STATE-LEVEL CARBON TAXES: OPTIONS AND OPPORTUNITIES FOR POLICYMAKERS*

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ABSTRACT

Greenhouse gas (GHG) emissions contribute to the risk of climatic disruption and ocean acidification. Pricing emissions, such as through an excise tax, would address the market failure associated with activities that pose risks to the environment. A number of studies have surveyed the design issues of a U.S. carbon tax at the federal level. This paper reviews the design challenges of GHG taxes at the state level. It analyzes essential elements of a state level carbon tax and how they affect the distributional and other economic outcomes of the policy. The paper also explains how a tax can be structured with EPA regulatory compliance in mind.

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I. INTRODUCTION

Greenhouse gas emissions (GHGs) contribute to the risk of climatic disruption and ocean acidification. Pricing carbon dioxide and other greenhouse gases, either through a carbon tax or a cap-and-trade system, would address the market failure inherent in an economy that doesn't discourage damaging emissions. Much has been written on the advantages and disadvantages of a carbon tax relative to other climate policies, and a number of studies have surveyed the design issues of a U.S. carbon tax at the federal level.[1] This paper extends the literature to review carbon tax policy issues arising at the *state* level.[2]

Several factors are converging to motivate work on the design of state-level carbon taxes. First, a state carbon tax is one way states can comply with regulations the U.S. Environmental Protection Agency (EPA) has begun promulgating under Section 111 of the Clean Air Act. For example, in its recent Clean Power Plan (CPP) rule, EPA imposed emissions targets for states' electric power plants. The rule allows State Implementation Plans (SIPs) to include carbon fees as measures that can induce the emissions abatement necessary to achieve the targets.[3] We return to option this in Section 5 below.

In addition, several states that already have relatively low-carbon electricity sectors are looking for ways to reduce emissions more broadly across their economies. Some advocates are taking inspiration from the economy-wide revenue-neutral carbon tax approach adopted by British Columbia. For example, an initiative heading to the November 2016 ballot in Washington state would institute a gradually rising carbon tax starting at $25 per metric ton CO_2 on fossil fuels consumed in the state.[4] The measure would use the revenue to reduce the state sales tax by one percentage point, fund a rebate for low-income working households, and effectively eliminate a tax on manufacturers.

Another policy motivation for a number of ambitious states is their commitments to deep long-term emissions reduction targets. In particular, Massachusetts, New York, and Rhode Island all have targets to reduce their GHG emissions by 80 percent of 1990 levels by 2050, while Oregon and Vermont have goals of 75 percent reductions of 1990 levels by 2050. [5] No consensus has emerged amongst proposals in these states on whether a tax would supplement

[1] Mathur and Morris (2014), Parry et al (2015). This paper draws from these studies where state and federal tax design principles are similar.

[2] For simplicity, we refer to the policy as a carbon tax, but it may also cover emissions of other greenhouse gases in proportion to their radiative forcing potential relative to carbon dioxide.

[3] cite the rule

[4] http://yeson732.org/plain-language/

[5] http://www.rff.org/blog/2016/look-six-state-proposals-tax-carbon

or displace existing state policies, what tax trajectory makes sense, what sources and sectors to cover, and how best to use the revenue.[6]

Some states, much like the federal government, face serious long-term fiscal challenges and may need to raise revenue, and some may find one that can cost effectively replace more costly subsidies and mandates, as well as achieve compliance with new EPA regulations, to be particularly attractive. Thirty-nine states require the budgets their legislatures pass to be balanced, and they now face looming unfunded pension liabilities, depleted rainy day funds, falling revenue from extractive industries, growing health care and education costs, infrastructure in disrepair, and the accumulated burden of unsustainable budget tactics.[7] Other states without compelling budget pressures may consider a pro-growth tax reform that swaps a carbon tax for revenue sources that more negatively impact economic growth, such as taxes on business activity.

Several states have begun pricing carbon through cap-and-trade programs and their emissions allowance auctions raise revenue, but those policies have primarily pursued environmental goals without a broader fiscal role. For example, California's implementation of Assembly Bill 32 and the Regional Greenhouse Gas Initiative (RGGI) for power sector emissions in nine northeastern states both earmark allowance auction revenue for environment-related purposes.[8] A study of the cumulative $1.4 billion in RGGI auction proceeds from 2008 to 2013 reports that the large majority of the revenue went to energy efficiency programs, energy bill assistance, and other GHG abatement activities. [9] However, the some RGGI states have shown interest in using the revenue for non-environmental purposes. For example, in 2010, New York used half of its revenue and New Jersey used all of its RGGI funds (prior to departing from the program the following year) to balance their budgets. A carbon tax, particularly above the price signals operating in those existing programs and applying economy-wide, could raise enough revenue in many states to play a more substantial fiscal role.[10]

Table 1 shows the energy-related CO_2 emissions by state, both per capita and in tons, in 2013.[11] The table provides a rough estimate of the potential revenue in each state, both in millions of dollars and as a share of state GDP in 2013.

[6] http://www.rff.org/blog/2016/putting-carbon-tax-revenues-work-efficiency-and-distributional-issues
[7] http://www.ncsl.org/research/fiscal-policy/state-balanced-budget-requirements.aspx; http://media.navigatored.com/documents/StateofStatePensionsReport.pdf; http://www.statebudgetsolutions.org/publications/detail/state-budget-gimmicks-of-2015
[8] elaborate and cite source
[9] http://rggi.org/docs/ProceedsReport/Investment-RGGI-Proceeds-Through-2013.pdf
[10] According to the RGGI website, the clearing price for allowances at the March 2016 RGGI auction was $5.25 per ton of CO_2, raising a total of $77.9 million. http://www.rggi.org/docs/Auctions/31/PR031116_Auction31.pdf
[11] http://www.eia.gov/environment/emissions/state/analysis/

Table 1. Energy-related CO_2 emissions and potential carbon tax revenue by state

	Per capita energy-related carbon dioxide emissions by state in 2013	2013 Electric Power Fossil Fuel Combustion CO_2	2013 Industrial Fossil Fuel Combustion	Total including transport	Total potential revenue, assuming 2013 emissions and tax rate of $20/ton CO_2	Total carbon tax potential revenue as a share of state GDP in 2013
	metric tons CO_2 per person	$MMTCO_2$	$MMTCO_2$	$MMTCO_2$	million$	
Alabama	24.8	64.20	21.30	119.8	2,396.40	1.24%
Alaska	49.0	2.60	17.50	36.1	722.00	1.26%
Arizona	14.1	54.70	4.50	93.8	1,875.60	0.68%
Arkansas	22.9	35.50	9.20	67.8	1,356.40	1.17%
California	9.2	45.70	72.90	353.1	7,061.60	0.32%
Colorado	17.2	38.50	13.80	90.5	1,810.40	0.63%
Connecticut	9.5	6.80	2.30	34.3	686.20	0.28%
Delaware	14.5	4.10	3.70	13.4	268.00	0.44%
District of Columbia	4.3	0.00	0.00	2.8	55.80	0.05%
Florida	11.1	104.60	11.00	217.6	4,352.60	0.54%
Georgia	13.3	53.60	14.40	132.5	2,649.60	0.59%
Hawaii	12.9	6.80	1.50	18.3	365.00	0.49%
Idaho	10.4	1.30	3.50	16.7	334.60	0.55%
Illinois	17.9	89.00	40.30	230.2	4,604.00	0.64%
Indiana	30.4	98.40	46.40	199.8	3,995.40	1.30%
Iowa	25.8	32.10	18.90	79.9	1,598.60	0.97%
Kansas	25.1	32.00	15.80	72.8	1,455.20	1.04%
Kentucky	31.1	86.10	16.20	137.0	2,740.60	1.51%
Louisiana	42.0	40.80	105.40	194.5	3,890.40	1.59%
Maine	12.2	1.40	2.40	16.2	324.40	0.61%
Maryland	9.7	17.40	2.60	57.9	1,157.40	0.34%
Massachusetts	9.7	12.60	3.80	65.3	1,305.60	0.30%

Michigan	16.2	62.10	20.50	160.2	3,204.00	0.74%
Minnesota	16.3	25.70	18.30	88.6	1,772.80	0.58%
Mississippi	20.1	21.60	11.30	60.2	1,203.00	1.17%
Missouri	21.7	75.80	9.10	131.3	2,625.80	0.96%
Montana	31.3	16.40	4.60	31.7	634.80	1.49%
Nebraska	28.4	26.00	9.30	53.0	1,060.60	0.99%
Nevada	12.8	15.40	2.40	35.8	715.60	0.56%
New Hampshire	10.5	3.30	0.80	14.0	279.00	0.41%
New Jersey	11.8	14.40	9.70	105.1	2,102.60	0.39%
New Mexico	25.8	28.20	8.40	53.9	1,077.40	1.21%
New York	8.1	30.00	9.50	160.3	3,206.00	0.24%
North Carolina	12.4	55.50	10.70	122.4	2,447.60	0.53%
North Dakota	78.2	28.70	16.10	56.6	1,131.80	2.18%
Ohio	19.8	101.50	38.30	228.7	4,573.60	0.82%
Oklahoma	26.8	44.20	22.20	103.1	2,062.00	1.17%
Oregon	9.8	9.00	4.70	38.4	767.60	0.38%
Pennsylvania	19.1	105.90	49.60	243.9	4,877.00	0.77%
Rhode Island	9.5	2.60	0.60	10.0	199.60	0.38%
South Carolina	14.5	28.20	7.90	69.2	1,383.00	0.76%
South Dakota	17.9	3.10	3.90	15.2	303.20	0.68%
Tennessee	14.9	33.60	16.50	96.7	1,934.40	0.67%
Texas	24.2	226.20	189.10	641.0	12,819.80	0.82%
Utah	22.9	34.90	8.30	66.4	1,327.80	0.99%
Vermont	8.9	0.00	0.40	5.6	112.00	0.39%
Virginia	12.5	30.90	12.90	103.0	2,059.60	0.46%
Washington	10.5	11.70	12.60	73.1	1,462.80	0.36%
West Virginia	50.3	68.70	10.40	93.3	1,865.40	2.66%
Wisconsin	17.3	43.30	14.00	99.5	1,990.00	0.71%
Wyoming	117.3	46.20	12.60	68.4	1,368.20	3.29%
TOTAL	16.7	2,021.30	962.10	5,278.64	105,572.80	0.64%

Some jurisdictions, such as the District of Columbia, would raise relatively little revenue owning in part to having no power plants or low carbon electricity sectors. Others, such as Wyoming and West Virginia could raise over two percent of GDP from a tax on fossil energy-related carbon emissions.[12] Of course, the actual revenue would depend on details of the tax base, the tax rate, how emissions respond to the price signal, and the macroeconomic shifts that could change revenues from other revenue instruments.

With an eye to informing the options for state policymakers, this paper analyzes a number of essential design elements of a state-level carbon tax. It also explains how states could use a tax approach to achieve compliance with GHG emissions standards imposed by EPA.

- In Section 2, we explore the challenge of setting a tax base, i.e. the fossil fuels and/or GHG emissions sources that would be subject to the tax. It also describes how states may set its initial rate and a course for the tax to change over time.
- Section 3 reviews the potential distributional outcomes of the tax and ways to use the revenue at the state level, with particular attention to approaches that can attract investment and boost economic growth, offsetting the burden of the carbon tax.
- Section 4 describes how states can incorporate a carbon tax into their compliance plans for EPA regulations under Section 111 of the Clean Air Act.
- Section 5 considers how a carbon tax compares with other potential state-level climate and energy policies.

2. THE TAX BASE, RATE, AND TRAJECTORY

The most economically-efficient GHG tax would fall broadly across all emissions of GHGs to the extent that tax authorities can feasibly attribute the emissions to a particular entity. This would equalize the incentives to abate all covered emissions at an incremental cost equal to the tax rate. However, a number of important decisions arise for states in deciding how broadly and ambitiously they wish to price GHGs, which entities in the supply chain of fossil energy to tax, and how tax rates should change over time.

Considerations regarding the point of taxation

The point of taxation refers to which entities would be required to monitor and report emissions and make tax payments.[13] For example, a state could impose the tax liability on fuel producers, distributors, or the facilities and consumers that combust them. Importantly, the point of taxation is largely independent of who actually bears the economic burden of the tax

[12] Data do not include emissions from uncombusted fuels exported from the state.
[13] CBO (Ramseur et al) 2012

because upstream producers or distributors will pass their costs along to those who buy their products.[14] That means that states can opt to impose the tax in a way that minimizes administrative costs and/or maximizes coverage.

If policymakers were taxing carbon at the federal level, the most efficient point of taxation would likely be at the choke point in the fossil energy distribution system, making for fewer taxpayers and greater coverage of emissions. In that context, the point of taxation would be coal mines or coal-fired power plants and processors for natural gas and oil. A federal tax would also apply to imported fuels at the border.[15]

At the state level, however, the easiest point of taxation may coincide with that of existing EPA data collection for stationary sources and existing state fuel excise taxes for transportation fuels. Large industrial emitters, including power plants, refineries, and a wide range of industrial facilities must report their GHG emissions to EPA each year. EPA makes this data publicly available, and any state can use this information to identify potential taxable emissions and estimate their potential revenues under different assumptions about which facilities would be subject to the tax. [16]

In addition, nearly all states already tax liquid transportation fuels; in July 2015, those taxes averaged 26.49 cents per gallon for gasoline and about 27.24 cents per gallon for diesel fuel (the federal taxes were 18.4 and 24.4 cents, respectively).[17] Some states also have taxes on natural gas, in some cases levied on distributors and in others levied on households. For example, Virginia imposes a tax on natural gas consumption [18] A state carbon tax would apply similarly in that taxing authorities would calculate the per-unit tax for each fuel based on the carbon content of that fuel. For example, a carbon tax of $25 per ton of CO_2 would convert to about $1 per thousand cubic feet of natural gas.[19] It would add about 21 cents per gallon to the price of gasoline and about 25 cents per gallon to the price of diesel fuel.

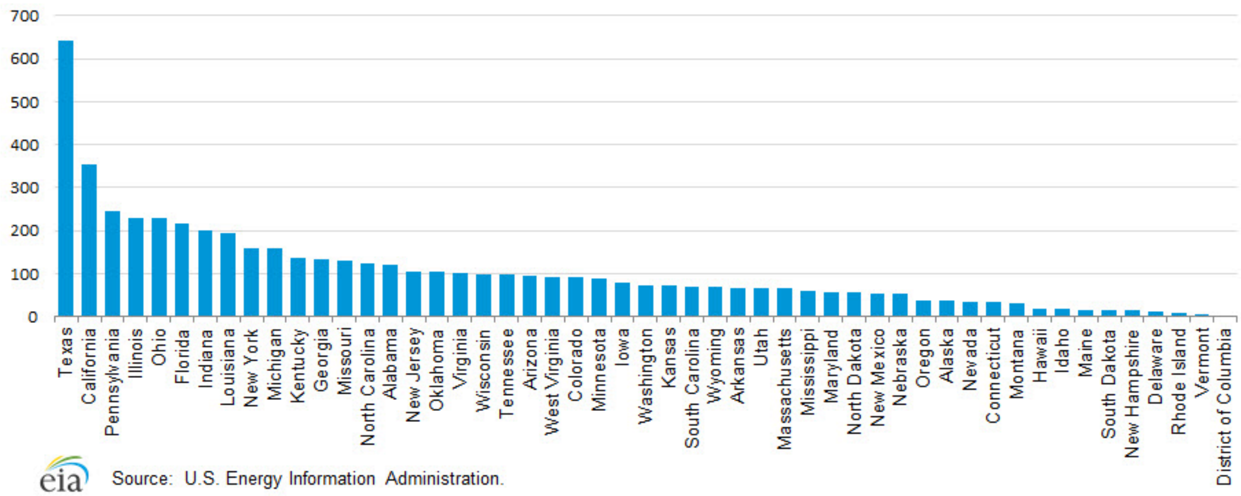
Sources covered

In imposing a GHG tax, states must identify which sources and sectors will be subject to the tax. For example, for carbon in fossil fuels, this means choosing whether to tax carbon in fuels in electric power production (mainly coal and natural gas), transportation fuels (primarily petroleum products), fuels used in homes and commercial buildings for heating and cooling, and/or fuels used in industrial processes. Figure 1 below shows the energy-related emissions by

[14] One exception could be certain regulated electricity markets in which price signals may be transmitted with significant lags.
[15] To incentivize technologies that capture and store carbon, carbon that is not emitted should be tax exempt or eligible for a tax rebate, depending on the point of taxation. For more, see Morris and Mather (2013).
[16] https://ghgdata.epa.gov/ghgp/main.do
[17] https://www.eia.gov/tools/faqs/faq.cfm?id=10&t=10
[18] http://law.lis.virginia.gov/vacode/title58.1/chapter29.1/section58.1-2904/
[19] http://www.rff.org/blog/2012/considering-carbon-tax-frequently-asked-questions#Q10

state in 2013 in million metric tons of CO_2.[20] The chart shows CO_2 emissions directly related to fossil fuel combustion in each state. The biggest emitters tend to be large states with fossil-intensive industries and/or coal-intensive electricity sectors.

Figure 1. Energy-related emissions by state, 2013
million metric tons carbon dioxide



Non-fossil carbon, such CO_2 emitted in cement manufacturing, could also be subject to the tax, as may: methane (CH_4) from landfills; coal mines; natural gas wells, pipelines, and processing facilities; and other industrial sources. States may even consider taxing methane associated with livestock production, carbon emitted from human activities in terrestrial ecosystems (such as tilling croplands and timber harvesting), and emissions of especially potent greenhouse gases used as refrigerants and in certain manufacturing processes.[21]

The Interstate Commerce Clause of the U.S. Constitution prohibits states from taxing fuels that are simply passing through the state. This restriction may not apply to fuels that are refined and then sold outside the state, but it is especially important in the context of fuels in transit by rail from one jurisdiction to another.

The broader the scope of coverage, the greater the potential environmental benefits and revenue, but the more administratively complex and potentially politically fraught the program could be. We next review some specific administrative considerations for different sources and sectors. Numerous other decisions arise in establishing the tax base, and they may seem picayune, but they can have important implications for certain stakeholder groups and incentives for both abatement and investment in the state. We discuss some of these issues here; many states have will have particular considerations given their unique industrial bases.

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[20] http://www.eia.gov/environment/emissions/state/analysis/

[21] A full inventory of U.S. GHG emissions appears here: http://www3.epa.gov/climatechange/ghgemissions/usinventoryreport.html.

Petroleum-based products

Petroleum products involve both emissions "upstream" (such as those from refinery operations) and "downstream" (such as those from driving a car). A useful point of division of the two is the bulk storage terminals that serve as the collection point for many federal and state taxes. Upstream emissions from refinery operations can be taxed based on the refinery reports to the EPA emissions database or similar reports. Downstream emissions are often easiest to tax "at the rack", i.e., at the bulk storage terminal.

As mentioned above, for states that have them, the easiest point of carbon taxation would coincide with taxes on motor gasoline and diesel. An important consideration is that some state constitutions exclusively direct motor fuel tax revenue into a state highway fund. Whether these constitutional restrictions apply to carbon tax revenues depends on the specific language and interpretation in each state, and the state's interpretation may be subject to litigation. Motor fuel taxes generally do *not* apply to fuel that is brought into the state in the fuel supply tank of a motor vehicle.

Two provisos apply to the general observation that it makes sense to apply carbon taxes on gasoline and diesel along with ordinary state fuel excise taxes. The first is that taxing carbon in diesel fuel used for trucking may best be done through the International Fuel Tax Agreement (IFTA).[22] The IFTA is an existing arrangement for dividing fuel taxes between the lower 48 states and Canadian provinces based on miles driven in the various jurisdictions; thus, using IFTA for carbon taxes could reduce concerns about interstate trucking competitiveness. Another consideration is that some diesel fuels (such as those used by non-highway farm equipment, construction equipment, and public school districts) are "dyed diesel" fuels that are not subject to many federal or state taxes. [23] States may or may not choose to impose a carbon tax on these dyed fuels, but the tax bill should make it clear either way.

Petroleum fuels are also used in planes and boats. There are several considerations in taxing the carbon in these fuels, some of which may also apply to railroad fuels. One is whether to discriminate across the uses of the fuel. For example, the carbon tax in British Columbia applies only to jet fuel and boat fuel on trips that both originate and terminate inside BC. A similar rule applies to California's cap and trade system. Concerns about tankering (fueling up in other jurisdictions to avoid the tax) or economic competitiveness in the transport industries may have been behind these decisions, but it is also possible that they were driven by emissions inventory conventions. According to standard GHG accounting methodologies developed by the Intergovernmental Panel on Climate Change, national emissions inventories do not include fuel used on international trips.[24] Some jurisdictions (including British Columbia and California)

[22] http://www.truckpermits.net/trucking-permits/ifta-permits.html
[23] http://www.dol.wa.gov/vehicleregistration/dyeddiesel.html
[24] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

may similarly limit their emissions inventories (and thus their tax base) to jet and boat fuel on trips that both originate and terminate inside that jurisdiction. Another approach would be to account for half of the carbon emissions associated with trips to or from another jurisdiction. This logic explains why designers of the I-732 carbon tax proposal in Washington State opted to tax fuels loaded onto planes or boats in Washington State, regardless of destination.

States may be able to disincentivize tankering by taxing carbon in fuel that is brought into the state in the fuel supply tank of a plane or boat, i.e., by not extending the exemption discussed above for vehicles to boats and planes. This would impose administrative costs, and states would have to decide whether it is worth the trouble. Taxing carbon in fuel tanks would probably be particularly feasible for arriving airplanes because airlines closely track fuel levels. However, airplanes have a more limited scope to avoid the tax than cargo ships because they can carry less fuel, and they incur a significant cost in carrying extra fuel.

A legal consideration also surrounds the disposition of revenue from a tax on the carbon in jet or boat fuel. It arose in a case in Washington State. An airline there has argued that the state cannot tax carbon in jet fuel because Section 49 U.S.C. 47133 earmarks aviation fuel taxes to airport-related spending; however, this law refers only to "local taxes" and so may not include state taxes.[25] On the other hand, another federal statute (49 U.S.C. 47107(l)(1)) and a related federal regulation make federal Department of Transportation (DOT) grants contingent on how states (not just localities) use their aviation-fuel-related revenues.[26] In other words, states that do not apply aviation-fuel-related tax revenue towards airport-related expenditures may not be eligible for federal funding for DOT grants to airports. The significance of this, along with the possible relevance of other state-level statutes and potential international legal considerations, suggest that state policymakers give careful consideration of the tax treatment of these fuels.

Two other considerations arise in drafting state bills that would tax carbon in aircraft fuel. One is that laws and regulations often treat “jet fuel” and “airplane fuel” differently, so the terminology in the bill may matter to certain stakeholders. The former generally refers to the kerosene-type fuels used by commercial airlines, and the latter to the gasoline-type fuels used in small airplanes. The second is that legal or policy questions can arise about the applicability of a carbon tax to fuels used by the military or other government entities. Carbon tax drafters may inadvertently include or exclude such fuels depending on other state statues to which their bill refers.

Petroleum fuels also include home heating oil and are embedded in products such as asphalt, plastics, and chemicals. Carbon taxes on these fuels can be levied at the bulk storage terminals,

[25] https://www.law.cornell.edu/uscode/text/49/47133
[26] https://www.law.cornell.edu/uscode/text/49/47107; https://www.gpo.gov/fdsys/pkg/FR-2014-11-07/pdf/2014-26408.pdf

but states may find it administratively simpler to cover home heating oil and exempt the other categories, particularly if they are responsible for small shares of overall emissions. The ballot measure in Washington state covers all petroleum products and offers a partial or complete rebate or exemption for uses of fossil fuels (not just petroleum products) that can be demonstrated to not increase atmospheric CO_2 concentrations.

Coal

Most coal is used to generate electricity; it can be taxed at the power plant (see below) or upon arrival in a state. Other uses of coal (e.g., for industrial purposes) may be covered by the EPA data discussed above.

Natural gas, propane, and related fuels

Carbon in natural gas, propane, and related fuels can be taxed upon arrival in a state and/or at the power plant (see below). States with wells or processing facilities may also have emissions (e.g., flaring) associated with producing those fuels. These emissions, at least from large sources, should appear in the EPA database.

Electricity

In principle, states can tax carbon emitted by electricity generators themselves, on the local distribution companies, or on consumers. Taxes levied on the consumer can be collected by utilities or local distribution companies in the same way that sales taxes are collected by retailers.

Power that is both generated and consumed in-state naturally fits in the tax base, but the tax treatment of imported power (power that is consumed in-state but generated out-of-state) or exported power (power that is generated in-state but consumed out-of-state).[27] To avoid Interstate Commerce Clause challenges, states may have to provide credit against similar carbon taxes paid in other states on electricity that is generated in that other state, but complex issues arise when one state prices carbon and surrounding states in the same grid do not.

Imported electricity

A state must decide whether to tax the carbon emitted in the process of generating electricity imported from other states. In general, it makes sense to do so in order to avoid distortions in sourcing electricity, but when utilities buy power from a multi-state grid, it may not be obvious how to assign a carbon intensity to the imported electricity. Some states require utilities to file

[27] The Washington State I-732 proposal, for example, taxes both imported power and exported power.

Fuel Mix Disclosure Reports, and that data can be a starting point for a carbon tax based on electricity consumption.[28]

California faced this issue in its design of the cap and trade program, as the state imports electricity from surrounding states and Mexico. California made a distinction between imports from a "specified" generation source, i.e. one owned by or contracted by the importer, and other sources. The California regulatory authority assigned emission factors to all power plants inside and outside California that the agency recognizes as "specified" sources. "Unspecified" imports, such as those from a spot market are a more significant policy challenge. It is possible to calculate an average carbon content for the electricity traded through a spot market, but using an average value can create an incentive for high-carbon electricity to be laundered through the spot market. California's regulator applies a default emissions factor that corresponds to the emissions from a relatively efficient natural gas combined-cycle power plant.[29] Treating imported electricity as if it was generated by coal, the most carbon-intensive fuel, avoids incentives for carbon laundering, but it inappropriately burdens lower carbon electricity producers who sell into the spot market.[30]

Exported electricity and fuels

A major question for fossil fuel-producing states such as Wyoming, Montana, and North Dakota, as well as states like Washington that have refinery operations, would be the tax treatment of fuels that they export to other states. Taxing those fuels could reduce the competitiveness of their extractive and refining industries relative to their competitors elsewhere, but it could also raise considerably more revenue and extend the price signal outside the state, potentially amplifying the emissions benefits of the tax. And, to the extent states can pass along higher (post-tax) prices to energy users outside the state, a tax on exported carbon could raise additional revenue without burdening a state's own residents.

For example, Gerarden et al. (2016) estimate that a carbon fee on coal extracted from federal lands, levied at the government's estimate of the social cost of carbon, would reduce emissions in the U.S. electricity sector by an amount equal to ¾ of the emissions reductions expected

[28] The I-732 proposal in Washington State, for example, imposes a tax on consumers of electricity that is collected and paid by utilities; the tax is based on reports similar to Fuel Mix Disclosure Reports, and then (to avoid double-counting) a credit is provided against carbon taxes already paid on in-state consumption of fossil fuels used to generate electricity.

[29] James Bushnell, Yihsu Chen, and Matthew Zaragoza-Watkins, "Downstream Regulation of CO_2 Emissions in California's Electricity Sector," *Energy Policy*: 64: 313-323 (2014).

[30] The ballot initiative in Washington State makes this default assumption about imported electricity from unspecified sources.

from the Clean Power Plan.[31] This work suggests that Wyoming, which has highly productive mines in the Powder River Basin, could impose a carbon tax on coal and export much of the economic incidence to out-of-state buyers of coal. Some of the economic incidence may also fall on railroads if they adjust their monopoly margins to maintain deliveries.[32] The dynamics of the oil and gas industry are somewhat different, and it could be difficult in more competitive markets for any one state to pass along the incidence of its carbon tax on those fuels to purchasers outside the state. This points, however, to the potential for fuel-producing states to work together to harmonize carbon tax policies; more on this below.

States that export electricity to their regional grids must decide whether to rebate any taxes paid by their generators or fuel suppliers. As with primary fuels, the economic and environmental outcomes of taxing carbon emitted while generating exported electricity depends on the competitiveness of the markets into which the power is sold. If the utility can pass along the tax incidence to residents in other states, then the tax may generate emissions reductions outside the state as a result of higher electricity prices. If not, depending on the nature of the generation mix, the carbon tax may make the state's utility less competitive, and thereby lower emissions internally by reducing generation within the state.

Changes in other fuel taxes and revenues

States may consider whether to reduce or eliminate existing gasoline or other fuel excise taxes when they adopt a carbon tax, an approach called fiscal cushioning. For instance, states could replace one fuel tax with a carbon tax, with a net increase or decrease of revenues depending on the applicable tax rates. Of course, such an approach could significantly reduce the abatement incentives created by the carbon tax, but if the new tax rises over time in real terms and the tax it replaces was fixed, the carbon tax would increase *expected* prices and drive investment accordingly, even if in the short term the observed price signal is no higher than the tax it replaced.

If states impose a carbon tax on top of other fuel excises, that will tend to lower revenues from those other instruments by virtue of further discouraging consumption of taxed products. We return to the question of revenue estimation in Section 4.

Another consideration arises in states with fossil fuel extraction taxes, such as severance taxes or royalties. A number of these states, including Wyoming and West Virginia, are experiencing sharp downturns in revenues associated with oil, gas, and coal production as the prices and/or production volumes decline. A carbon tax could replace some of these lost revenues. One

[31] Gerarden, Todd, W. Spencer Reeder, and James H. Stock, "Federal Coal Program Reform, the Clean Power Plan, and the Interaction of Upstream and Downstream Climate Policies," April 2016. http://scholar.harvard.edu/files/stock/files/fedcoal_cpp_v9.pdf?m=1461850687

[32] Gerking et al 's http://eadiv.state.wy.us/mtim/StateReport.pdf

important difference between a carbon tax and these other extraction-related taxes is that a carbon tax is a function only of the quantity of each fuel produced, and not the price. Thus, a carbon tax may be a less-volatile source of revenue than a severance tax.

Harmonizing with other states

Carbon tax harmonization across states would simplify multi-state compliance for large firms, allow more upstream taxation, and help avoid driving investment and emitting activities to other states, a phenomenon known as leakage. Precedents for such cooperation exist, as illustrated by the IFTA discussed earlier. Also, the Multistate Tax Commission advises states on the adoption of uniform tax policies to simplify the tax code and ease the burden on interstate commerce.[33] It would be feasible to extend these discussions to the context of a carbon tax, and in principle the harmonization could also include Canadian provinces.

Tax rates and trajectories

States must set an initial tax rate and decide how it should evolve over time. A tax rate that starts too low or rises too slowly would delay investments in cleaner energy and do little to abate emissions. On the other hand, excessive rates of increase would provoke opposition (even repeal), strand long-lived capital, and potentially drive investment elsewhere. Thus the setting of a carbon tax rate and its adjustment over time is as much art as science.

Setting the tax rate at a reasonable estimate of the emissions' marginal damages to the environment (the social cost of carbon, or SCC) ensures that the benefits of abatement are greater or equal to the tax rate. However, current estimates of the social cost of carbon used by the U.S. federal government may be higher than politically acceptable tax rates in any given state.[34] For example, the four SCC estimates for 2015 are: $11, $36, $56, and $105 (in 2007 dollars) per metric ton of CO_2. The high value represents the SCC under a scenario of higher-than-expected impacts from temperature change. Even if the figure is scientifically justifiable, a tax at that level would raise gasoline prices by more than a dollar per gallon, risking sharp voter backlash.

A gradual and predictable policy would promote efficient turnover of long-lived industrial plants and equipment, allow households to adjust with minimal disruption, and incentivize innovation and deployment of new technologies. Some economists recommend that the real rate of increase in a tax should match the returns on relatively low-risk capital assets, which is about four or five percent above inflation.

[33] http://www.mtc.gov/
[34] https://www3.epa.gov/climatechange/EPAactivities/economics/scc.html

Tax credits

States may choose to credit or exempt carbon in fossil fuels that is not ultimately emitted into the atmosphere, for example because it is embedded into products, such as plastics, or because the carbon is stored underground in a carbon capture and sequestration (CCS) project. One consideration for states is whether to cap the credit at a level that corresponds to the expected cost of these technologies. Otherwise, the tax credit could end up being a large tax expenditure with sizable rents going to CCS entities.

3. DISTRIBUTIONAL CONSIDERATIONS AND REVENUE

Policymakers are rightfully interested in the potential effects of a carbon tax on consumers, low income households and neighborhoods, rural communities, small businesses, and other stakeholders. In general, lower-income households spend a higher percentage of their income on energy and other goods whose prices would go up under a carbon tax. That suggests a carbon price could be regressive. However, its effect in reality is more complicated. Some of the tax will be passed backward to producers through lower wages for workers and lower returns to shareholders. A carbon tax could also substitute for other, less efficient ways of reducing GHG emissions, and a carbon tax could be more or less regressive than other environmental policies, depending on exactly what they are.

The incidence of a carbon tax depends heavily on what happens to the tax revenue. For example, devoting the carbon tax revenue to lowering corporate income taxes is more likely to be regressive than reducing state sales taxes. Policy makers may consider a number of options for cushioning those burdens on low income individuals, but approaches that blunt the price signal, for example subsidies on energy bills, could blunt incentives to conserve energy and either lower the environmental benefits of the program or increase the costs of achieving the same environmental goal. Lump sum rebates, benefits through other social safety net systems, and other approaches would retain incentives to shift consumption away from emission-intensive goods.

The revenues from a carbon tax are subject to a (desirable) erosion of the tax base, particularly over the long run as capital in long-lived power plants and other industrial facilities turns over. If states adopt tax rates that rise in real terms, the rising rate can more than counteract the decline in the tax base. In that case, it could take decades before states need worry about declining carbon tax revenues.

One potentially efficient use of carbon tax revenues is to reduce tax rates on taxes on labor and capital income, other business activities, and other distortionary revenue instruments. Income taxes reduce the returns of working and create a disincentive to work. Some people work slightly less than they otherwise would because to them that last hour of work just is not worth it once they factor in the taxes. The higher the marginal tax rate, the tax on the last dollar earned, the greater the disincentive to work. This tax-induced disincentive to work results in a lower-than-efficient amount of labor supply in the economy, and that inefficiency is costly. Likewise, taxes on capital income (like the state corporate income taxes) lower investment, and that reduces future consumption below what it would have otherwise been.

The excess burden produced by the last dollar of revenue can vary a lot across different kinds of taxes. Using carbon tax revenue to reduce other marginal tax rates thereby reduces the excess burden of the fiscal system, and it can greatly improve the economics of a price on carbon and environmental policy more generally. The most efficient form of revenue recycling would offset the most distortionary taxes, meaning the ones that create the greatest excess burden for the last dollar they bring in. Some experts believe the most distortionary taxes are likely those on capital income, like dividend, capital gains, and corporate earnings. While rebates carry some political appeal, they do not reduce any of the existing distortions in the tax system, so they do not lower the overall costs to the economy of the carbon tax.

4. COMPLIANCE WITH EPA REGULATIONS

This section describes how states can incorporate a carbon tax into their compliance plans for EPA regulations under Section 111 of the Clean Air Act.[35] Section 111, entitled "New Source Performance Standards," requires EPA to establish emission standards for a multiple pollutants from newly-built sources in dozens of separate "source categories" of emitters. These categories are remarkably specific (e.g., categories include kraft pulp mills, glass manufacturing plants, synthetic fiber production facilities, Portland cement plants, and the like). Section 111(d) requires EPA to establish emission standards (a.k.a. "emission guidelines") for certain pollutants from existing sources in each category after EPA has promulgated an emission standard for that pollutant for new emitters.[36] Since CO_2 is a 111(d) pollutant, EPA will establish CO_2 emission guidelines for existing emitters in each source category. However, unlike the process for standards applicable to new sources, Section 111(d) requires that states submit a plan to EPA setting out how each state will ensure compliance from the relevant existing sources (the state implementation plan, or SIP).

[35] 42 U.S.C. § 7411(d). This section draws in part from: Wara, Michael, Adele Morris, and Marta Darby, "How the EPA should modify its proposed 111(d) Regulations to allows states to comply by taxing pollution," Brookings, October 28, 2014.

[36] *See* 42 U.S.C. § 7411(d)(1), (2). Section 111(d) applies only to emissions not otherwise regulated under Sections 110 or 112 of the Clean Air Act. Emissions for which EPA has promulgated a national ambient air quality standard (NAAQS) under section 109 are regulated under section 110. 42 U.S.C. § 7411(d)(1)(A)(i). EPA regulates hazardous pollutants under section 112. EPA has not promulgated a NAAQS for CO_2, nor has it designated CO_2 emissions a hazardous pollutant.

EPA has recently finalized its first such CO_2 emissions guidelines, for fossil-fuel fired power plants (the Clean Power Plan or "CPP"). The U.S. Supreme Court has stayed the implementation of the rule, but for the purposes of this paper let us assume that eventually states must go forward with policies that will satisfy the CPP (or a similar rule subject to court revisions) and future EPA regulations under this Clean Air Act authority.

For a variety of reasons, instead of establishing a CO_2 emission standard that would apply to each coal-fired power plant (and a separate standard to apply to each gas-fired plant), EPA elected to treat all of the power plants in a state collectively, and thus set collective, state-specific goals for CO_2 emissions from these power plants.[37]

The CPP expresses its state-specific standards in two forms: a limit on the number of pounds of CO_2 emitted per kilowatt hour (lb/kWh) generated (the "rate standard") or as a total mass (in tons) of CO_2 emitted (the "mass standard").[38] The standards reflect the degree of emission limitation that EPA determined can be achieved through the application of the "best system of emission reduction" that, "taking into account the cost of achieving such reduction and any non-air quality health and environmental impact and energy requirements, the [EPA] Administrator determines has been adequately demonstrated."[39]

CPP compliance occurs in two phases; covered sources in each state must meet three interim targets over the 2022-2029 period and then a final target in 2030 and thereafter. As noted above, Section 111(d) requires each state to submit to EPA a SIP demonstrating that the state will meet the standard. EPA can approve, reject, or conditionally approve the state plans. In other words, EPA sets the CO_2 target for each state, and states decide how to achieve it subject to EPA's approval. For their SIPs to be approved, states must show EPA that their policies would reduce power plant CO_2 emissions to meet the target levels.

In the CPP, EPA has emphasized the wide flexibility states have to achieve their interim and final targets. Flexibility is important because states have very different existing emissions levels, costs of abatement, regulatory structures, and electricity demands. In doing so, EPA specifically stated that states may employ a carbon tax to achieve their CO_2 targets: "the state measures plan type could accommodate imposition by a state of a fee for CO_2 emissions."[40]

[37] As a legal matter, EPA actually established such standards, but since no existing coal-fired power plant could meet the applicable standard the collective state standard is the de facto standard.
[38] EPA asserts that each state's rate and mass standards are equivalent.
[39] 42 U.S.C. § 7411 (a)(1) and (d).
[40] 80 Fed. Reg. 64836 (October 23, 2015). For a legal analysis of this point, see: Eisenberg, Samuel D., Michael Wara, Adele Morris, Marta R. Darby, and Joel Minor, "A State Tax Approach to Regulating Greenhouse Gas Emissions Under the Clean Air Act," Brookings, May 22, 2014.

EPA has not yet issued guidance to states on how to demonstrate the sufficiency of their carbon taxes or other measures that do not directly cap emissions or emissions rates. It will likely require modeling the impacts of the policies, along with policies of other states, on regional electricity markets and demand for electricity in the state.

One advantage of a carbon tax implementation strategy is that states can easily expand their tax base with each additional source category EPA regulates under section 111(d). States would set a tax rate for each new source category designed to achieve EPA's category-specific emissions target. This tax rate could be different than the tax rate the state imposes on previously regulated categories, depending on the marginal abatement costs for future 111(d) standards. Alternatively, states could choose a single tax rate high enough to achieve the goals for all source categories, albeit with the outcome that they would overcomply with most.

One potential drawback of an excise tax approach is that states must pass a law to pursue it. The requirements for legislating new taxes vary from state to state, with some more stringent than others. On the other hand, many states likely will have to amend state law to adopt other policies to implement the CPP. While some states have strong legislative support and regulatory capacity to address greenhouse gas emissions, others may need a simple approach that accomplishes other goals as well. A carbon tax, especially if state fiscal reforms are desirable for other reasons, might be no heavier lift than other legislative or regulatory changes that could implement the EPA rule.

5. A CARBON TAX VS. OTHER OPTIONS

A carbon tax is a more efficient abatement policy than many other policy options states could choose. For example, a tax is more efficient subsidies for clean energy technologies for several reasons. First, it is very hard to target subsidies toward the most cost effective abatement, both because the government does not know which technologies will be most cost effective and because it is hard to implement a program that is not prone to political favoritism. Second, it is nearly impossible to preclude subsidizing abatement that would happen anyway. Clean energy subsidies can also have the perverse effect of increasing the overall supply of energy and making it cheaper, partly offsetting the benefits of the subsidies. In short, it is easier to be cost effective in discouraging things we do not want than encouraging things we do want.[41]

A carbon tax is also more efficient than standards for renewable electricity and similar policies. For one thing, the carbon tax price signal incentives energy conservation at the retail level,

[41] Morris and Mathur (2014)

which regulatory standards may not.[42] Also the tax incentivizes lower-carbon fossil fuel sources in electricity generation (which renewable electricity standards do not) and more-efficient coal-fired electricity (which clean energy standards do not).

[42] Fischer, Carolyn. "Renewable Portfolio Standards: When Do They Lower Energy Prices?" The *Energy Journal* 31 (2010): 101-19.