

# MARKET MECHANISMS: OPTIONS FOR CLIMATE POLICY



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Climate change poses a significant risk for a broad range of human and natural systems. Policies to reduce emissions are critical if we are to avoid the most costly damages associated with a rapidly changing climate. Compared to traditional command-and-control regulations, market-based policies can more cost-effectively reduce greenhouse gas (GHG) emissions by creating financial incentives for GHG emitters to emit less. Ten U.S. states and many jurisdictions outside the United States have established market-based programs to reduce GHGs. This brief—an update to our 2015 brief—describes the theory behind market-based approaches; their success in cost-effectively reducing GHGs and other emissions; and a range of market-based options, including: a carbon tax, a cap-and-trade program, a baseline and credit program, and a clean energy standard.

## **ECONOMIC EXTERNALITIES—POLLUTION**

All environmental pollution, including emissions of greenhouse gases (GHGs), imposes costs on people who did not create the pollution. This is an example of an economic externality—a consequence or side effect of an action that is not experienced by the individual or entity from which it originates, and that is not reflected in prices. The damages and associated costs to society that GHGs cause through climate change (e.g., increased extreme weather events, rising sea levels, and loss of biodiversity) are not paid for by the entities that emit those gases, so those costs are not reflected in the market prices of goods and services. Because polluters do not have to account for the costs associated with the damages that greenhouse gases create, society produces and

consumes too many pollution-creating products (like fossil fuels) resulting in additional GHG emissions being put into the atmosphere.

Market-based policies aim to correct this form of market failure (an instance where economic resources are allocated inefficiently). They do this by constructing systems that cause the “external” costs associated with pollution to be incorporated in the polluting entity’s decision-making. When firms explicitly see and must pay for the societal cost of pollution, they are able to determine how best to meet an environmental objective. Moreover, when prices of products reflect their full environmental costs, consumers also are better able to make informed purchasing decisions.

## MARKET-BASED VERSUS COMMAND-AND-CONTROL REGULATIONS

Market-based environmental policies are a potentially attractive alternative to traditional command-and-control regulatory programs. Command-and-control policies typically require polluters to take specific actions to reduce emissions by installing a particular technology or meeting a specific performance (emissions) standard. Command-and-control regulations have been criticized as not providing the flexibility to take into consideration that different plants face different compliance options and associated costs—some can do more for less, while others face higher costs. Moreover, traditional regulations do not provide an incentive for firms to innovate by going beyond the reductions required by a standard.

Market-based options provide greater flexibility for firms and seem particularly appropriate in the context of policies to reduce GHG emissions. For some types of pollutants, it matters that emissions at any particular point or region do not exceed health-related thresholds. For those types of pollutants, command-and-control

regulation is often the appropriate policy response. Because GHGs are not harmful on a localized basis—they are globally mixed in the atmosphere and do damage on a global scale—market-based policies that provide greater compliance flexibility can achieve environmental objectives at lower overall costs. Beyond providing an incentive for the use of lower emitting technologies, market-based policies also provide a financial incentive for inventors and investors to develop and deploy lower-emitting technologies. This type of policy also leaves the private market to determine which technologies will thrive and expand. At the U.S. federal level, market-based policies have been used to reduce sulfur dioxide emissions at a fraction of the originally estimated cost, while at the state level they have been used successfully in renewable energy programs and cap-and-trade programs for greenhouse gases and nitrogen oxides.

## EXAMPLES OF MARKET-BASED POLICY OPTIONS FOR GREENHOUSE GAS EMISSIONS

Market-based environmental policies work by creating an incentive to reduce or eliminate emissions. Under this structure, each regulated business chooses independently how to most cost-effectively achieve the required pollution abatement. Notably, some companies can reduce pollution more cheaply than others (because of the age of their equipment or the technology they are using), allowing them to reduce their pollution more, to compensate for those facing higher costs doing less. Taken together, the overall environmental objective will be achieved at the lowest possible total costs. The key criterion in determining if a policy is ‘market-based’ is that it provides a financial incentive designed to elicit a specific behavior from those responsible for the pollution. Some policy options are applicable as economy-wide solutions where greater efficiencies can be achieved, while others are more generally targeted to a particular market segment or sector. The following section explores seven major market-based policy options. (**Appendix A** provides a quick reference for the market-based options described here.)

Each of the policy options described below has the flexibility to be structured in a variety of ways to meet particular political contexts or sets of economic challenges. Further, none of the policies, alone, is a panacea for solving the global climate crisis. For example, complementary policies aimed at research and development and programs to adapt to climate change may also be required. Moreover, different policy approaches may be required depending on the specific market failure that needs to be addressed (e.g., capturing externalities, splitting incentives between building developer and occupant).

### TAXES

The most basic form of a market-based policy is a tax that sets a price on each unit of pollution. By introducing a tax on pollution, the entity producing the pollution incurs an additional cost based on the amount of pollution emitted. Because of this, the entity has an incentive to reduce the pollution produced by changing its processes or adopting new technology. In this way, the

## BOX 1: Uncertainty

Assessing the cost to society from pollution is often difficult. While some damages caused by pollution are relatively easy to estimate in monetary terms, others are much more challenging to quantify. For example, if pollution causes a reduction in the fish population for a commercial fishery, we can estimate the damages based on the lost value of the fish at market prices. If, however, wetlands are destroyed or a species becomes extinct, it is not clear how society should assign a specific economic value to that loss. Other complications make it difficult to put a precise dollar figure on the costs imposed by a unit of pollution. They involve questions of how damages that apply to future generations should be valued in today's decisions, and how to quantify consequences when there is a range of possible outcomes or the potential exists for a low-probability, high-impact event.

tax provides a continuous incentive for innovation; the more emissions can be reduced, the less tax a company would pay. Ideally, the cost of the tax would be set equal to the cost to society that the pollution creates. Ascertaining this cost, however, is not always easy. (See **Box 1**.) Taxes to reduce GHGs can come in two broad forms: an emissions tax, which taxes firms directly based on the GHG emissions they produce, and a tax on goods or services that are generally GHG-intensive—an example would be a carbon tax on gasoline, see **Box 2**.

A carbon tax has the potential to raise significant revenues for the government. Ultimately, how the revenue is used will be a political decision. Recent U.S. congressional carbon pricing proposals would use the revenue to fund clean technology, reduce payroll taxes (i.e., tax and invest), or use at least some portion of the revenue as a dividend (e.g., tax and dividend).

### CAP-AND-TRADE PROGRAM

Another market-based mechanism is a cap-and-trade program. This approach is “quantity-based.” Instead of setting a price on each unit of pollution, the regulatory authority determines a total quantity of pollution (a “cap”) that will be allowed. Companies buy and sell emission allowances (tradable certificates that allow a certain amount of emissions) based on their needs. The limited number of these allowances creates scarcity. The requirement that regulated businesses hold enough allowances to cover their emissions ensures the cap is met and creates demand for the allowances.<sup>1</sup> If it is less costly for a company to reduce emissions than to buy allowances, the company will reduce its own emissions. Similarly, if a company can reduce emissions below its requirements, so it has excess allowances, those allowances can then be banked for future use or sold in an open market to a firm that finds it more difficult (costly) to reduce emissions.

Because there is a scarcity of allowances and businesses can trade them, the allowances are valuable and lead to a price on greenhouse gas emissions. This price provides a continuous incentive to reduce emissions and innovate since firms can save money if they reduce their emissions and avoid buying allowances. Some firms may actually be able to raise revenue by selling their excess allowances. This is particularly true if firms are allocated some number of allowances for free—allowances are grandfathered to existing emitters. Since the allowances are valuable, how they are distributed has implications. If they are given away for free, this is a financial benefit to the recipients. If they are auctioned, the resulting revenue can be channeled to specific groups or uses (see **Box 3**). As discussed below, cap and trade has been successfully used to reduce ozone-depleting substances under the Montreal Protocol, acid rain under the Clean Air Act, greenhouse gases under programs in Europe, in California and 10 U.S. states in the Northeast and Mid-Atlantic.

### BASELINE-AND-CREDIT PROGRAM

Somewhat similar to a cap-and-trade program is a baseline and credit program which establishes a defined emissions limit either in terms of absolute emissions or emissions per unit of output. Firms that emit below their baseline limit would be able to create credits and sell these to firms that emit more than their baseline limit. For example, in the power sector, standards could be based on tons of carbon dioxide per megawatt hour of electricity produced with a specific type of technology. With a baseline and credit approach, firms would be able to meet a technology-based standard either by reducing their own emissions or by buying credits from other firms.

## BOX 2: Choosing Between Price-Based and Quantity-Based Market Policies

The trade-off between price-based (e.g., carbon tax) approaches and quantity-based (e.g., cap and trade) approaches is either greater compliance cost certainty or greater environmental certainty. Setting an explicit price on a unit of pollution offers a high degree of price certainty for the regulated businesses. However, while the compliance cost is more certain, the resulting level of pollution reduction overall is less certain because each company will respond differently to the price set by the tax. For example, a tax of \$1 per gallon of gas could cause Company A to reduce its gasoline consumption by 20 percent but cause Company B to reduce its consumption by only 1 percent. The level of the reduction is difficult to know in advance and the level of the tax may need to be adjusted over time to achieve a specific emission reduction goal.

In contrast, a quantity-based market policy provides certainty about the environmental outcome because only a limited number of pollution allowances are distributed or auctioned. In this case, while the environmental outcome is certain, the cost to firms for emitting pollution is uncertain (particularly at the outset of the program) and will be determined by the market price for allowances. Real-world market-based policy proposals, however, are not so “black and white” and can be designed with policy components that create more certainty for both price and quantity. For example, programs in California and the Regional Greenhouse Gas Initiative (RGGI) have included price floors and allowance reserve (that acts like a price ceiling)—to give more compliance cost certainty.<sup>2</sup>

The program to remove lead from gasoline in the 1980s, for example, used a rate-based baseline-and-credit approach to achieve reductions at much lower cost than originally anticipated (see below). More recently, in 2018, Alberta, Canada updated their baseline-and-credit program which is part of their climate program. The Carbon Competitiveness Incentive Regulation requires covered entities to meet product-based benchmarks (e.g., electricity generation, oil sands mining) that are set at 80 percent of production-weighted average emissions intensity. To meet this target, companies can buy performance credits from facilities doing better than the benchmark, use greenhouse gas offsets, or pay into a fund that will be used to reduce emissions and advance other climate-related solutions in the province.

### CLEAN ENERGY STANDARD

Clean energy standards are types of electricity portfolio standards typically targeted to spurring commercialization of less-polluting technologies (often with specific provisions to favor one or more particular technologies) in the electric power sector. These standards can be designed so that each utility within a particular territory must obtain a certain percentage of its delivered electricity from a defined set of clean or renewable sources. To be considered a market based policy that creates a continuous incentive to reduce emissions, this mechanism should allow a utility that exceeds the standard to

create tradable credits that can be banked for future use or sold to other utilities for their compliance obligations. Twenty-nine states and the District of Columbia already have their own clean or renewable electricity standards in place, some of which are tradeable.<sup>3</sup>

### FEEBATES

Feebates are a regulatory program creating a schedule of fees and rebates (hence “feebates”) to the purchase price of a good based on an aspect of the good that policy hopes to influence. Feebates are most often discussed in the context of changing the relative prices of automobiles based on their fuel economy, but could be applied to a wide range of consumer durables (like refrigerators, washer-dryers, televisions, etc.). Not dissimilar to a gas-guzzler tax, a feebate goes a step further and uses the revenue collected from such a tax to create a subsidy for fuel-efficient purchases. Because it both collects fees as well as distributes rebates (subsidies), the system can be designed to be revenue-neutral to the government (or could be structured to generate revenues or direct expenditures depending on the relative magnitudes of the fees and rebates).

### **BOX 3: Uses of Revenues from Taxes or Allowance Auctions**

Either a GHG tax or a cap-and-trade system that auctions emission allowances has the potential to raise revenues for the government. For a tax, the potential revenue raised would be equal to the tax rate times the total quantity of GHG emissions produced in a given year. Under a cap-and-trade program, the revenue generated would depend on the share of allowances offered for sale and the allowance prices at auction.

There are many possible ways these revenues could be used. A large body of research suggests that using these revenues to reduce existing distortionary taxes on labor and capital investments, would lower the economy-wide costs of the program. Sweden and British Columbia provide two examples of GHG taxes being used specifically to offset taxes on, respectively, labor and individuals/businesses.<sup>4</sup>

However, there may be reasons to use carbon revenue for other purposes. In addition to economic efficiency, policy-makers have to address questions of equity (avoiding burdensome impacts on particular households and businesses). In addition, there are valuable programs that may require funding (e.g., clean energy R&D, adaptation). Member states in the Regional Greenhouse Gas Initiative—where 100 percent of allowances are auctioned—direct at least 25 percent of all revenues generated at auction to consumer benefit, renewable energy, or energy efficiency programs. Since 2008, allowance auctions have generated more than \$3 billion in economic benefits for the region with a significant portion of the revenue used to accelerate emission reductions by funding energy efficiency, renewable energy and direct emission abatement.<sup>5</sup>

## **AN OVERVIEW OF THE USE OF MARKET MECHANISMS**

Market-based policies designed to improve the environment are not new. They have been used extensively to protect human health as well as sensitive habitats. These market-based policies have been used in environmental contexts as diverse as tradable development rights, water effluent, wetland protection, and even biodiversity. The United States has been a leading proponent of market-based policies globally and both political parties have historically embraced these types of policies in a range of contexts. The examples below highlight some of the market-based policies that have been used in the United States and abroad for reducing different types of air pollution.

### **PHASING OUT LEADED GASOLINE**

The U.S. Environmental Protection Agency (EPA) started a program to reduce the amount of lead in gasoline in the mid-1970s. Airborne lead, a byproduct of the combustion of leaded gasoline, is known to cause significant health problems. Lead also reduces the function of catalytic converters which were by then required on new vehicles to help reduce other forms of air emissions. The initial program required that each refinery individually meet the gasoline lead concentration requirements—though eventually companies were

allowed to average across operations company-wide, rather than just refinery-wide.

In the early 1980s, it became clear that reducing the content of lead in gasoline even further was required to protect public health. In 1982, under the Reagan Administration, EPA started an enhanced program that operated as a rate-based, flexible emissions standard. It required refiners to meet the lead content requirement based on the quantity of gasoline produced, and allowed firms to trade credits generated by outperforming the standard. If a firm, for example, produced 100 gallons of gasoline, it would be given rights (in 1982) for 110 grams of lead (100 gallons times 1.1 grams per gallon). If the lead content of the gasoline produced by the firm was less, the difference was tradable in the form of credits to another firm that exceeded its rate-based target.

Firms were also allowed to bank credits from one compliance period for use in the next. Estimates from EPA suggested that savings to refiners as a result of the banking provision for the program were on the order of \$228 million (1985 US\$), and other analysts have suggested that the savings were even higher.<sup>6</sup> While the final costs and benefits of the rule were never re-estimated, EPA originally estimated compliance costs at \$2.6 billion compared with \$36 billion in health benefits from reduced airborne lead.<sup>7</sup>

## LIMITING OZONE-DEPLETING SUBSTANCES

Under Title VI of the 1990 Clean Air Act Amendments, EPA established regulations for the reduction of ozone-depleting substances to meet the requirements of the 1987 Montreal Protocol to protect the stratospheric ozone layer. The regulations called for a cap-and-trade program in which each of the producers (and importers, as defined by the Clean Air Act) were allocated production allowances according to their historical (1986) market shares. Trading of allowances was done on the basis of ozone-depleting potential—that is, the relative amount of harm each chemical inflicts on the ozone layer (in this case, denominated by the ozone-depleting potential of CFC-11).

EPA has estimated that in 1992 the trading provisions enabled cost savings of \$250 million “and perhaps twice as much by 1996.” Also important were savings in administrative costs—EPA was able to run the program with just four staffers, compared to the 33 that were estimated to be needed under a traditional standards-based, command-and-control regulatory approach. Record keeping for industry would have cost around \$300 million under a command-and-control approach but cost only \$2.4 million under the trading program.<sup>8</sup>

## ACID RAIN PROGRAM

The 1990 Clean Air Act Amendments (Title IV) also initiated a program aimed at reducing sulfur dioxide emissions, the major industrial pollutant responsible for the formation of acid rain.<sup>9</sup> This program instituted a cap-and-trade program that is widely credited with reducing emissions at much lower costs than command-and-control. The program was designed to increase the stringency of emissions reductions in two phases. Phase I, started in 1995, targeted large sources in the eastern half of the United States—where the acid rain problem was most acute—and was followed by Phase II, in 2000, which covered nearly all power plants.

The acid rain program allocated most emission allowances based on historical fuel use and environmental performance benchmarks to the regulated power companies, but retained a small portion of the allowances for an open auction in which all were free to participate. Allowances were both tradable and bankable—so at any given moment the market for allowances included the current year’s emission allowances as well as all unused emission allowances from previous years.

The acid rain program has widely been held up as a model for the success of market-based environmental policy, and for cap and trade in particular. Prior to the start of the program, credible estimates for the costs of compliance for the sulfur dioxide trading program ranged from \$2.7 billion to \$8.7 billion annually by the year 2000. As a result of the flexibilities provided by the market mechanisms associated with the policy, the actual annual compliance costs (averaged from 2000–2007) were \$1.9 billion.<sup>10</sup>

## EUROPEAN UNION EMISSIONS TRADING SYSTEM

The European Union Emissions Trading System (EU ETS) created in 2005 is the world’s oldest and largest multi-sector greenhouse gas trading program. Designed to be consistent with the emission reductions targets included in the Kyoto Protocol, the EU ETS created a market of tradable allowances for emissions among the European Union member states. In 2020, emissions across the program are 21 percent lower than in 2005 and are intended to be 43 percent lower in 2030.

The program requires that each member state limit and distribute emissions allowances in a manner that is consistent with the nation meeting its international reduction commitment. Once allocated, however, the emission allowances are tradable among all participating companies in a common market. Member states have also built upon the rules in the EU ETS with specific provisions that suit their own program objectives. For example, the United Kingdom implemented a carbon price floor in its electricity sector that has contributed to a significant decline in coal use.<sup>11</sup> The EU ETS is currently in its fourth phase, which will run from 2021 through 2030 and is designed to be consistent with the European Union’s contribution under the Paris Climate Agreement.

## REGIONAL GREENHOUSE GAS INITIATIVE

The Regional Greenhouse Gas Initiative (RGGI) was the first mandatory U.S. cap-and-trade program for carbon dioxide. The program originally covered 10 New England and Mid-Atlantic states that agreed to set a cap on carbon dioxide emissions from power plants throughout the region, and allow regulated entities to trade carbon emission allowances to achieve compliance.<sup>12</sup> RGGI originally set the cap to stabilize power plant emissions at 188 million tons of carbon dioxide annually between 2008 and 2011.

Power generators have a variety of options to comply with the targets. They can reduce their emissions through efficiency measures, switching fuels, using carbon capture and storage, or purchasing additional allowances at auction or from other firms. Generators can also use emission offsets to meet their emission reduction obligations. Offsets under the RGGI program are defined as emission reductions from sources other than power plants. For example, a permissible source of offsets could be the capture of methane emissions (a potent greenhouse gas) from landfills or agricultural sources. The RGGI program currently allows generators to meet up to 3.3 percent of their compliance obligations through the use of offsets. However, because of relatively low allowance prices, offsets have yet to be used for compliance in the program.

One of the design elements in RGGI often highlighted by policy makers as essential, has been its periodic program review “to consider program successes, impacts, and design elements.”<sup>13</sup> RGGI has undertaken two program reviews since 2008. The 2012 Program Review lowered the emissions cap in 2014 and was set to decline 2.5 percent annually until 2020. The 2012 Program Review also introduced several policy provisions. One of these is the Cost Containment Reserve, which is intended to keep the price of allowances from rising above a program-wide trigger price by releasing a limited supply of allowances once that price is reached. The 2016 Program Review set an overall cap reduction of 30 percent between 2020 and 2030. The Cost Containment Reserve remains in place but with a higher trigger price. It also includes a new mechanism called the Emissions Containment Reserve, which allows states to withhold up to 10 percent of their annual emissions budget if

prices fall below certain triggers. In this way, states can choose to force more reductions if prices are lower than currently projected.

## CALIFORNIA CAP-AND-TRADE PROGRAM

California’s program was the first multi-sector cap-and-trade program for greenhouse gases in North America. The cap-and-trade program covers nearly 85 percent of the state’s total greenhouse gas emissions.<sup>14</sup> The program initially covered electric generators and industrial plants. Since 2015, the program has also included distributors of transportation and heating fuels. California’s emissions trading system is expected to reduce greenhouse gas emissions from regulated entities by more than 16 percent between 2013 and 2020, and by an additional 40 percent by 2030.

California’s program builds on the lessons learned from RGGI and the EU ETS. Emission allowances are distributed by a mix of free allocation and quarterly auctions. The portion of emissions covered by free allowances varies by industry and will decline over time. California’s program also sets a price floor for each auction, which can be helpful in encouraging investments in emission-reducing technologies that would be undermined if allowance prices were too low. Starting in 2014, California and Quebec linked their cap-and-trade programs, which resulted in the first multi-sector cap-and-trade program linkage in North America. Offsets and allowances can be traded across the two jurisdictions. The partnership aims to create a gateway and framework for greater international greenhouse gas reductions.

## TOWARD CLIMATE SOLUTIONS

Often the debate surrounding policies to reduce greenhouse gases focuses primarily on the cost of implementing them. However, the failure to regulate greenhouse gases will also entail costs—the costs of climate damage resulting from inaction.<sup>15</sup> Market-based climate policies can help minimize compliance costs while also avoiding the worst consequences of a dramatically changing climate.

No single policy can provide a comprehensive solution to mitigating climate change—a variety of policies will undoubtedly be required to address the challenges specific to different sectors of the economy. Market-based policies provide the most economically efficient path for doing so. The more flexibility that regulated businesses have, the more opportunities they will find to innovate and to reduce the costs associated with protecting the environment.

## APPENDIX A: POLICY SUMMARY TABLE

POLICY	INNOVATION	COMPLIANCE COST CERTAINTY	ENVIRONMENTAL CERTAINTY	LINKABILITY	EXPANSION	REVENUE RECYCLING
<i>Technology Mandate – Command-and-Control</i>	Limited – incentive exists to achieve mandated technology at lower costs. (Possible through frequent revision of the policy requirements.)	Yes	Yes – but depends on technology. Some technology will eliminate the pollution and others will just reduce it.	N/A	N/A	No revenue raised by policy.
<i>Performance Standard (rate based, non-tradable)</i>	Limited – once the standard can be met, there is little incentive to continue to improve performance beyond reducing costs. (Possible through frequent revision of the policy requirements.)	No – difficult for policy-makers to understand cost structures that will lead to compliance.	Some – a performance standard will require that each unit have a certain emissions profile but total emissions will depend on overall use characteristics.	Difficult to link beyond a specific sector.	Some – policy-makers can create standards specific for each sector to expand their reach.	No
<i>Performance Standard (rate-based, tradable)</i>	Yes – firms have incentive to innovate to reduce emissions and avoid buying allowances (or to have more excess allowances to sell).	No – difficult for policy-makers to foresee trading prices based on sector-wide marginal compliance costs.	Some – a rate-based standard determines the emission intensity of output; but total emissions will vary with output.	Yes – resulting “carbon price” could theoretically be linked to similar trading programs.	Potentially – but rarely done because of the need for emission conversion factors. Alberta’s baseline and credit program is essentially a performance standard across several sectors.	Potentially if there is a monetary path for compliance.

<b>POLICY</b>	<b>INNOVATION</b>	<b>COMPLIANCE COST CERTAINTY</b>	<b>ENVIRONMENTAL CERTAINTY</b>	<b>LINKABILITY</b>	<b>EXPANSION</b>	<b>REVENUE RECYCLING</b>
<i>Performance Standard (mass-based, tradable)</i>	Yes – firms have incentive to innovate to reduce emissions and avoid buying allowances (or to have more excess allowances to sell).	No – difficult for policy-makers to foresee trading prices based on sector-wide marginal compliance costs.	Yes – a mass-based standard determines the quantity of emissions output.	Yes – resulting “carbon price” could theoretically be linked to other trading programs.	Potentially – but rarely done because of the need for emission conversion factors. Alberta’s baseline and credit program is essentially a performance standard across several sectors.	Potentially – if there is a monetary path for compliance.
<i>Renewable or Clean Energy Portfolio Standard (potentially tradable)</i>	Can be limited – if standard is met and there is no ongoing incentive to invest in additional renewables. (Possible through frequent revision of the policy requirements.)	Minimal – can be difficult to know costs of meeting a renewable quota.	Some – an RPS/CES behaves similarly to a performance standard. Total emissions will vary with overall output since an RPS/CES typically requires some fraction of power to be renewable.	Yes – programs can be designed to trade production quotas, or buy renewable power, from other regions.	Minimal – an RPS could link with a renewable fuels standard, but these renewable fuel mandates are probably limited to electricity generation and transportation fuels.	No
<i>Energy Efficiency Resource Standard (potentially tradable)</i>	Can be limited – if standard is met and there is no ongoing incentive to invest in additional energy efficiency. (Possible through frequent revision of the policy requirements.)	Minimal – can be difficult to know costs of meeting an energy efficiency quota.	Some – an energy efficiency standard (or energy efficiency target) behaves similarly to a performance standard.	Limited – programs, however, can be designed to trade energy efficiency credits.	Minimal – an energy efficiency resource standard could be expanded to encompass heating fuels as well.	No

<b>POLICY</b>	<b>INNOVATION</b>	<b>COMPLIANCE COST CERTAINTY</b>	<b>ENVIRONMENTAL CERTAINTY</b>	<b>LINKABILITY</b>	<b>EXPANSION</b>	<b>REVENUE RECYCLING</b>
<i>Cap-and-Trade</i>	Yes – firms have incentive to innovate to reduce emissions and avoid buying allowances (or to have more excess allowances to sell).	No – difficult for policy-makers to foresee the price of allowances in a tradable open market (can be mitigated with price bands).	Yes – a “cap” on emissions means that the total level of emissions is known (certainty reduced with price cap or floor).	Yes – new regions can be included or merged into a trading program (may be complicated by price bands).	Yes – can be expanded to other sectors or regions.	Depends on if allowances are allocated for free or if they are auctioned to raise public revenues. Also could have a tax on trades where revenue could be recycled.
<i>Carbon Tax (on emissions or product)</i>	Yes – firms have incentive to innovate to reduce emissions and tax payments. May lead to substitution toward other goods and could lead to process efficiencies or new techniques with low carbon products.	Yes – the marginal cost of a unit of pollution is defined by the tax rate.	No – with a fixed tax rate, actual emissions will vary depending on the cost of reducing emissions as determined by such factors as economic growth, technological progress, and changes in energy supply.	Potentially harmonized with the tax rates of other governments, but may be politically contentious. Cannot be linked to trading programs to reduce compliance costs.	Potentially can be expanded to include additional sectors or regions as needed.	Yes

## APPENDIX B: GLOSSARY OF MARKET MECHANISMS CONCEPTS

**Allocation:** Under an emissions trading scheme, one approach is for emission allowances to be given away for free. Sometimes referred to as ‘grandfathering’ allowances allocated in this manner can be based on past emissions or output in a base year, or on emission performance benchmarks, or on an ‘updating’ approach based on more recent emissions or output. The alternative is to auction permits. Policymakers have discretion when allocating emission allowances and this can be a useful political tool to ease the transition to an emissions trading program, or to compensate affected parties.

**Banking:** The carry-over of allowances from one emissions trading period to the next, i.e., saving emissions allowances for use at a later date. In order for an entity to bank allowances, it must have an excess of allowances from an earlier period.

**Borrowing:** The conceptual opposite of banking; using a future emissions allowance for compliance in the current period. Often regulators design borrowing programs to include the assessment of a fee or penalty to discourage over-use of this type of provision. Borrowing leads to fewer emission reductions in the early period and more emission reductions in the later period.

**Cap and Trade:** A cap-and-trade system sets an overall limit on emissions, requires entities subject to the system to hold sufficient allowances to cover their emissions, and provides broad flexibility in the means of compliance. Entities can comply by undertaking emission reduction projects at their covered facilities and/or by purchasing additional emission allowances (or credits) from the government or from other entities that have reduced emissions below the amount of allowances held.

**Carbon Tax:** A surcharge placed on the carbon content of oil, coal, and gas that discourages the use of fossil fuels and aims to reduce carbon dioxide emissions.

**Cost containment reserve:** A policy option designed to keep allowance prices from rising above a program-wide level by releasing a supply of additional allowances once a threshold or trigger price is met, with the goal of increasing supply and reducing the market price of each allowance. Generally the number of allowances in a reserve are limited in supply and separate from the program budget.

**Cost-Effective (Cost-Effectiveness):** Minimizing the costs of achieving some given objective. A ‘cost-effective’

environmental policy achieves its environmental goals at the lowest possible overall costs. Improving a policy’s ‘cost-effectiveness’ moves in that direction – it achieves an environmental objective at a lower average unit cost.

**Discounting:** The process that reduces future costs and benefits to a present value reflective of the time value of money and preference for consumption now rather than later. A ‘discount rate’ makes an explicit assumption about the relative value of a good or service in the future compared to the present.

**Emissions Cap:** A mandated restraint in a scheduled timeframe that puts a “ceiling” on the total amount of emissions that can be released into the atmosphere, and a key component in a ‘cap-and-trade’ program. This can be measured as gross emissions or as net emissions (emissions minus gases that are sequestered).

**Emissions Tax:** A tax applied to the quantity of emissions produced.

**Emissions Trading:** A market mechanism that allows emitters (countries, companies or facilities) to buy emissions from or sell emissions to other emitters. Emissions trading is expected to bring down the costs of meeting emission targets by allowing those who can achieve reductions less expensively to sell excess reductions (i.e., reductions in excess of those required under some regulation) to those for whom achieving reductions is more costly.

**Externality:** A consequence or side effect of an economic activity that impacts individuals not directly related to the activity, and that is not reflected in prices. Environmental pollution is an example of a negative externality because pollution imposes a cost on people who are not necessarily a party to the activity that produces the pollution. It is a form of market failure.

**Linkability:** The ability of a policy mechanism to be coordinated with other similar policies. An emissions trading program (like cap and trade) has linkability because such a program can be designed so that its participants can trade emissions allowances with participants in other programs, essentially creating a common market.

**Market Failure:** When a market does not allocate resources efficiently. A negative externality caused by pollution is an example.

**Offsets:** A voluntary emission reduction project done outside of a mandatory requirement where the resulting emission reductions can be quantified and ownership transferred. Some trading programs allow the resulting ownership credit of the offset to displace a similar level of emission reduction within a trading program.

**Price Ceiling (Safety Valve):** A price ceiling is a policy option for an emissions trading program in which the regulatory authority makes a standing offer to sell additional allowances into the system at a specified price. That price serves as the upper bound that the market price for tradable emissions allowances will reach. This is used to ensure that compliance costs do not exceed policy-makers' design assumptions.

**Price Floor:** The conceptual opposite of the 'price ceiling'. In an emissions trading program, the price floor is the minimum price at which an allowance can be sold at auction. The price floor serves to place a lower bound that the market price for tradable emissions allowance will reach. Price floors are used to guarantee the value of emissions allowances, which is important for encouraging investment in emission-reducing technology.

**Revenue Recycling:** The re-use of the government revenues generated as a result of a market-based policy (either from tax receipts or from the proceeds of an allowance auction).

**Subsidy:** A government payment to encourage a particular economic action; the opposite of a tax.

## ENDNOTES

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The Center for Climate and Energy Solutions (C2ES) is an independent, nonpartisan, nonprofit organization working to forge practical solutions to climate change. Our mission is to advance strong policy and action to reduce greenhouse gas emissions, promote clean energy, and strengthen resilience to climate impacts.

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