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Designing Successful Greenhouse Gas Emission Reduction Policies: A Primer for Policymakers – The Perfect or the Good?

Bruce Phillips and John Reilly

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This reprint is intended to communicate research results and improve public understanding of global environment and energy challenges, thereby contributing to informed debate about climate change and the economic and social implications of policy alternatives.

—Ronald G. Prinn and John M. Reilly,
Joint Program Co-Directors

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Designing Successful Greenhouse Gas Emission Reduction Policies: A Primer for Policymakers – The Perfect or the Good?

Bruce Phillips[1] and John Reilly[2]

Abstract: This paper evaluates four types of greenhouse gas emission reduction policies, carbon taxes, cap and trade (C&T) programs, tradeable performance standards (TCES) and technology-neutral clean energy standards (CES), with a focus on the design levers available to policymakers to shape their structure and impacts. These design elements include production metrics, pricing mechanisms, technological neutrality, uniform standards, scope of coverage, balancing emission and cost risks, and managing distributional impacts. The paper concludes that, while there are fundamental differences among the four policy approaches and careful design is needed for any of them to work as well as possible, each of them could: 1) reasonably satisfy a comprehensive list of policy criteria and as such be environmentally effective, cost effective, equitable, robust and durable, and at the same time also be 2) preferable to either command and control regulations or 100% renewable portfolio standards approaches to deep decarbonization. The paper ends by identifying several implications for policymakers: 1) most importantly, federal policy makers have a broad array of options to craft durable greenhouse gas emission reduction policies; 2) if a carbon tax or C&T legislation cannot be passed, the importance of durability likely argues for the policy that could be enacted through legislation rather than agency rulemaking, which suggests a preference for a CES over a TPS; and 3) there is also opportunity to establish a regionally diverse mix of emission reduction policies, building on current regional and state efforts, provided they are linked or harmonized to deter emissions leakage and foster cost effectiveness. Given the historic difficulty of establishing federal climate policies and the uncertainty of achieving broad support for any single policy going forward, the chances of success will be increased if regulators can be given more policy options rather than fewer.

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1. Introduction and Summary

Over the last 10 years, despite considerable effort, the United States has not established a comprehensive federal policy to control greenhouse gas emissions: cap and trade legislation failed to gain Congressional approval in 2010, the emission regulations embodied in the Clean Power Plan of 2014 are currently being litigated and, more recently, a carbon tax was not incorporated into the Tax Cuts and Jobs Act of December 2017. At the same time, state and local proposals to fully decarbonize the power sector exclusively with renewable portfolio standards (RPS) have become increasingly common, though many if not most energy policy analysts see this as a costly and uncertain if not impractical pathway to full decarbonization of the U.S. economy.

In concept, the need for a better greenhouse gas emission reduction policy could be met by any of at least four policy approaches: carbon taxes, cap and trade (C&T) programs, tradeable performance standards (TPS) and tradeable, technology-neutral clean energy standards (CES).[1] The carbon tax and C&T approaches are generally well known. A technology-neutral CES requires covered entities to meet or achieve a minimum percentage of their supplies through qualifying sources of low-carbon or zero-carbon energy (like a renewable portfolio standard but on a technology-neutral basis). A TPS is a form of a conventional emission performance standard but also includes a mechanism for trading emission credits, hence the term tradable performance standards or TPS.

Before discussing these emission reduction approaches, it is worth noting that they should not be considered substitutes for technology innovation policies. Well-designed emission reduction policies, with enough stringency and durability, can provide a “market-pull” incentive for the private sector to deploy existing technologies and invest in technology innovation. But achieving the ambitious goal of completely decarbonizing the global economy in the relatively short period of just several decades will require both substantial cost reductions and performance improvements in existing technologies as well as the development and commercialization of new firm, dispatchable zero-carbon technologies. This is most likely to come about with parallel, complementary “technology-push” policies, including expanded government-sponsored R&D, demonstration and deployment programs that go beyond what the private sector would otherwise undertake on its own. While this is an important policy need, for the purpose of this paper, it is separable from emission reduction policies, and so does not explicitly factor into the policy criteria used to evaluate emission reduction policies in this paper.

Economic and policy analyses of these emission reduction approaches in recent years have often focused on which one is economically optimal or otherwise the “best”, and that debate underlies current policy discussions about the most promising federal climate policy going forward.

In brief summary, this paper argues that there are two basic policy-relevant tests to consider in evaluating candidate emission reduction policies, that policymakers have a large number of tools available to design policies in ways that meet these two tests and that (while recognizing fundamental differences among the policy approaches and the need for careful design) any of the four policy approaches could be designed to reasonably meet the tests.

The first of these tests is whether a policy could be designed to be environmentally effective, cost effective relative to the status quo (that is, no new federal greenhouse gas emission reduction policy), equitable in a distributional sense, robust in the face of emission and cost uncertainty and durable over time. The second test is whether the policy could be designed to be preferable to the most likely alternatives to that policy, that is, whether the policy does a better job of satisfying these criteria than the alternatives. At this point in time, these alternatives include piecemeal command and control regulations of greenhouse gas emissions at the state and federal level, and a federal renewable portfolio standard policy designed to achieve deep levels of decarbonization exclusively with renewable generating technologies (referred to in this paper as a 100% RPS policy). [2]

In evaluating the extent to which any of the four policy approaches could meet these twin tests, it is essential to keep in mind that there are many design elements available to policymakers in shaping the contours and impacts of these policy approaches. These design elements include the use of production-based metrics (that is, a unit of productive output such as tons emitted, electricity generated or emissions per unit of energy), pricing mechanisms, technological neutrality across all zero- and low-carbon generating technologies, uniform emission standards, broad policy coverage and harmonization with GHG policies in other sectors, mechanisms to balance emission and cost risks, and tools to manage distributional impacts.

While there are fundamental differences between the four policy approaches discussed in this paper and inevitable tradeoffs among them, any of them could be designed to reasonably satisfy the policy criteria and be preferable to

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[1] Since there are numerous ways to design each of these policies (the point of regulation, the mix of auctions and free allocation of allowances, the scope of emission and technology coverage, etc.) and their impacts inevitably rest on many important details, this paper typically refers to “approaches” as a general form of regulation rather than “policies” as a more specific form of any of these general approaches.

[2] Another candidate test is political feasibility, the likelihood that any of these approaches could in some form be enacted. While clearly important, that debate is outside the scope of this paper.

the 100% RPS and command and control alternatives. The strengths, advantages and complexities of carbon taxes and C&T in this regard are well-recognized. However, CES and TPS policies, when designed around production metrics, pricing systems, technological neutrality, linkages to emission polices in other sectors, and quantity-based tools to manage emission and cost risks, could also reasonably satisfy the policy criteria outlined in this paper. Importantly, while CES and TPS approaches are generally more costly than taxes or C&T policies (and therefore, in this respect, not perhaps the optimal or "best" approach), analyses presented in the policy literature show that well designed CES and TPS could be less expensive than command and control regulations or 100% RPS policies and yield economic benefits roughly five to ten times their costs. Further, tools discussed later in this paper are available to policymakers to make CES and TPS policies environmentally effective, equitable, robust and durable.

So, while carbon taxes and C&T may often be considered "the perfect", CES and TPS policies could reasonably be considered "the good" when compared to command and control, 100% RPS and the status quo, and so well worth pursuing if one becomes a politically viable policy path forward.

This points to several implications for policymakers.

- First, policy makers have a broad array of options available to successfully craft a durable federal greenhouse gas emission reduction policy. Given the historic difficulty of establishing a federal climate policy and the uncertainties of achieving broad support for any single policy option going forward, the chances of success will be increased if regulators can be given more policy options rather than fewer.
- Second, if carbon tax or C&T legislation cannot be passed and the policy decision comes down a choice between well-designed CES and TPS policies, the importance of durability over time would likely argue for the policy that could be enacted through legislation rather than agency rulemaking. This may suggest a preference for a well-designed CES policy over a well-designed TPS policy.
- Third and finally, it also implies some opportunity for a regionally diverse mix of these policies, building on current regional and state efforts, provided that they are harmonized or linked in some fashion, either directly or indirectly, to deter emissions leakage and foster cost effectiveness.

The remainder of this paper is organized as follows. First, it describes a set of policy criteria for evaluating alternative carbon emission reduction approaches that is synthesized from the literature over the last decade. Following that, the paper discusses a short list of policy design elements that could be used by policymakers to tailor the four emission reduction approaches discussed in this paper, so they come as close as possible to satisfying the policy criteria. The paper then evaluates the four policy approaches in light of these design elements and the policy criteria.

2. Criteria for Evaluating Emission Reduction Policies

In considering the four emission reduction approaches and the alternatives to those policies, a successful emission reduction policy will need to satisfy the following policy criteria:

- **Environmentally Effective** – The policy should help lead to or be compatible with full decarbonization, including the power and non-power sectors of the economy, other sources of greenhouse gas emissions (non-point, small carbon and non-carbon emissions) as well as greenhouse gas emissions in other countries. Broad sectoral and emissions coverage, provisions to minimize emissions leakage, and the structural flexibility to be expanded over time and linked to other greenhouse gas policies, domestic or international, are all important attributes.
- **Cost Effective** – The policy should be more cost-effective than the status quo (that is, no comprehensive federal greenhouse gas emission policy) as well as command and control regulation and 100% RPS approaches to deep decarbonization, accounting for the direct costs of the policy, indirect social costs and any macroeconomic impacts including those associated with recycling of government tax or emission credit auction revenues.
- **Equitable** – While economic winners and losers are to some extent inevitable, the impact of the policy on consumer wealth and employment across a range of income levels including low income households, wholesale and retail market prices, state economies in high-carbon energy producing and consuming regions of the country, the international competitiveness of energy intensive industries must be sufficiently equitable to be accepted by the public and policymakers.
- **Robust** – The policy should be sufficiently flexible so that it can perform successfully under economic and technical uncertainty. Large unanticipated emission outcomes or compliance cost impacts triggered by commodity price fluctuations, technology developments or other conditions in the economy should be manageable at the overall program level and also by emitters covered under the policy without requiring fundamental restructuring of the policy itself.
- **Durable** – Policies that can satisfy these first four criteria should also be durable over time, an essential attribute of any such policy intended to endure for several decades at a minimum.

While not exhaustive,[3] this list of policy criteria is consistent with the climate policy literature that has been published over the last dozen years. See, for instance, Parry and Pizer (2007), Stavins (2007), Metcalf (2007), Furman *et al.* (2007) and Rubin (2009). These five policy criteria represent a reasonably comprehensive list and policy approaches satisfying the criteria will likely have better prospects than other approaches.

3. Fundamental Policy Attributes and Design Elements

The four policy approaches discussed in this paper can all be designed in various ways to achieve specific policy goals and satisfy the criteria listed earlier. The following is a list of policy attributes and design elements that may be used to characterize the policy approaches and shape their design. A table at the end of this paper summarizes these design elements in relation to the four policy approaches.

1. **Production-Based Metric** – Emission reduction policies would best act on the basis of a production metric, that is, a unit of generation or productive output such as tons emitted, electricity generated or unit of emissions per unit of energy input or output (more specifically, tons per MWh or pounds per MMBtu). A production-based metric provides incentives for covered entities to make operational improvements such as re-dispatch or efficiency improvements as well as investments in new low- and zero-carbon technologies and retirements of existing carbon-emitting power plants, which, in turn, provides a stronger incentive for cost-effectiveness. This approach contrasts with a policy based on a unit of generating capacity or similar metric that is not tied to the amount of productive output associated with a generating facility. One example of a capacity-based metric would be a simple "birthday" policy requiring fossil-fired power plants, when they reach a predetermined age to either retire or retrofit with carbon capture and sequestration equipment in order to achieve a specified carbon emission rate.[4] While this type of birthday policy could be relatively straightforward for vertically-integrated utilities to implement as part of their resource planning processes, it would, without an emissions trading program, incent retirements and retrofits but not the operational improvements that would lead to greater cost effectiveness.
2. **Pricing Mechanism** – A transparent price applied to the production metric would establish compliance incentives and flexibility for covered entities, and cost effectiveness for the emission reduction program. See, e.g., Metcalf (2007), Parry and Pizer (2007), Stavins (2007). In the centralized wholesale power markets, the price would be reflected in the energy bids provided by generators, economic dispatch decisions and market prices for energy. This would improve the relative competitiveness of low-emitting and zero-emitting resources and facilitate more cost-effective compliance decisions. Forms of market-based pricing have been a hallmark of cost-effective environmental policy over the last several decades as detailed in Schmalensee *et al.* (2015).
3. **Technological Neutrality** – Covering all emitting and non-emitting power generating technologies in a technologically-neutral manner promotes cost effectiveness by providing broad operational, investment and retirement incentives for all technologies operating within the integrated energy system, rather than just a preferred subset of low-carbon technologies such as solar or wind. Regardless of the particular policy approach, technology-neutrality would have the effect of pulling the lowest cost low-carbon or zero-carbon technologies into the market, causing the retrofit or retirement of relatively high-emitting sources of generation and efficiently shifting the dispatch between emitting and non-emitting generators. Taken together, this would lead to more cost-effective emission reductions than would be achieved by alternative policies designed for a limited subset of low or zero carbon technologies while also accounting for other essential services provided by the electric system including reliable and resilient service. See, for instance, Parry (2015).
4. **Uniform Standards** – Applying policy regulations on a uniform basis (i.e. with the same or consistent emission standards) across all covered emitting technologies (new and existing resources, technologies that vary by fuel type and efficiency, technologies with differing combustion processes, etc.) and across geographic areas (such as states and regions) would reduce emission leakage and support overall cost-effectiveness. Consistency would help avoid material differences in the marginal compliance costs across firms or regions and encourage emission reductions where possible at relatively low cost. See, e.g., Goulder and Hafstead (2018). As discussed later, there are likely to be tradeoffs between this design element

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[3] This list of policy criteria does not, for example, reflect some other practical considerations such the policymaking risk associated with the need for alternative forms of legislation to be considered by different Congressional committees, or the implementation risk associated with the need for alternative policies to be implemented through different administrative agencies or subject to varying degrees of judicial review.

[4] If a birthday policy were applied to all the fossil power plants in a region or across the country, it would in effect establish a soft emissions cap with the cap depending on the utilization of each power plant subject to the birthday requirement and the emission rate it would be required to meet if it retrofits rather than retires. With a trading program, the birthday concept would start to look like a version of a C&T program with a soft cap or else a tradeable performance standards policy.

and other design elements that influence the distribution of gains and losses from regulations as well as overall program cost effectiveness.

5. **Broad Coverage and Harmonization** – Broad coverage within and across sectors of the economy that emit greenhouse gases, including both existing and new capital equipment would encompass a broader range of potential emission reduction activities and avoid leakage to sectors not covered by the policy as discussed in Goulder and Hafstead (2018) and Stavins (2007). Broad coverage facilitates deep emission reductions and leads to cost effective compliance. To the extent an initial emission reduction policy is not economy-wide, the opportunity to expand it or link it to policies covering other sectors of the domestic economy (such as transportation or industry) or small, non-point or non-CO_2 emissions would support cost-effectiveness over time. And regardless of whether an initial policy is economy-wide, the opportunity to coordinate or harmonize it with similar policies in other countries is similarly helpful. This might be done by linking emission credit trading markets, coordinating pricing levels across similar programs, establishing border adjustments or implementing other mechanisms as discussed later in relation to the four policy approaches.
6. **Tools to Manage Distributional Impacts** – The distribution of economic gains and losses resulting from these policies will differ across income groups, regions of the country and industries, including energy-intensive exporters and importers, in ways that implicate the fairness and feasibility of the policy. This includes concerns from the environmental justice community about the local impacts of plant operations on minorities and low-income groups. The pattern of impacts will be shaped by the particular design of each policy and a wide variety of policy tools are available to help manage the distribution of costs and benefits in a way that could be acceptable to the public and policymakers. A partial list of these include the allocation of emission credits, changes in tax rates, credits, rebates, exemptions, border carbon adjustments, subcategorization of emission rate standards, and the rate at which clean energy credits are issued and redeemed. See, e.g., Goulder and Hafstead (2018).
7. **Tools to Balance Emission and Cost Risks** – Emission reduction policies that rely strictly on pricing mechanisms without constraints on the quantity of emissions provide relative certainty for program costs but allow for uncertainty in the level of emission reductions that will be achieved over time. In contrast, policies that rely strictly on emission limits or caps do the reverse – they provide certainty over emission reductions but allow for uncertainty in program pricing and costs. Each of these approaches is potentially problematic in its own way. Price volatility may deter new investments and raise overall program costs, undermining cost effectiveness as discussed in Parry (2015). Emissions uncertainty calls into question when and whether the policy will achieve its fundamental goals to reduce and effectively eliminate greenhouse gas emissions over time. Both sources of risk undermine policy durability. In response to these types of concerns, various policy tools have been developed and some implemented over the years such as banking, borrowing, alternative compliance payments and mechanisms to adjust carbon tax levels. Combining these mechanisms in a way that hybridizes pricing and quantity-based approaches may yield improvements in cost effectiveness as discussed in Schmalensee (2015).

4. The Four Policy Approaches in Context

Before delving into an assessment of the policy approaches, a brief note on what is meant by each of the four policy approaches is in order.

The carbon tax and C&T approaches are commonly known. The first is a tax on the carbon content of fossil fuel production or fossil fuel-fired electric generation intended to reduce carbon emissions. The second is a regulatory system involving a limit or cap on carbon associated with fossil fuel production or electricity generation and a mechanism for entities covered by the regulation to trade emission allowances under the cap. Among other variations, either may be designed to cover the electric sector alone (through a downstream point of regulation) or be economy-wide (with an upstream point of regulation).

Each of the two other policy approaches discussed in this paper, CES and TPS, represent a particular formulation of that policy approach that is material to this discussion. The CES, as discussed later, is assumed to be technology neutral. That is, unlike some other variants of a CES that exclude certain zero- and low-carbon generating technologies, it is envisioned to provide qualifying clean energy credits to all zero-carbon technologies including nuclear and partial credit to low-carbon fossil technologies. The partial credit would be scaled to reflect the relatively low carbon emissions from natural gas-fired electric plants and any carbon capture and sequestration utilized at fossil power plants. The TPS policy approach is unlike conventional emission performance standard regulations as it is envisioned to include a mechanism for tradeable credits, hence the term tradable performance standards. See Burtraw (2012).

There are without question fundamental differences among the four policy approaches. For instance, carbon taxes and C&T programs could be implemented on an economy-wide basis, facilitating relatively deep and cost-effective emission reductions. In contrast, CES and TPS policies are more reasonably limited to the electric sector though they could be complemented by analogous emission reduction policies in other sectors. Similarly, carbon taxes and C&T programs may also be designed to raise revenue for the government. This could facilitate cost effectiveness depending how the revenue is recycled through the economy and may be used to address concerns over distributional equity.

The policy details of each approach matter in important ways. The list of design elements discussed in section III reflects levers that policymakers may use to shape the contours of emission reduction programs: technological neutrality, scope of program coverage, uniformity of emission standards, various tools to manage cost and emission risks, and other mechanisms to manage distributional equity. These may be used to improve performance across a range of policy criteria.

Focusing specifically on carbon taxes and C&T policies, there is general agreement among many policy analysts that these two approaches can, with thoughtful design, be structured in ways to hybridize them and draw on each policy's strength to achieve quite similar economic, risk and distributional impacts. These are discussed at length by Parry and Pizer (2007), Stavins (2007), Parry (2015) Goulder and Hafstead (2018).

While this opportunity does not hold to the same extent for CES and TPS, it is nonetheless the case that policymakers still have considerable flexibility to design these approaches and that this flexibility can allow them to reasonably satisfy the criteria listed in Section II and outperform policy alternatives such as command and control regulation and 100% RPS policies.

In fact, several policy analysts, in considering a diverse range of emission reduction policies and using a variety of policy criteria, have concluded that the specific design of an emission reduction policy may in some circumstances be more important to the policy's cost effectiveness and ability to satisfy other policy criteria than the general form of the policy. Goulder and Parry (2008), Parry (2015) and Goulder and Hafstead (2018).

The remainder of this section addresses these issues in greater detail, evaluating the four broad policy approaches considering the policy attributes and design elements reviewed in section III.

4.1 Environmental Effectiveness

Broad coverage across the multiple sectors of the economy emitting greenhouse gases, both domestically and internationally, is desirable because it would drive deeper emission reductions and allow a more complete array of potential low-cost emission reductions to be captured by the policy.

Carbon taxes and C&T programs are particularly strong in this regard because they can be designed to cover electric and non-electric sectors of the economy and, in the absence of major industry exemptions or carve-outs, have economy-wide coverage, at least within the United States. In contrast, CES and TPS programs are limited to downstream points of regulation in the electric sector and so have more narrow coverage than could be achieved under an economy-wide approach. Without complementary emission reduction policies for other sectors and careful program design, relying solely on policies such as CES or TPS would not yield broad economy-wide emission reductions and could result in emission leakage from sectors of the economy covered by the policies to other uncovered sectors of the economy.

At the same time, linking relatively narrow emission reduction programs and harmonizing program designs can help address this limitation of TPS and CES programs. They may also allow domestic and international emission reduction programs to be brought into line with one another. Such linking and harmonization of policies would improve cost-effectiveness, facilitate trading liquidity and promote price stability as argued by Aldy (2017).

Separate but similarly designed emission reduction programs may be directly linked by allowing covered emission sources in one program to demonstrate compliance by acquiring equivalent allowances from the other program. This is most readily seen in the context of multiple C&T programs as is currently being done by the California, Ontario and Quebec programs.

Some policy analysts (Mehling *et al.*, 2017; Aldy, 2017) have argued that emission reduction programs differing more broadly, including those that use different policy metrics, may also be directly linked to one another, at least under some conditions. For instance, Mehling, Metcalf and Stavins (2017) have suggested that carbon tax systems could be linked to C&T programs by allowing emission sources covered under the C&T program to sell allowances to sources covered under the tax system and allowing those emission credits to be used to reduce the tax obligation. They also argue that in principle tax systems and C&T programs could be directly linked with performance-based regulatory systems. As long as the regulatory metric in the performance standard system is in the form of a similar quantity-based standard, an emission intensity standard may be translated into a quantity standard comparable to the C&T or tax program (Mehling *et al.* 2017; Burtraw *et al.* 2012).

Where the regulatory metric is not denominated in the quantity of emissions but rather another form such as the amount or rate of clean energy generation as in a CES program, direct linkage is not likely feasible. However, harmonizing the separate programs may still be possible and beneficial. Disparate programs might be harmonized if the stringency of each program is set in a way that the marginal abatement costs of each program are generally in line with one another. Similarly, analysts have suggested that separate carbon tax programs could be harmonized by setting the taxes at the same level. See, e.g., Aldy (2017) and Goulder and Parry (2008). In the case of the Clean Power Plan (CPP), EPA sought to allow states with existing GHG regulatory programs to satisfy the requirements of the CPP by demonstrating the equivalency of their programs with the CPP standards; this would be an example of harmonization between the EPA's CPP program (in essence, a TPS program) and state GHG regulatory programs (cap and trade programs).

This opportunity to harmonize or link differing programs also raises the prospect of tying together what would otherwise be disparate regional or state-based programs across the country into a more coherent and cost effective decarbonization pathway. This may allow regions and states seeking to achieve somewhat differing distributional impacts across their economies to achieve these disparate outcomes and be an alternative to a nationally uniform policy. Jenkins and Karplus (2016) argue that there may be advantages to this from a political economy perspective.

Directly linking compatible programs across international boundaries or, alternately, harmonizing their goals and stringencies, could also be beneficial. For example, international linkage of policies could involve formally recognizing that emission reductions achieved in one nation's program could be used to demonstrate compliance under another nation's program. See, for instance, Mehling *et al.* (2017).

There are limits to the environmental gains that may be achieved through direct linking and harmonization relative to more uniform, economy-wide approaches. Looking at the U.S., Parry (2015) concluded that the combined effect of a CES program, fuel economy standards and energy efficiency standards concluded such an approach would miss about a third of the reduction opportunities achievable under an economy-wide policy.

At the same time, linking and harmonization provide a powerful set of tools to expand the effective coverage of emission reduction policies, both domestically and internationally. They are unlikely to make all four policy approaches equivalent in terms environmental effectiveness, but they should allow for a broad scope of coverage.

4.2 Cost effectiveness

The cost effectiveness of the four broad policy approaches is influenced in part by fundamental aspects of each approach but are also strongly shaped by specific design choices that can vary across proposals that take the same overall approach.

Taxes and C&T Relative to Command and Control

Many economists and other policy analysts studying carbon tax and C&T policies over the years have concluded that either approach could be a cost effective or economically efficient way to reduce carbon emissions when compared to the status quo (that is, the economy without a federal carbon emission reduction policy) or when compared to command and control policies designed to reduce carbon emissions. See, for example, Parry and Pizer (2007), Stavins (2007 and 2009), Metcalf (2007), Aldy (2017), Aldy *et al.* (2010), Furman *et al.* (2007).

The reason these policies can be more cost effective than command and control regulations, fundamentally, is that policymakers designing command and control regulations will not have complete information on all potential compliance options or how they vary over time, and so will not be able to design and adapt command and control polices to achieve the lowest cost compliance possible as market conditions change over time; in contrast, a carbon price provides financial incentives for emitters to seek out the lowest cost emission reduction opportunities and for innovators to develop new low-emitting technologies. Because covered emitters and innovators have more and better information about the full range of potential compliance options, providing them incentives and the flexibility to achieve compliance as they best see fit will tend to result in lower cost compliance than would be likely under command and control regulation.

Several the design elements listed earlier in section III contribute in important ways to the cost effectiveness of carbon taxes and C&T policies. Both carbon taxes and C&T policies rely on production metrics (tons of emissions over the course of a year), pricing systems (whether set by a tax per ton of emissions or a market-based emission allowance credit trading system), technological neutrality (allowing for all low- and zero-carbon technologies to contribute to abatement), broad sectoral coverage (potentially on an economy-wide basis) and uniform emission standards (a common standard for carbon emissions covered under the program.) With an upstream point of regulation for carbon taxes or cap and trade programs, tax credits or emission offsets for carbon captured and sequestered would be appropriate to achieve technological neutrality.

In contrast, command and control regulations typically reflect few if any of these design elements. While varying from program to program, command and control regulations may be narrow in scope (excluding potentially low-cost abatement options), impose a technology requirement (that does not allow for compliance flexibility), or establish a capacity-related metric (that does not allow for changes in production to achieve compliance). These and related types of restricted program designs will tend to increase the cost of emission reduction policies relative to carbon taxes and C&T programs.

This cost effectiveness advantage of carbon taxes and C&T policies relative to command and control policies can be substantial. Goulder and Parry (2008) cite three earlier sets of estimates and conclude that abatement costs relying on power sector carbon taxes and C&T policies would be about 50% lower than corresponding emission reduction policies relying on various conventional performance standards (that is, without emissions trading).

Taxes and C&T Relative to CES and TPS

CES and TPS policy approaches share important design elements with carbon taxes and C&T policies including their use of production metrics and pricing systems, and can also be designed to be technologically neutral. In the case of CES policies, designs that give credit to all zero-carbon generating technologies including nuclear plants and partial credit to relatively low-carbon generating technologies such as natural gas-fired combined cycle plants and fossil plants with carbon capture and sequestration equipment would be technology-neutral. These attributes facilitate low cost compliance and improve program cost-effectiveness similar to a well-designed tax or C&T policy.

At the same time, CES and TPS approaches differ from carbon taxes and C&T policies in other regards that may, depending, importantly, on program design, make them less cost effective to some extent. For example, structured exclusively around the electric sector, CES and TPS policies will (absent linkage to emission reduction programs in other sectors) have a narrower scope of coverage than economy-wide versions of a carbon tax or C&T policy and not capture the full array of low-cost compliance options available to economy-wide policies. As another example, TPS and CES are both intensity standards that, in effect, provide a subsidy to increase generating output that tends to lower their price impacts relative to a carbon tax or C&T policy. Absent offsetting energy efficiency programs, this would dampen the amount of cost-effective demand reductions realized by the policy. Finally, in contrast to CES and TPS policies, carbon taxes and C&T policies with allowance auctioning to raise government revenues which, depending on how they are recycled through the economy, may contribute to cost effectiveness. This is because using revenues to reduce distortionary taxes tends to reduce the economic cost of these policies relative to other approaches that directly allocate revenue to consumers or that do not raise revenues as shown in Parry (2015) and Goulder and Hafstead (2018).

The difference in cost effectiveness between carbon taxes and C&T on the one hand and TPS and CES on the other can be material. For instance, two studies (Burtraw *et al.* 2014); McKibben *et al.* 2015) comparing TPS to either a carbon tax or C&T policy conclude that, depending on program design, the tax or C&T policies may be 30% to 55% less costly than the TPS.

However, in making comparisons of the cost-effectiveness across the four policy approaches, as suggested earlier, policy design is critical. As discussed earlier, the opportunity to formally link or indirectly harmonize sectoral emission reduction policies could, by expanding the scope of opportunity available to secure cost-effective emission reductions, improve the cost effectiveness of policies such as CES or TPS limited to a single sector. Similarly, complementary energy efficiency programs may offset the dampened incentive for cost effective demand reductions associated with intensity-based policies such as CES and TPS. Mignone *et al.* (2012) argue that by carefully calibrating the rates at which CES credits are issued and surrendered, policymakers could "roughly approximate" the incentives of an electric sector carbon tax or C&T policy, with the main difference being the extent to which the carbon price signal was passed on to consumers.

CES and TPS Relative to the Status Quo, C&C and 100% RPS Policies

Comparison to Status Quo

Despite these differences among the four policy approaches, it is also the case that TPS and CES can be designed to produce emission benefits that have economic value far in excess of program costs and, as a result, are cost effective when compared to the status quo economy without new federal carbon emission reduction policies.

For example, Goulder and Hafstead (2018) estimated the welfare costs and benefits (including both climate and co-benefits) of a CES policy and found that total benefits were 10 times welfare costs. By way of comparison, the corresponding ratio for a similarly scaled power sector carbon tax ranged between 8.4 and 10.2 depending on whether tax revenues were recycled through lump-sum rebates to consumers or cuts in individual income taxes, very similar to the modeled CES policy. [5]

For a TPS policy, Burtraw *et al.* (2014) found the ratio of total welfare benefits (including both climate and emission co-benefits) to total welfare costs was 5.4 while the corresponding ratio for C&T policies ranged from 5.3 to 11.3 depending on whether emission allowances were freely allocated to consumers through the local electric distribution company or auctioned. [6]

In these studies, then, CES and TPS policies yielded economic benefits roughly 5 to 10 times greater than the economic costs of the policies and, in some circumstances, of a similar magnitude to carbon tax and C&T policies depending on their design.

Note that, while these particular benefit/cost ratios reflect estimates of the social cost of carbon and emission co-benefits – both of which are subject to some debate – the more generalized finding that benefit/cost ratios for CES and TPS policies are above 1.0 is robust. Excluding the emission

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[5] See Goulder and Hafstead (2018) Table 6.2, page 158.

[6] See Burtraw *et al.* (2014) Table 1 page 10.

co-benefits and accounting only for the estimated climate benefits based on the assumed social cost of carbon, the benefit/cost ratio for the CES policy is 4.4 (as opposed to 10.0 including emission co-benefits) and 2.3 for the TPS policy (as opposed to 5.4 with emission co-benefits). Further, reducing the assumed $/ton value of the climate benefits by half would still yield benefits in excess of costs (that is, benefit/cost ratios of 2.2 for CES and 1.15 for TPS). Consequently, the CES and TPS can be designed to have benefits well in excess of program costs.

Comparison to Command and Control Regulations

When compared to command and control regulations achieving similar levels of emission reductions, it is also clear that the TPS and CES policy approaches can be designed to be lower cost and therefore more cost-effective. For instance, Burtraw (2012) concluded a TPS would result in overall costs two-thirds lower than a traditional performance standard without trading. Similarly Parry (2015) estimated the average per ton cost within the energy sector of a clean energy standard could be roughly half that of efficiency policies or tighter fuel economy standards.

This economic advantage relative to command and control regulations occurs because the CES and TPS policy approaches share many of the design elements that support low cost compliance, including production metrics, pricing systems, technology neutrality and, at least within the electric sector, relatively broad emissions coverage. For these policy approaches, production metrics take the form of carbon tons for a TPS and clean energy MWhs generated for a CES. Pricing, under either approach, results from emission credit trading systems, tradable performance standards on the one hand and clean energy credits on the other. (In this sense, CES and TPS may be considered to be carbon pricing regulations, just as carbon taxes and cap and trade programs.) Both CES and TPS can be designed to be technologically neutral, encompassing relatively low and zero carbon generation (such as natural gas-fired combined cycle and nuclear technologies).

Comparison to 100% Renewable Energy

Finally, CES and TPS policies are likely to represent substantially lower cost pathways to deeply decarbonize the electric sector than policies that seek to achieve full decarbonization exclusively by relying on renewable technologies alone. The central reason for this is that the CES and TPS approaches allow for technological neutrality (and therefore a full range of low- and zero-carbon generating resources) while 100% RPS policies (which otherwise share many of the characteristics of a CES policy) do not.

As a practical matter in the United States, given the difficulty of developing new firm, dispatchable renewable resources such as reservoir hydropower and geothermal energy, RPS policies tend to rely very heavily on wind and solar technologies, which are intermittent, non-dispatchable generating resources. In addition to hourly and daily fluctuations, the generating output from these technologies also exhibit substantial seasonal variation, which create long periods of over- and under-supply relative to electric loads. These periods may stretch over weeks, months, or seasons. Illustrating this seasonality, U.S. wind capacity factors during the 2001 to 2013 period averaged about 32% on an annual basis, but just the low 20's during August and the high 30's during April. Comparing those two months, the April capacity factor is about 70% higher than the August capacity factor, a difference that is not in line with the changes in seasonal electric load as shown in U.S. DOE EIA (2015).

Overcoming the resulting seasonal mismatch between generation and load requires either: 1) firm, dispatchable generating technologies such as fossil generation with carbon capture and sequestration equipment or nuclear generation, or else 2) other renewable generating technologies and energy processes to align generation and load. This second approach could involve a combination of wind and solar overbuilding (which would result in the curtailment of surplus renewable generation when not needed to meet electric load), significant expansion of regional high voltage transmission networks (to transfer surplus generation to neighboring regions where it may have greater value), deployment of new seasonal storage technologies (to shift generation from periods of surplus to periods of deficit) and much larger customer load management and curtailment programs than are currently in place.

One noteworthy aspect of these complementary technologies and processes is the practical uncertainty associated with them: the wind and solar would need to be deployed at sufficient scale, the regional transmission would need to be successfully permitted and built, the new seasonal storage technologies would need to be commercialized and deployed at scale, and the load management/curtailment programs would need to be expanded. All of these would likely be required to make the 100% RPS approach viable, and the practical difficulty of doing this suggests this approach is at best an uncertain pathway to deep decarbonization.

Setting that issue aside, deploying the complementary technologies needed to facilitate a 100% renewables pathway would raise the overall system cost of providing electric service at deep levels of decarbonization. For instance, Williams *et al.* (2014) estimates the incremental energy costs of achieving an 80% reduction in U.S. carbon emissions by 2050 could be approximately three times as high under a "high renewables" case than under a more diversified portfolio including non-renewable zero carbon technologies. Similarly, Brick and Thernstrom (2016), summarizing a series of studies of renewables and decarbonization in California, Wisconsin and Germany, conclude that electric systems seeking to decarbonize primarily with renewable generation would have materially higher average electric system costs than the same systems with a diversified resource mix. More recently, Sepulveda *et al.* (2018), after analyzing nearly 1,000 modeling cases covering a range of carbon limits, technology uncertainties and geographies, concluded that, relying on renewables alone, system costs rise very rapidly as the emissions limit approaches zero, and that, under full decarbonization, the availability of diverse firm low-carbon technologies reduces the system cost of electricity by 10% to 62%.

Consistent with this, several studies have concluded that, at deep levels of decarbonization, the proportion of generation supplied by renewables is less than 100%, with the percentage of renewables varying widely based on assumptions regarding the availability and cost of competing technologies among other considerations. For instance, de Sisternes, Jenkins, and Botterud (2016), in an analysis of decarbonizing the Texas electric market, conclude that at high levels of decarbonization the optimal share of renewables ranges between 19% and 34% of total generation depending on assumptions for energy storage. Further, Mai *et al.* (2012) conclude that commercially available renewable technologies, in combination with a more flexible electric system, could supply 80% of total U.S. electricity generation in 2050. More recently, the National Renewable Energy Laboratory has been publishing an annual report summarizing the results several standard scenarios for the U.S. power sector including an 80% national renewable portfolio standard. Cole *et al.* (2018). And finally, graphical results from Sepulveda *et al.* (2018) suggest that, under conditions of full decarbonization, the share of total energy supplied by variable renewable technologies could range from a low of roughly 15% to as much nearly 80%.

The wide range of these cost and energy modeling results highlights the importance of analytical assumptions regarding the availability and performance of competing generating technologies and complementary energy processes over time.

Nevertheless, the most practical and cost-effective pathway to full decarbonization is likely to reflect a diverse set of low-carbon technologies rather than one relying on renewables alone. The policy implication of this is that technology-neutrality, and the compliance flexibility it suggests, is a key attribute of policy design. This is also the key distinguishing feature between 100% RPS policies and the other policy approaches discussed in this paper.

So, while the CES and TPS policy approaches are often costlier than some forms of taxes and C&T, they are also cost effective relative to command and control and 100%RE RPS policies especially at deep levels of decarbonization.

4.3 Equity

Because of the potentially large impacts of carbon emission reduction policies across consumer and industrial groups, policy tools to mitigate the largest negative impacts and facilitate greater degrees of equity or fairness are essential to achieving acceptance from policymakers.

For carbon taxes, many policy tools are available and have been widely studied. To address potentially regressive impacts on low income and other household groups, these include reducing income tax rates, expanding the earned income tax credit, and establishing income or payroll tax rebates. For discussion and analyses of these and related policy mechanisms see Metcalf (2017), Goulder and Hafstead (2018), Barron *et al.* (2018) and Dinan (2015).

To address impact on industries that may be made economically vulnerable by an emission reduction policy, tools include targeted tax exemptions and tax credits (perhaps tradeable), reduced corporate tax rates, and taxing solely on emissions exceeding a predetermined level as discussed by Goulder and Hafstead (2018).

To resolve concerns regarding the international competitiveness of trade-exposed U.S. industries and emissions leakage overseas, policymakers could consider taxing imported fossil fuels, refundable tax credits for fuels exported from the U.S., sector-specific exemptions and border carbon adjustments (which are taxes on the carbon emissions embodied in imported products and rebates on the carbon emissions embodied in exported products). See for instance Metcalf (2017), Fischer *et al.* (2015), Aldy (2016), Goulder and Parry (2008), Bordoff and Larsen (2018), and Flannery *et al.* (2018).

For C&T policies, the primary tools available to mitigate distributional impacts include the distribution of free allowances and the use of revenues from allowance auctions which might in concept include many of the tax revenue mechanisms mentioned previously for carbon taxes including cuts in economically distortionary taxes. See for instance Stavins (2007), Goulder and Hafstead (2018) and Schmalensee (2015).

For TPS policies, design decisions related to technology subcategorization and geographic uniformity of standards (whether standards are designed on a state-specific, region-specific or in a nationally uniform manner) will influence distributional impacts and cost-effectiveness as discussed by Burtraw *et al.* (2012).

For CES policies, setting the rate at which clean energy credits are issued to generators per unit of electric output (credits per MWh generated) and the corresponding rate at which credits must be surrendered by entities covered by the regulations (credits per MWh of total generation) have a large impact on the outcomes of the regulation. These design choices include the extent to which credits are issued to pre-existing sources of qualifying clean generation or solely to new sources of qualifying clean generation and how allocations may differ across regions of the country with pre-existing mixes of qualifying clean energy and non-qualifying generation as discussed in Mignone *et al.* (2012). In other respects, polices such as CES which do not raise revenues for governments tend to have less flexibility to address potential distributional concerns on industries and households than revenue raising policies such as carbon tax and C&T policies as described in Goulder and Hafstead (2018).

In addressing concerns over distributional fairness, industry impacts and international competitiveness, tradeoffs across policy criteria are inevitable because the tools discussed in this section to address distributional equity often reduce overall cost-effectiveness at least to some extent as discussed in Goulder and Hafstead (2018), Barron *et al.* (2018). This can often give rise to difficult revenue recycling issues for tax and C&T policies. Klenert *et al.* (2018) argue that achieving political acceptance will require giving behavioral economics and political context greater weight relative to efficiency and competitiveness concerns. At the same time, most economic analyses have concluded that the impact of the distributional policy tools on overall cost effectiveness is generally limited. For instance, see Goulder and Hafstead (2018) and Mignone *et al.* (2012).

In sum, tools exist to address distributional equity and international competitiveness concerns for all the four policy approaches. This is the case even without substantially impairing cost effectiveness. In general, taxes and C&T generally have more options and flexibility than the other policy approaches, which is a strength. However, the policy complexity and potential impacts of revenue allocation decisions (which are implicit in CES and TPS policies) may be a hindrance to achieving broad policy agreement on the design of tax and C&T policies.

4.4 Robustness

Over recent years, as the efficiency and other benefits of managing cost and price risks has become better understood, analysts have studied various ways to hybridize price-based and quantity-based approaches.

With quantity-based approaches such as C&T, these mechanisms include credit banking (allowing covered entities to over-comply in early periods in order to under-comply in later periods), credit borrowing (allowing entities with compliance obligations to under-comply in some early periods in exchange for a promise to over-comply in future periods), price caps (commonly in the form of alternative compliance payments or ACPs which allow capped sources to purchase additional allowances from the government at a predetermined price), price collars (which is a price cap coupled with a price floor), and emissions cost reserve (ECR) mechanisms (such as was recently adopted by RGGI). These mechanisms may be used to provide greater cost certainty to covered entities and a C&T program as a whole albeit with greater emissions uncertainty as a consequence. See for instance Stavins (2007), Aldy (2017), Goulder and Hafstead (2018), Burtraw *et al.* (2017), Schmalensee (2015), and Goulder and Parry (2008).

With price-based approaches such as a carbon tax, other mechanisms are available to provide greater degrees of emission certainty. For example, a trigger mechanism based on the actual level of emission reductions achieved at a given point in time could be used to adjust the level of the tax going forward over time, either upward or downward, in order to achieve greater or lesser levels of emission reductions as discussed by Aldy (2017).

Periodic updating of program stringency of other design elements could also be used by policymakers to address both price and quantity risks as has been done on a discretionary basis for the C&T programs in California and the RGGI states and might be done on a more formalized structured basis as has been proposed in several ways for a U.S. carbon tax as described by Aldy (2017) and Metcalf (2018).

Importantly, the mechanisms developed to manage price risks associated with C&T programs can often be applied to other quantity-based approaches like TPS and CES. Banking of credits could be applied to TPS programs potentially increasing program efficiency by allowing sources to shift reductions to lower-cost time periods and smoothing price variations over time as suggested by Burtraw *et al.* (2012). In concept, several the other price-management mechanisms developed for quantity-based C&T programs could also be applied to other quantity-based systems such as TPS programs. For instance, mechanisms providing temporal flexibility such as credit banking, credit borrowing, and ACP mechanisms can be devised for CES programs (See, Mignone *et al.*, 2012).

In brief, for these reasons, policymakers have at their disposal a diverse array of mechanisms to address the emission and cost uncertainty for all four policy approaches.

4.5 Durability

Policies that can reasonably satisfy the preceding policy criteria – environmental effectiveness, cost effectiveness, distributional equity and robustness – should, by doing so, also be durable over time.

As each of the four general policy approaches reviewed in this paper can be designed in ways to satisfy the other four policy criteria, they can also be durable. In contrast, as the command and control and 100% RPS policy alternatives satisfy fewer of the policy criteria, they are less likely to be durable over time, particularly at deep levels of decarbonization. Perhaps most importantly, command and control and 100% RPS policies are like to become prohibitively expensive at deep levels of decarbonization either because they exclude certain low-carbon technology options or do not provide strong economic incentives to achieve lower cost compliance.

Further, as a general matter, policies established through legislation are likely to have broader and perhaps bipartisan political support, more so than policies established strictly through rulemaking processes without new legislative authority. Similarly, once enacted, it may be more difficult for policymakers to repeal the legislation than to reverse an agency rulemaking. Because of this, tradeable performance standard policies established by agency rule may be less durable than the other policy approaches (carbon taxes, C&T and a federal CES) that would require new legislation. And conversely taxes, C&T and CES established through legislation are likely to be more durable than policies such as a TPS established through agency rulemaking. For this reason, if tax and C&T policies are not achievable, assuming both policies are well-designed, a legislatively-enacted CES approach may be preferable to a TPS that is established through rulemaking.

5. Conclusions and Implications

The overriding conclusion from this assessment is that, while recognizing fundamental differences among the four general policy approaches and acknowledging that thoughtful policy design is needed for any of them to function as well as intended, it is also the case that each of the four approaches could reasonably meet two important policy-relevant tests. More specifically, they could be 1) environmentally effective, cost effective, equitable, robust and durable, and at the same time 2) preferable to either command and control regulations or 100% renewable portfolio standards.

Carbon taxes and C&T policies can be designed with all the design elements discussed in this paper: production metrics, technological neutrality, pricing systems, emissions standard uniformity, broad coverage and harmonization, mechanisms to manage distributional impacts, and tools to manage emissions and cost risks. These attributes allow well-designed versions of these policy approaches to satisfy all the policy criteria discussed in the paper (environmental effectiveness, cost effectiveness, equity, robustness and durability) and also to be materially preferable to command and control regulations or a 100% RPS policy.

The CES and TPS policy approaches potentially share many of these same characteristics. When designed with production metrics, pricing systems, technological neutrality, direct linkages or harmonization with emission polices in other sectors, and quantity-based tools to manage emission and cost risks, they could satisfy most, or all the policy criteria outlined in this paper. Importantly, while generally costlier than the tax and C&T approaches, prior analyses show that well-designed CES and TPS policies could yield economic benefits roughly five to ten times their costs, demonstrating their economic value relative to the status quo alternative without a federal greenhouse gas emission reduction policy. For similar reasons, they are less expensive than corresponding command and control regulations or 100% RPS policies, one reason they pass the second of the two policy-relevant tests discussed earlier. Since policies established through legislation (such as taxes, C&T and CES) are likely to be more durable than policies established through agency rulemaking (such as TPS), if tax and C&T policies are not achievable, a legislatively-enacted CES approach may be more durable and therefore preferable than a TPS.

Importantly, while carbon taxes and cap and trade policies may be thought of as “the perfect” when it comes to greenhouse gas emission reduction policies, it is also fair to say that CES and TPS policies could be thought of as “the good” and materially better than other policy alternatives.

This leads to several implications as policymakers consider how best to move forward with constructive policy.

- First, when considered in this way, policy makers have more latitude to craft effective, successful and durable federal greenhouse gas emission reduction policies than might sometimes be thought. Given the difficulty of establishing a federal climate policy over the last ten years and the uncertainties of doing that in the next several years, the chances of success will be increased in future years if regulators can be given more policy options rather than fewer.
- Second, if the carbon tax or cap and trade policy approaches are not achievable for whatever reason, and the policy choice devolves to a well-designed CES and or a well-designed TPS policy, the importance of durability over time would likely argue for the policy that could be enacted through legislation rather than agency rulemaking. This may suggest a preference for a CES policy over a TPS policy.
- Third, considering the potential to harmonize or link differing emission reduction policies, it also implies some opportunity for a policy outcome that involves a mix of regionally diverse greenhouse gas emission reduction policies within the U.S. building on current regional and state programs. This might either be an alternative to a nationally uniform policy or evolve into one over time.

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SUMMARY TABLE – Policy Approaches and Design Elements

Design Elements	Policy Approaches			
	Tax	**C&T**	**TPS**	**CES**
1. **Production-based metric** *Promotes cost-effective operations, investment and retirement*	Tons emitted	Tons emitted	Tons per MWh or pounds per MMBtu	Qualifying clean energy MWh
2. **Pricing Mechanism** *Provides compliance flexibility and cost effectiveness*	Tax is inherently price-based for carbon emissions	Credit trading mechanism produces price for carbon emissions	Credit trading mechanism produces price for carbon emissions	Credit trading mechanism produces price for clean energy generation
3. **Technology neutrality** *Promotes cost effectiveness*	Implicit in tax With upstream regulation, tax credits for CCS	Implicit with C&T With upstream regulation, offsets for CCS	Should provide incentives for all existing and new low- and zero-carbon resources	Should include existing and new zero-carbon resources as well as NGCC without CCS
4. **Uniformity of standards** *Reduces leakage and supports efficiency*	Uniform tax level	National trading program	Uniform (national, vintage, etc.) standard and national trading	Uniform (national, vintage, etc.) standard and national trading
5. **Broad Coverage & Harmonization** *Allows deep reductions, limits leakage and supports cost-effectiveness*	Economy-wide or electric sector If sectoral, linkage and harmonization with other programs	Economy-wide or electric sector If sectoral, linkage and harmonization with other programs	Likely sectoral Linkage and harmonization with other programs	Electric sector Linkage and harmonization with other programs
6. **Tools to Manage Distributional Impacts** *Foster equitable distribution of program costs and benefits*	Form of tax revenue recycling (changes in tax rates, credits, rebates, exemptions, border adjustments)	Distribution of free allowances Recycling of auction revenues (changes in tax rates, credits, rebates, exemptions, border adjustments)	Technology and geographic subcategorization of standards Border adjustments possible?	Rate of credit issuance and redemption Border adjustments possible?
7. **Tools to Manage Emission & Cost Risks** *Promotes cost effectiveness and program durability*	Price fixed by tax Emission risk managed with tax triggers based on actual emission levels	Quantity fixed by cap Cost risk managed with banking, borrowing, price caps (ACPs), price collars, ECR	Emission rate fixed by standard Cost risk managed with banking, borrowing, price caps (ACPs), price collars, ECR Possible emission rate trigger?	Clean energy rate fixed by standard Cost risk managed with banking, borrowing, price caps (ACPs), price collars, ECR Possible clean energy rate trigger?

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