy and accelerated the introduction of renewables across and beyond Europe (Gerarden 2018). These measures have had beneficial effects in driving technological transformation, but they have also placed downward pressure on allowance prices, thereby undermining the role of the ETS as a cornerstone of the EU's climate policy.

The fundamental dilemma for the EU is that low allowance prices undermine confidence that the ETS will achieve its goals, leading member states to consider additional companion measures. This, in turn, puts further downward pressure on allowance prices while, some argue, further fragmenting climate policy in Europe.

The persistent low allowance price to date has had several implications for Sweden's climate policy. For instance, Sweden has implemented an aviation tax on domestic flights. The tax helps reduce climate impacts of contrails and cloud formation, which are not included by the EU ETS, but it also covers emissions from fuel combustion that are covered by the EU ETS. The tax raises revenue and provides a price signal to guide the intended decarbonization of Sweden's economy, but the presence of the waterbed effect raises the concern that emissions reductions are offset by increases in emissions at other sources regulated by the EU cap-and-trade program, and thus have had no immediate effect on total emissions. Second, the emissions reduction efforts at these Swedish facilities contribute to downward pressure on allowance prices in the EU ETS. The low ETS prices are not sufficient to guide investments at facilities not covered by the carbon tax that would be necessary to achieve Sweden's 2045 carbon goals.

FIGURE 5. EU ETS CO_2 ALLOWANCE PRICES

Sources: Phases 1 and 2 OTC spot prices, Thomson Reuters; Phase 3 nearest future contract prices, ICE.

5.1. The Market Stability Reserve

In 2015, to address the low prices and apparent over-supply of allowances, the EU added a new feature to the ETS called the Market Stability Reserve. Under the original 2015 proposal, in each year starting in 2021, when the total number of allowance in circulation (TNAC) surpasses a ceiling maximum of 833, 12 percent of the TNAC would be withheld from the following year's auction and placed in the MSR; however, as the MSR was originally envisioned, these withheld allowances could re-enter the market when the size of the MSR falls below a threshold of 400 allowances. Consequently, from a long-term perspective the total quantity of allowances would remain unchanged. Economists argued this approach would not affect prices because compliance entities would behave as if their long-run obligation was unchanged, and after 2015 the performance of the market tended to align with this prediction (Hepburn et al. 2016).

However, in November 2017 the European Commission, the European Parliament and the European Council of Ministers agreed on a further reform to the EU ETS, introducing three new features that increase the stringency of the EU ETS. First, the total amount of allowances will be reduced at a faster annual rate than previously; at 2.2 percent per year instead the previous rate of 1.73 percent. Second, movement of allowances to the MSR will begin in 2019 rather than 2021 and from 2019-2023, 24 percent of the TNAC would be moved to the MSR when the 833 threshold is exceeded. Starting in 2024, that number would decrease to 12 percent. Third, a mechanism is introduced that provides the opportunity for permanent cancellation of allowances under specific circumstances. Beginning in 2023, the volume of allowances that can be held in the MSR will be limited to the previous year's volume of auctioned allowances. The difference in the MSR will be cancelled, permanently affecting the long-run supply of allowances. Estimates indicate this provision may result in the retirement of up to 2.4 billion allowances in 2023 (ICIS 2017), in comparison to a current annual cap of about 1.6 billion, which will continue to decline. Our own modeling suggests that about 3 billion allowances would be cancelled from 2023 to 2030 under a normal mitigation scenario. This cancellation would have an observable effect on allowance prices. Table 3 displays modeling results for three different mitigation scenarios. For each scenario and year, the table displays total emissions, the size of the TNAC, movement of allowances to the MSR, cancellation of allowances from the MSR, and the size of the MSR. Under the normal mitigation and fast mitigation scenarios, the MSR takes in allowances and allowances are cancelled in almost all years. Even under the slow mitigation scenario, there is MSR intake and cancellation of allowances, except in the final three years.

TABLE 3. MARKET STABILITY RESERVE AND CANCELLATION MODELED OUTCOMES

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Normal Mitigation													
Emissions	1,754	1,684	1,639	1,656	1,627	1,565	1,590	1,501	1,501	1,464	1,414	1,370	1,269
TNAC (bank)	1,733	1,389	1,241	1,026	1,086	956	991	984	912	858	834	830	992
Intake to MSR		666	1,633	298	246	261	115	119	118	109	103	100	0
Cancellation from MSR						2,144	303	0	147	145	128	124	125
MSR Volume		666	2,299	2,597	2,843	960	772	891	861	826	801	776	652
Fast Mitigation													
Emissions	1,750	1,683	1,642	1,582	1,522	1,462	1,402	1,342	1,282	1,222	1,162	1,102	1,042
TNAC (bank)	1,737	1,393	1,241	1,100	1,247	1,181	1,377	1,483	1,570	1,679	1,809	1,956	2,110
Intake to MSR		667	1,634	298	264	299	142	165	178	188	202	217	235
Cancellation from MSR						2,182	362	12	216	218	226	242	260
MSR Volume		667	2,301	2,599	2,863	981	760	914	875	845	820	795	769
Slow Mitigation													
Emissions	1,750	1,683	1,642	1,622	1,602	1,582	1,562	1,542	1,522	1,502	1,482	1,462	1,442
TNAC (bank)	1,737	1,393	1,241	1,060	1,137	977	1,038	984	891	802	813	817	806
Intake to MSR		667	1,634	298	254	273	117	125	118	107	0	0	0
Cancellation from MSR						2,162	319	0	149	139	123	0	0
MSR Volume		667	2,301	2,599	2,853	964	762	887	856	823	700	700	700

Notes: Normal Mitigation scenario emissions are taken from Bloomberg New Energy Finance, approximately a 2.3% average reductions per year rate. Fast Mitigation scenario emissions are based on a 3.7% average reductions per year rate. Slow Mitigation scenario emissions are based on a 1.2% average reductions per year rate.
Sources: Bloomberg New Energy Finance; Author calculations.

The MSR reform is an important and encouraging change in the ETS, and may enable new implementation of companion policies at the EU level or at member state level. With the reform the waterbed effect will be reduced and emissions reductions from companion policies will be more effective in reducing total EU emissions. The dynamics are as follows: if a member state introduces an extra policy reducing emissions in the trading sector, say a carbon tax or a renewables support policy, the surplus of EU allowances in circulation will increase and a percentage of those allowances will be moved to the MSR. When the MSR volume exceeds the maximum level of the previous year's volume of allowances in the auction, allowances will be cancelled to bring the MSR down to that level. Because of this complex process, one unit of extra emissions reductions does not directly lead to one cancelled allowance; however, the MSR reform does provide an opportunity for some portion of extra emissions reductions to cause allowance cancellation at some point in time.

Under this new framework, it is not obvious how the waterbed effect is impacted and what the implications are for member states implementing companion policies that lead to additional emissions reductions. To address this, we conduct two analyses based on the MSR model that answer two similar, but importantly different questions.

The first analysis addresses how the MSR framework affects what happens to allowances in circulation on average, a question that is relevant to audiences focused on understanding ETS dynamics as a whole. Our analysis follows the course of an average allowance over time, starting from the year in which it enters circulation, by estimating the portion of the allowance remaining in circulation, the portion sitting in the MSR, and the portion that is permanently cancelled in each year. By way of example, for allowances entering circulation in 2018, 67 percent will have been moved to the MSR by 2022. In 2023, the first year of cancellation, 75 percent of those will be cancelled. Thus, in 2023, 50 percent of the allowances entering circulation in 2018 will have been cancelled (75 percent of 67). This process of movement from the TNAC to MSR and to cancellation continues in each year until 2030, and Table 4 displays the outcome of the average allowance in 2030.

The second analysis estimates the marginal impact of one additional unit of emissions reduction that might result from companion policies, a question more relevant to policymakers in ETS member states. This analysis traces the outcome over time of an allowance freed up due to an additional ton of reduced carbon emissions, starting from the year in which the additional mitigation occurs. To illustrate, for a marginal unit of emissions reduction in 2018, an equivalent of 67 percent of the freed up allowance will have been moved to the MSR by 2022. When the cancellation provision begins in 2023, 100 percent of what has been moved to the MSR will be cancelled because these additional allowances will be added on top of an already oversized MSR (meaning that the MSR volume will exceed the 2022 auction volume). Therefore, in 2023, 67 percent of the marginal allowance will have been cancelled (100 percent of 67). This process will continue until 2030. Table 5 shows the outcome in 2030 of an additional unit of mitigation based on the year in which the mitigation occurs. This demonstrates how additional emissions reductions accomplished by member states affect the long-run supply of ETS allowances.

TABLE 4. OUTCOME OF AN AVERAGE ALLOWANCE IN 2030

Normal Mitigation Scenario			
Year entered to Circulation	**Residual in TNAC**	**Residual in MSR**	**Cancelled**
2008-2018	0.12	0.14	0.74
2020	0.20	0.20	0.60
2022	0.35	0.29	0.36
2024	0.53	0.28	0.20
2026	0.68	0.22	0.09
2028	0.88	0.10	0.02

Note: the rate of cancellation is based on the portion of allowances cancelled from the MSR in each year.

TABLE 5. OUTCOME OF A MARGINAL ALLOWANCE IN 2030

Normal Mitigation Scenario			
Year of Reduction	**Residual in TNAC**	**Residual in MSR**	**Cancelled**
2008-2018	0.12	0.00	0.88
2020	0.20	0.00	0.80
2022	0.35	0.00	0.65
2024	0.53	0.00	0.47
2026	0.68	0.00	0.32
2028	0.88	0.00	0.12

Note: The rate of cancellation is dependent on whether cancellation occurs each year. If cancellation occurs, then that entire allowance portion is cancelled. If cancellation does not occur, the allowance portion will remain in the MSR until a year in which cancellation does occur. These rates build on our model results finding that cancellation occurs in all years but one from 2020-2030. Our model results are consistent with those from other observers (ICIS 2017, BNEF 2017 and Perspectives 2017).

Our model of the MSR produces three key conclusions. First, the waterbed effect is reduced, but not completely, so that an additional unit of emissions reduction will lead to less than one cancelled allowance. This is because surplus allowances are not moved into the MSR on a one-to-one basis; instead, when the TNAC is above the 833 threshold, a number of allowances equal to 24 percent (12 percent beginning in 2024) of the TNAC is removed from the subsequent year's auction and moved to the MSR. In each year, the movement of surplus allowances into the MSR and their ultimate cancellation are also dependent on, respectively, whether the TNAC is greater than the 833 threshold and whether the volume of the MSR exceeds the previous year's auction volume.

Second, we find that mitigating earlier leads to a higher rate of cancellation. The ability of allowances to accumulate in circulation and in the MSR across years means that an additional unit of reduced emissions in a given year can contribute to cancellation even if cancellation does not occur in that year. In fact, we find that additional emissions reductions in the near term will have a greater impact on cancellation than emissions reductions later, even though cancellation does not begin until 2023. Table 5 shows, based on our MSR model with normal mitigation, the outcome of one additional unit of emissions reduction in 2030 based on the year in which the reduction occurs. For any unit of reduction that occurs from 2008-2018, that reduction will lead to 0.88 cancelled allowances by 2030. In contrast, a reduction occurring in 2024 will lead to 0.47 cancelled allowances by 2030.

Third, we find that as long as the annual surplus (allocation minus emissions) is sustainably positive, the TNAC will grow and (sooner or later) allowances will be absorbed by the MSR and ultimately will be cancelled or will remain in the MSR in 2030.[6] With a smaller annual surplus that is not always positive, MSR absorption and cancellation will take more time or will not occur, thus reducing the rate of cancellation before 2030.

The MSR cancellation mechanism means that Sweden's implementation of companion policies could reduce total emissions, though not with one-to-one effectiveness. Automatic cancellation leads to a reduction in the total supply of allowances, which would reduce overall emissions. The lower supply would also help sustain the allowance price and provide buoyancy for the trading program. Thus, the MSR with cancellation allows the ETS to capture the benefits of additional emissions reductions in Sweden.

Perino (2018) and Zetterberg (2018) also predict that the cancellation mechanism will help alleviate the waterbed effect, at least for some years. However, the MSR remains subject to the criticism that its potency may be temporary. If the MSR volume is reduced below the threshold level such that it is in a mode where allowances in the MSR are not cancelled, then the waterbed effect will reappear and will impact the effectiveness of member states' companion policies. Additionally, Perino argues that at the end of the next decade the volume of allowances in the MSR may fall below the lower threshold which would enable allowances in the reserve to re-enter the market. However, our analysis and three other studies find that the MSR will not reach the lower threshold before 2030 (ICIS 2017, BNEF 2017, Perspectives 2017). The reason for this is that over the next decade emissions are estimated to be lower than allocation, which in part can be explained by a higher carbon price and renewables policies.

[6] Even if the TNAC declines to the 833 threshold, as long as the ETS maintains an annual surplus of at least 100 tons, then allowances will continue to flow into the MSR.

We find that if the annual surplus is sustained over time this will increase the TNAC, with allowances sooner or later flowing into the MSR, pressing the MSR above the cancellation level. In addition, one may argue that since cancellation under the MSR encourages companion policies by diminishing the waterbed effect, mitigation may increase and reduce emissions even further.

The MSR remains subject to the general criticism that it lacks transparency and predictability. Further, there is no economic theory that provides guidance on limiting the size of the TNAC, which is the approach taken with the MSR. In fact, most economic modeling suggests the accumulation of a large number of allowance in circulation through mitigation measures in the early years of a long-term program, and drawing that number down in later years, is on the least-cost pathway to long-term decarbonization. In that scenario, however, prices would be higher in the early years to reflect greater mitigation costs, an outcome that has not been observed in the EU ETS.

A third feature of the 2017 reform is the reaffirmation of the ability of member states to unilaterally cancel emissions allowances, although it is unclear how much latitude member states are given in this regard and whether cancellation can occur immediately or only after several years of accumulated emissions data. Previously, Sweden has accomplished unilateral cancellation through the purchase and retirement of allowances. The cost-effectiveness of unilateral cancellation is reduced by the cancellation mechanism introduced to the MSR, as allowances may be cancelled anyway through the MSR mechanism.

6. Lessons for the Swedish Context

The experience of the North American trading programs and their employment of companion policies provide useful insights for Sweden, but the Swedish context differs from North America primarily due to the presence of the Market Stability Reserve in the EU ETS. Our analysis of the North American experience and the EU context provide a set of lessons for Sweden. We provide insights on Sweden’s options for effectively achieving emissions reductions through companion policies, unilateral cancellation of allowances potentially triggered by a price floor mechanism, and an option for the expansion of Sweden’s carbon tax and the refunding of that revenue. Finally, we provide insights for Sweden’s policy advocacy in the EU.

6.1. Companion Policies

The use of companion policies provides an opportunity to help Sweden meet its 2045 emissions reductions goals. Regulatory standards and measures, while likely to be less cost-effective in directly driving down emissions, have a range of ancillary benefits that may speed up long-term decarbonization of the Swedish economy. Carbon taxes, which have already been implemented in Sweden in a few sectors, provide opportunities for least-cost emissions reductions. The North American programs demonstrate the viability of interacting companion policies with a cap-and-trade system, and California (in the WCI) illustrates the possibility for carbon pricing to play a growing role in the policy portfolio over time. Both RGGI and the WCI have implemented price floors to combat the waterbed effect, which otherwise would diminish the effectiveness of companion policies in reducing total emissions.

Our analysis of allowance cancellation under the MSR framework concludes that the waterbed effect in the EU ETS remains, but is reduced, providing a strengthened opportunity for Swedish companion policies to drive down total emissions. We find that additional emissions reductions by Sweden will have a bigger impact on cancellation by 2030 the sooner they are achieved.

6.2. Unilateral Cancellation of Allowances

In the case that EU emissions reductions slow down enough that MSR cancellation stops occurring, another policy tool for Sweden could be to unilaterally cancel allowances. This would decrease the total supply of allowances in the ETS; however, the usefulness of unilateral cancellation is limited when allowances in the MSR are cancelled anyway, although cancellation would occur at a rate that would be unknown to Sweden at the time of its unilateral cancellation. Unilateral cancellation is a more useful option when allowances are being cancelled at a lower rate, or not being cancelled through the MSR mechanism.

Sweden might implement its own price floor or Emissions Containment Reserve, with cancellation of unused allowances. This policy would be more effective within a coalition of other European countries such as the *Powering Past Coal Alliance* taking similar action at a multilateral level. However, this could be costly; if Sweden is the only (or one of a few) member states with a minimum price on all or some of its allowances, this will reduce or eliminate Sweden's auction revenue. If the MSR is cancelling allowances, then to some degree unilateral cancellation by Sweden would cause a rebound under the MSR, with fewer allowances being canceled under that mechanism. The prospect of reduced revenue also may represent a tradeoff for Sweden in reaching its emissions reduction goals, as it may inhibit Sweden's abilities to invest those revenues into companion policies that also help it to reach those goals.

It is noteworthy that the reduced supply and increase in price also would lead to an increase in auction revenue for other countries, realizing a transfer among countries. That may align with other goals, such as the modernization fund within the EU that provides resources and compensation to eastern European countries with a fossil-intensive electricity sector. A multilateral effort would distribute this cost burden more widely. By analogy in RGGI, two of the nine currently participating states did not opt to introduce the Emissions Containment Reserve, meaning that a coalition of seven of the nine RGGI states will be introducing this feature by applying a minimum sales price on 10 percent of their allowances, which is above the reserve price applying to all other allowances in the auction.

6.3. Carbon Tax

Extending and strengthening Sweden's carbon tax, currently applied to a limited number of industries, would accelerate Sweden's decarbonization. This could put Swedish industry at a disadvantage in the short term due to economic leakage. However, tax revenue could be refunded to prevent leakage by providing a production incentive in proportion to each facility's production activity. This approach is evident in the Swedish nitrogen oxides emissions tax, which refunds tax revenues among the regulated facilities on the basis of their production levels, thereby penalizing relatively inefficient generators while rewarding efficient ones (OECD 2013). Refunds might be directed to fund new investments at the affected facilities.

Incremental emissions reductions under the carbon tax, as for all companion policies, are likely to have reduced impacts on emissions under the ETS due to the reduced, but still present waterbed effect, and their impacts will be lower when allowances are cancelled at a lower rate through the MSR mechanism. Hence, Sweden may want to direct some tax revenue to purchase emissions allowances, which are likely to have a relatively low cost per ton, and hold them out of the market for possible future cancellation. The allowances would thus continue to be counted towards the TNAC and would thus contribute to the MSR intake calculus. Holding allowances out of the market may be a particularly advantageous strategy for Sweden when the rate of cancellation through the MSR is low.

After five years, according to EU guidelines, Sweden could evaluate the effectiveness of the MSR in canceling ETS allowances and consider the permanent cancellation of some of the allowances that Sweden holds. This amount could be sufficient to guarantee that Sweden's unilateral efforts yield emissions reductions at the EU level.

An illustrative approach to this strategy could work as follows: Sweden could start with a quantitative goal, say, 38 percent reduction in an industrial sector by 2030. If the EU ETS linear reduction factor of 2.2 percent yields roughly 25 percent reduction in the cap by 2030, then Sweden would purchase the difference (13 percent), using tax revenue to purchase the relatively low-cost allowances. It would hold those allowances out of the market for five years, at which time they would be eligible for cancellation according to the current rules. In this time, they would still count towards the TNAC and the MSR calculus. After five years, Sweden could cancel some portion of the withheld allowances, or otherwise reintroduce the remaining allowances through its auction.

6.4. EU ETS Program Design

The approaches taken in designing the North American trading programs also provide useful lessons for policy advocacy by Sweden and the design of the EU ETS. Both the RGGI and WCI trading programs use a minimum price in the auction (a reserve price), and RGGI's ECR imposes an additional price step at which the supply of allowances is reduced. These mechanisms help sustain allowance prices and reduce the waterbed effect (particularly when unsold allowances are permanently cancelled as they are in RGGI), are simple and transparent, and remain effective for the duration of the program. Inclusion of a reserve price or an ECR with permanent cancellation in the EU ETS, even in addition to the MSR, would help the program more effectively capture the benefits of additional mitigation actions taken by leading member states like Sweden.

6.5. Summary

The inclusion of the MSR and its cancellation mechanism into the EU ETS provides an opportunity for Sweden to pursue additional emissions reductions through companion policies subject to a weakened waterbed effect. The sooner these emissions reductions are accomplished, the greater an effect they will have on cancellation during the 2023-2030 period. Similar considerations apply to the unilateral cancellation of allowances; however, the effectiveness of cancellation evolves in the opposite way—it is likely to be more effective later in the 2023-2030 period. The additionality of unilateral cancellation is relatively low in the near term because allowances that are bought and retired by Sweden would be relatively likely to be cancelled by the MSR. However, as the MSR becomes less effective over time and fewer allowances are cancelled (assuming the current rules remain in effect), then the effectiveness of unilateral cancellation will increase. Thus, a reasonable approach would be to focus on implementation of companion policies in the near term and consider unilateral cancellation later if the MSR becomes less effective over time. Nonetheless, the complex nature of the MSR cancellation process creates market uncertainty and does not fully eliminate the waterbed effect. A Swedish tax could be designed to interact with the EU ETS and potentially help to remedy the limitation of the MSR. Further, the use in the EU ETS of a minimum price and an Emissions Containment Reserve with cancellation of unused allowances, following successes in the RGGI and Western Climate Initiative programs, would provide a transparent and effective complement to the MSR by automatically adjusting supply of allowances to account for shifting demand.

7. Conceptual Framework for the Path Forward

Companion policies are ubiquitous in regions that have adopted cap-and-trade programs for carbon emissions. Many prevalent types of companion policies, regulatory standards and technology-specific subsidies, are not price-based and tend to be less efficient, thus reducing the overall economic efficiency of regions' policy portfolios, at least in the short term. However, these policies can play a valuable role. Due to their political viability relative to price-based climate policy, they generally precede cap-and-trade programs and create technology pathways that render the implementation of those trading programs feasible. When they coexist with cap and trade, they enable jurisdictions to pursue more stringent climate goals or to address environmental justice concerns. Companion policies can also address externalities and other market failures that carbon pricing programs do not address, such as barriers to innovation. As such, the short-term efficiency losses from companion policies may result in long-term efficiency gains if they catalyze faster technological transformations. Companion policies are also not limited to regulatory standards and technology subsidies—they can embody incentive-based methods such as renewable portfolio standards that impart flexibility to the regulated facilities. Most efficient are policies that directly price the emissions, including additional cap-and-trade programs, such as Massachusetts is currently adopting, or carbon taxes, as in Sweden. These price-based companion policies preserve short-term economic efficiency and allow jurisdictions to pursue more stringent goals.

Implementing any form of companion policy in a cap-and-trade framework creates challenges that can compromise program outcomes if they are not addressed. Because emissions caps generally determine the overall level of emissions that will occur in a region, any efforts to further reduce emissions without reducing the cap will likely have a net-zero impact on emissions. This waterbed effect, in which emissions reductions at one source enable increased emissions at another source by lowering allowance prices, can undermine the impacts of companion policies.

Careful design of cap-and-trade programs is critical for allowing jurisdictions to pursue a suite of climate policies while mitigating the waterbed effect. The most robust existing program design mechanism that addresses this problem is the auction price floor and the Emissions Containment Reserve, currently adopted by RGGI. The ECR uses price thresholds to allow the total supply of allowances to change based on demand, thus translating low allowance demand into a reduction in emissions. The treatment of unsold allowances is an important consideration when establishing a price-responsive allowance supply mechanism like a price floor or the ECR, because its effectiveness may be compromised if unsold allowances are expected to reenter the market at a later date. In practice, in RGGI the allowances unsold at the price floor have been cancelled and under the ECR, these allowances are automatically cancelled. In California, some allowances have re-entered the program but most unsold allowances will be moved to the cost containment reserve and would be available only at very high prices. In the EU ETS, the Market Stability Reserve and the cancellation mechanism also reduce the waterbed issue but may be less transparent compared to a price floor or ECR.

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