MARKET MECHANISMS: UNDERSTANDING THE OPTIONS

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April 2015

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. Market-based policies would be among the options available to states to reduce GHGs from power plants under the U.S. Environmental Protection Agency's proposed Clean Power Plan. This 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, a clean or renewable electricity standard, and an energy efficiency resource 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 the 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

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.

that needs to be addressed (e.g., capturing externalities, splitting incentives between building developer and occupant). To the extent the introduction of these policies proceeds in a piecemeal fashion, it is important to remember that market-based policies are more efficient the more businesses and sectors they cover. With more options for reductions, it is more likely that some will be less expensive to achieve—thus reducing overall costs for a given level of emissions reduction. For this reason, designing more limited market-based policies (e.g., directed at a specific sector or state) that can later be interconnected with other market-based emission can help reduce the costs of meeting an environmental objective.

TAXES AND SUBSIDIES

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 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**.

Subsidy programs that provide government assistance (or tax credits) for specific types of low-emitting activities or technology applications function in a similar way to taxes, in that they provide a specific financial mechanism to motivate a particular environmentally beneficial outcome (they are, in fact, negative taxes). Subsidy programs are by their nature a "cost" to taxpayers in general but they are often more popular than new taxes, being seen as a carrot rather than a stick. The federal investment tax credit for solar and the former federal production tax credit for wind are examples where tax breaks are used to incentivize the deployment of renewable energy technologies. These technologies reduce greenhouse gas emissions to the extent that they displace fossil energy generation.

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.[1] 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

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.[2]

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, and greenhouse gases under programs in Europe, in California and in nine 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.

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 2007, Alberta, Canada implemented a baseline-and-credit approach as part of its climate program. The program requires large emitters to either: reduce their emission intensity—i.e., emissions per unit of reduction—by 12 percent, buy emission performance credits from other facilities in Alberta, buy offsets from other firms in Alberta that have voluntarily reduced their emissions, or pay into a fund aimed at reducing GHG emissions in the province. Similar to a cap-and-trade program, the baseline limit creates the scarcity and trading generates a value on those GHG emissions.

RENEWABLE ELECTRICITY STANDARDS

Renewable electricity 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. Often this is combined with a mechanism that reduces overall compliance costs by allowing a utility that can exceed the standard to create tradable credits that can be banked for future use or sold to other utilities for

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.[3]

However, there may be reasons to use carbon revenue for other purposes. In addition to economic efficiency, policymakers 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 $2 billion in cumulative auction proceeds.[4]

their compliance. Thirty states and the District of Columbia already have their own clean or renewable electricity standards in place.[5]

ENERGY EFFICIENCY RESOURCE STANDARD

An energy efficiency resource standard—or an energy efficiency target—is a mechanism to encourage more efficient generation, transmission, and use of electricity.[6] An energy efficiency resource standard is similar in concept to a clean or renewable electricity standard, in that the former requires utilities to reduce energy use by a specified and increasing percentage or amount each year. Twenty-one states have established mandatory long-term energy savings targets through an energy efficiency resource standard, with five other states having a non-mandatory energy savings goal. In additional cases, the state clean or renewable electricity standard or goal allows energy efficiency measures to qualify. In a few states private companies can generate energy savings certificates by taking steps to reduce electricity consumption. These certificates can then be sold to utilities and used toward compliance with the state standard.

CAFE STANDARDS

Corporate Average Fuel Economy (CAFE) standards are used for regulating the fuel economy (i.e., miles per gallon of gasoline) of new light-duty vehicles, which include passenger cars and light trucks such as pickups.[7] This standard is calculated using the harmonic mean of the fuel economy of vehicles produced for sale in a year using a set of fuel economy targets that is based upon each vehicle's footprint. The automaker must meet or exceed this standard (including using optional credit transfers) or the firm must pay a fine based on the number of vehicles sold and the magnitude of the difference between the standard and the achieved sales-weighted average. Like a rate-based baseline-and-credit type of emissions program, CAFE standards are designed so that companies that exceed their fuel economy requirements can sell credits associated with that additional fuel economy to firms that do not meet the standard in a given year.

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).

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 $228 million (in 1985 US$), and other analysts have suggested that the savings were even higher.[8] 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.[9]

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.[10]

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.[11] 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.[12]

EUROPEAN UNION EMISSIONS TRADING SYSTEM (EU ETS)

The European Union Emissions Trading System (EU ETS) 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 creates a market of tradable allowances for emissions among the European Union member states.

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. Firms can also use emission reduction credits from the Clean Development Mechanism (CDM) for compliance with the program.[13] While some CDM credits have been the subject of controversy, they are widely supported by industry as a tool to control program costs and provide market liquidity. The EU ETS is currently in its third phase, which will run from 2013 through 2020. Firms were allowed to bank excess allowances and credits from phase two to phase three.

REGIONAL CLEAN AIR INCENTIVES MARKET (RECLAIM)

A regional example of an environmental market-based policy is the Regional Clean Air Incentives Market (RECLAIM) in Southern California. RECLAIM is designed to reduce emissions of nitrogen oxides and sulfur dioxide in the region in a cost-effective manner. The program splits the affected region in Southern California into two zones, coastal and inland. The trading program—which began in 1994—allows trading of emission allowances within each of the zones, but prohibits trades from the inland region to the upwind coastal region (in an effort to enhance the protection of the downwind region—trading from the coastal region to the inland region is allowed). The program does not allow banking of current allowances for future years, which has reduced its cost-saving potential but has enhanced the protection to human health by minimizing highly localized pollution concentrations.

REGIONAL GREENHOUSE GAS INITIATIVE (RGGI)

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.[14] RGGI originally set the cap to stabilize power plant emissions at 188 million tons of carbon dioxide annually between 2008 and 2011. Following the departure of New Jersey, the cap was lowered to 165 million tons between 2012 and 2013. As of 2014, the emissions cap was again lowered to 91 million tons. The cap will further decline 2.5 percent annually until 2020, resulting in a cumulative 15 percent reduction in annual emissions from the 2014 cap.

RGGI requires fossil fuel power plants over 25 megawatts in participating states to obtain an allowance for each ton of carbon dioxide emitted annually. 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.

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.[15] The program initially covered electric generators and industrial plants. As of 2015, the program also includes distributors of transportation and heating fuels. California's program imposes an overall greenhouse gas emission limit that will decrease by 2 percent annually from 2013 to 2015, and by 3 percent annually from 2015 through 2020.

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.

MARKET MECHANISMS UNDER THE CLEAN POWER PLAN

Absent congressional action to reduce greenhouse gas emissions, EPA has taken steps to regulate greenhouse gas emissions under its Clean Air Act authority. To that end, EPA has proposed emission regulations for power plants. Specifically, EPA's proposed Clean Power Plan would regulate carbon dioxide emissions from existing power plants with the aim of reducing emissions 30 percent from 2005 levels by 2030. The plan would establish different target emission rates for each state—due to regional variations in generation mix and electricity consumption.[16] States would have flexibility to design implementation plans that work best for them in achieving their emission targets. State plans could include market-based mechanisms, such as averaging or trading.

States could convert their emission rate (tons per megawatt-hour) to a mass-based standard (tons per year). This option should make it more straightforward for states to comply through a mass-based emissions allowance program. This would allow California and the nine states participating in RGGI to demonstrate that their cap-and-trade programs satisfy the required reductions under the plan, and that further regulations are unnecessary. Other states could use this option to implement the Clean Power Plan, completely or partially, through a cap-and-trade system, a carbon tax, or any other mix of market-based mechanisms.

The proposed Clean Power Plan also gives states the option of complying as an individual state or as a group of states. States have long collaborated to achieve energy and environmental goals (e.g., through the sulfur dioxide trading program) and the Clean Power Plan would provide an opportunity to expand on these efforts. A multi-state approach could be similar to RGGI in that it would regulate carbon dioxide emissions from power plants across multiple states.[17] This could also be accomplished through another existing authority such as a local Regional Transmission Organization (RTO) or Independent System Operator (ISO).[18] Alternatively, states sharing common plan elements could allow trading across state lines even though the programs are not formally linked.

Flexibility is a key feature of the Clean Power Plan and the ability to use a market-based program to meet GHG objectives is one that several states are exploring.[19] Using a market-based approach will likely allow power plants and states to reduce their overall compliance costs by taking advantage of the lowest-cost opportunity for emissions 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.[20] 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. The proposed Clean Power Plan would give states significant flexibility to use market-based approaches and interstate cooperation to reduce power plant carbon emissions.

APPENDIX A: POLICY SUMMARY TABLE

POLICY	INNOVATION	COMPLIANCE COST CERTAINTY	ENVIRONMENTAL CERTAINTY	LINKABILITY	EXPANSION	REVENUE RECYCLING
Technology Mandate—Command-and-Control	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.
Performance Standard (rate based, non-tradable)	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 policymakers 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 - policymakers can create standards specific for each sector to expand their reach.	No
Performance Standard (rate-based, tradable)	Yes - firms have incentive to innovate to reduce emissions and avoid buying allowances (or to have more excess allowances to sell).	No - difficult for policymakers 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 other trading programs.	No - difficult to expand beyond initial sector.	No

POLICY	INNOVATION	COMPLIANCE COST CERTAINTY	ENVIRONMENTAL CERTAINTY	LINKABILITY	EXPANSION	REVENUE RECYCLING
Renewable or Clean Energy Portfolio Standard (potentially tradable)	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
Energy Efficiency Resource Standard (potentially tradable)	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
Cap-and-Trade	Yes - firms have incentive to innovate to reduce emissions and avoid buying allowances (or to have more excess allowances to sell).	No - difficult for policymakers 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.

POLICY	INNOVATION	COMPLIANCE COST CERTAINTY	ENVIRONMENTAL CERTAINTY	LINKABILITY	EXPANSION	REVENUE RECYCLING
Carbon Tax (on emissions or product)	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
Production Tax Credit	Limited - induces innovation for production of favored technologies. Does not incentivize new technologies or processes. (Possible through frequent revision of the policy requirements.)	Yes - provides financial incentive to producers. Costs to businesses taking advantage of the credit are negative.	No - actual deployment of technologies will depend on other market conditions in addition to the magnitude of the tax credit.	No	No	No - reduces tax receipts.
Feebates (revenue neutral)	Yes - efficiency is priced into the good so consumer-demand will continuously shift for more efficient products.	Yes - there is no compliance cost to manufacturers, only changing consumer demand patterns based on altered final retail prices.	No - many other market factors will influence ultimate uptake of efficient goods.	No	No	Depends on "zero-point" of feebate. Typically designed to be revenue-neutral.

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-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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3 Joseph E. Aldy, Eduardo Ley, and Ian W. H. Parry, *A Tax-Based Approach to Slowing Global Climate Change*, RFF DP–08–26, (Washington, DC: Resources for the Future, 2008), http://www.rff.org/rff/documents/rff-dp-08-26.pdf.

4 "Regional Greenhouse Gas Initiative (RGGI) CO2 Budget Trading Program - Auction Results," Regional Greenhouse Gas Initiative, last accessed April 8, 2015, http://www.rggi.org/market/co2_auctions/results.

5 "Renewable and Alternative Energy Portfolio Standards," Center for Climate and Energy Solutions, last accessed April 8, 2015, http://www.c2es.org/us-states-regions/policy-maps/renewable-energy-standards.

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7 "Federal Vehicle Standards," Center for Climate and Energy Solutions, last accessed April 8, 2015, http://www.c2es.org/federal/executive/vehicle-standards.

8 Robert Hahn, "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders," *The Journal of Economic Perspectives* 3, No. 2 (1989): 95–114.

9 Thomas H. Tietenberg, *Emissions Trading: Principles and Practice* (Washington, DC: Resources for the Future, 2006).

10 "Savings from Using Economic Incentives for Environmental Pollution Control," U.S. Environmental Protection Agency, last modified April 7, 2015, http://yosemite1.epa.gov/EE/epa/eed.nsf/webpages/SavingsFromEconomicIncentivesTOC.html.

11 For more information about the Acid Rain Program, see A. Denny Ellerman and Paul L. Joskow, *Emissions Trading in the U.S.: Experience, Lessons, and Considerations for Greenhouse Gases* (Arlington, VA: Center for Climate and Energy Solutions, 2003), http://www.c2es.org/publications/emissions-trading-us-experience-lessons-and-considerations-greenhouse-gases.

12 Larry Parker, and Brent D. Yacobucci, *Climate change costs and benefits of the cap-and-trade provisions of H.R. 2454*, R40809 (Washington, DC: Congressional Research Service, Library of Congress, 2009).

13 The Clean Development Mechanism was created under Article 12 of the Kyoto Protocol. The mechanism allows for the approval of emission-reduction (or emission removal) projects in developing countries that can earn certified emission reduction (CER) credits. These saleable credits can be used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol.

14 "Regional Greenhouse Gas Initiative (RGGI)," Center for Climate and Energy Solutions, last accessed April 8, 2015, http://www.c2es.org/us-states-regions/regional-climate-initiatives/rggi.

15 "California Cap and Trade," Center for Climate and Energy Solutions, last accessed April 8, 2015, http://www.c2es.org/us-states-regions/key-legislation/california-cap-trade.

16 "Carbon Pollution Standards," Center for Climate and Energy Solutions, last accessed April 8, 2015, http://www.c2es.org/federal/executive/epa/carbon-pollution-standards-power-plants.

17 Sam Hile, *Cross-State Electricity Load Reductions under EPA's Proposed Clean Power Plan* (Arlington, VA: Center for Climate and Energy Solutions, 2014), http://www.c2es.org/publications/cross-state-electricity-load-reductions-under-epas-proposed-clean-power-plan.

18 Ken Colburn, "Tackling 111(d): Could Regional Approaches Rule?" Regulatory Assistance Project, last accessed April 8, 2015, http://www.raponline.org/featured-work/tackling-111d-could-regional-approaches-rule.

19 The Virginia Department of Environmental Quality commented that EPA should amend the definition of "emission standard" in regulations associated with the Clean Power Plan rule to increase state flexibility. They note states could devise broader, more creative, and more effective options to reduce emissions, possibly through some type of allowance system. See Michael G. Dowd, *Comments Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units* (Richmond, VA: Virginia Department of Environmental Air Quality, 2014), available as an attachment to *Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units*, Docket ID No: EPA-HQ-OAR-2013-0602, http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2013-0602-23258. Michael Wara and Adele Morris note that states could use a carbon tax to comply through the Clean Power Plan. However, they argue the proposed rule does not give states full flexibility in how they might design their carbon excise taxes—i.e., if a state imposes a carbon tax on the fuels used by power generators, the tax liability would be on the fuel suppliers and not the power generators. Clarifying the definition of "emission standard" ensures states could impose a carbon tax on existing power generators instead of upstream or downstream entities. See Michael Wara, Adele Morris, and Marta Darby, *How the EPA Should Modify Its Proposed 111(d) Regulations to Allow States to Comply By Taxing Pollution* (Washington, DC: The Brookings Institution, 2014), available as an attachment to *Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units*, Docket ID No: EPA-HQ-OAR-2013-0602, http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2013-0602-21275.

20 See "Science & Impacts," Center for Climate and Energy Solutions, last accessed April 8, 2015 http://www.c2es.org/science-impacts; and "Adaptation," Center for Climate and Energy Solutions, last accessed April 8, 2015 http://www.c2es.org/science-impacts/adaptation.