Carbon Pricing and Innovation in a World of Political Constraints

Workshop Report, *December 2020*

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held virtually on March 19-20, 2020

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Disclaimer: The views and opinions expressed in this report are a synthesis of those presented at the workshop and do not reflect the views of any specific author or participant.

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Executive Summary

Workshop Purpose

- In March 2020, we convened a **workshop of academic and policy experts** including economists, political scientists, energy innovation scholars and policy practitioners, seeking to **synthesize collective expertise and academic research and to reflect on the role of carbon pricing and innovation in climate policy**.
- Participants discussed the experience with carbon pricing around the world and the way forward for carbon pricing as a climate policy tool, including political feasibility, economic efficiency, and interaction and integration with other policy mechanisms. The workshop emphasized in particular the importance of **political economy considerations** on the design, implementation, and durability of climate policies.

Main Points of Discussion

- Carbon pricing has been an important pillar of climate policy discussions, facing no shortage of support from economists and policymakers favoring cost-effective reductions in carbon pollution. **To date, around 15% of global carbon emissions are subject to carbon prices, most well under \$50/tCO_2**.
- Real-world experience with carbon pricing policies is mixed. In Sweden and British Columbia, carbon taxes have led to some emissions reductions, while many other places have low and ineffectual prices. Jurisdictions like Australia and Ontario, Canada have also rolled back policies. Broad-scale experience in California, the Northeast and mid-Atlantic (RGGI) states, and the EU has shown that carbon pricing systems should be seen in the context of wider climate policies and can be a source of revenues for other policy objectives.
- Key criteria for climate policy design are environmental efficacy, cost-effectiveness, and political feasibility as well as durability over time and the interaction of carbon pricing with broader climate, environmental, economic and social policies and political priorities.
- Political challenges in the form of **wavering public support and interest group pressures can handicap carbon price policies** as prices rise and benefits are perceived as diffuse. Research indicates this is particularly true in nations with higher income inequality.
- Carbon prices supported by **complementary innovation and industrial policies** can bring down technology and compliance costs and can potentially be sequenced to build political coalitions for more expansive climate policy over time.

Key Recommendations

- Well implemented carbon pricing policies are a potentially important tool in the climate policy toolkit. However, **carbon pricing cannot stand alone**. Politically feasible carbon pricing policies are not sufficient to drive emissions reductions or innovation at the scale and pace necessary.
- Carbon pricing should be implemented as **part of a comprehensive suite of climate policies**, such as clean energy standards, low or no-carbon transportation projects, government procurement and subsidy for market adoption of emerging technologies, and direct support for clean energy research, development, demonstration, and deployment (RDD&D).
- **Using revenues** from carbon pricing for clean energy RDD&D, public infrastructure projects, public procurement or subsidy, and alleviating distributional burdens associated with climate policy, may further decarbonization goals and increase public support.

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Introduction

Carbon pricing is widely considered a powerful climate policy tool that can harness market forces to help drive innovation, the adoption of clean energy technologies, and other actions that reduce greenhouse gas (GHG) emissions. Putting a price on carbon can take various forms: from a system that caps and gradually reduces emissions and allows regulated entities to trade allowances to emit under that cap (“cap-and-trade”), to one that taxes GHG emissions directly on a per ton basis. Economists generally argue carbon pricing policies are the most cost-effective way to address the negative externalities carbon emissions pose, while raising revenue to address the distributional impacts of the policy through transfers or to put towards other (and oftentimes complementary) public policy objectives.

Carbon pricing adoption and implementation faces several practical challenges ranging from political constraints to negative consequences of poor policy design and challenges related to integration with existing policies. In particular, the distributional impacts of climate policy invariably collide with the political economy of a given jurisdiction to constrain the real-world implementation of carbon pricing. For example, in the simplest sense, carbon pricing creates direct, visible costs on carbon-intensive industries, which are generally politically powerful. It also imposes costs on consumers, in the form of higher energy prices. This combination of concentrated costs on key industries, visible costs to the general public, and diffuse and delayed benefits of reduced carbon emissions, makes it politically challenging to adopt carbon pricing, especially at the ambitious level—in terms of price and covered sectors—that is necessary to drive deep economy-wide emissions cuts. Even in sectors where low-carbon substitutes are readily available and cost-competitive, from a political economy perspective, it is not likely to be the most effective tool to achieve long-term deep decarbonization, at least not on its own.

In March 2020, we convened a workshop, *Carbon Pricing and Innovation in a World of Political Constraints,* bringing together an interdisciplinary group of academic and policy experts including economists, political scientists, energy innovation scholars and policy practitioners. Participants discussed the experience with carbon pricing in practice around the world, challenges, and the way forward for carbon pricing as a climate policy tool, including discussion of environmental efficacy, political feasibility, economic efficiency, and the interaction and integration of carbon pricing with other policy mechanisms. This report summarizes the workshop discussion.

— Jesse Jenkins, Leah Stokes, and Gernot Wagner

Policy Design Considerations with Carbon Pricing

When a government sets out to put a price on carbon emissions, key aspects of the policy's design can help enable its success in decarbonizing the economy, and hopefully remain politically popular. Poorly designed carbon pricing policies, on the other hand, face practical and political challenges that hamper their efficacy. Good design is not a panacea for carbon pricing's political challenges, but it can be useful. Here we explore some of the key design choices.

Mechanisms

Carbon pricing can be most directly implemented through a carbon tax or cap-and-trade system. Tax instruments provide greater price certainty; quantity instruments, like cap-and-trade, provide greater emissions certainty. Under a carbon tax, the carbon price remains stable, while emissions can vary depending upon the degree to which emitters choose to pay the tax versus reducing emissions. Carbon prices are often designed to increase over time—a feature that may increase their efficacy while undermining their popularity.[1] With cap-and-trade programs, the emissions level is set by the cap, while the price can vary depending upon the supply and demand for allowances.[2] In practice, quantity and price instruments can be hybridized to achieve some of the benefits of both approaches. California's cap-and-trade system, for example, includes price floors and ceilings to limit price uncertainties.

Other cap-and-trade design considerations concern carbon "leakage"—the potential for carbon pricing in one jurisdiction or sector to lead to increases in emissions in other jurisdictions or sectors—and other trade implications, emissions hotspots, linkage to other systems, and whether or not to allow carbon offsets.[3] All these decisions need to weigh a number of competing environmental, economic, and political priorities.

The Social Cost of Carbon

One metric often combined—and all-too-often confused—with conversations around carbon pricing is the social cost of carbon (SCC). The SCC, technically the "SC-CO_2," is typically defined as the marginal social damage, or cost, of one additional ton of carbon dioxide (CO_2) being emitted into the atmosphere. It plays an important role in shaping policy decisions across the world, providing a metric to measure the economic harm of climate impacts, and to thereby calculate the benefit of regulatory or policy action. To calculate the SCC, researchers estimate the current and future CO_2 or broader GHG emissions impacts on the economy, earth systems, and human welfare. Computing the SCC combines modeling of complex economic, behavioral, and geophysical systems.

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[1] Bechtel, Michael .M., Scheve, Kenneth. F. & van Lieshout, Elisabeth. 2020. "Constant carbon pricing increases support for climate action compared to ramping up costs over time." *Nature Climate Change.*

[2] Metzger, Eliot. 2018. "Bottom Line on Cap-and-Trade." *World Resources Institute*.

[3] Schmalensee, Richard, and Robert N. Stavins. 2017. "Lessons Learned from Three Decades of Experience with Cap and Trade." *Review of Environmental Economics and Policy.*

Social cost of carbon calculations have a long and storied history. Yale economist Bill Nordhaus was one early pioneer. He shared the Nobel Prize in economics for his efforts leading to the calculation of the SCC. His calibrations have been famously conservative, leading to an SCC of around $40/ton of CO_2 (tCO_2) emitted today, a number similar to that calculated by the Obama Administration's Interagency Working Group for the Social Cost of Carbon.[4] Recent work applying the same fundamental benefit-cost model has led to SCC estimates of at least $100/$tCO_2$, sometimes $200/$tCO_2$ and above, typically driven by updated climate damage and discount rate assumptions.[5] Most unknowns and unknowables result in still higher SCC estimates. The same goes for other extensions such as more disaggregated climate damage functions, and heterogeneity within and across countries, which result in estimates of around $400/$tCO_2$.[6]

The Obama Administration's establishment of a $40/$tCO_2$ SCC has helped shape a number of regulatory decisions targeting GHG emissions across the country, for example in Colorado.[7] Meanwhile, the Trump Administration moved to undervalue the SCC by changing key assumptions—excluding the consideration of international climate change impacts, and placing less weight on future impacts—with the expressed goal of reducing the SCC to help it justify its deregulatory climate agenda.[8] It is also worth noting that other national governments use much larger SCC estimates. German government guidance, for example, presents SCC estimates of around $200/$tCO_2$ and almost $800/$tCO_2$, the latter reflecting a zero percent rate of pure time preference.[9]

The SCC is designed to inform regulatory decisions; it does not, on its own, create a price signal that induces private actors to internalize their carbon pollution. To establish a "carbon price," an explicit government program, like cap-and-trade or a carbon tax, is necessary to impose that pricing mechanism on the private sector. The SCC value is relevant to carbon pricing: it could inform the stringency of the carbon pricing mechanism, or any form of climate policy. It need not. Some, for example, argue that instead of using an SCC, prices should be chosen based on modelled timelines and targets for decarbonization.[10]

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[4] Greenstone, Michael, Elizabeth Kopits & Ann Wolverton. 2013. "Developing a social cost of carbon for US regulatory analysis: A methodology and interpretation." *Review of Environmental Economics and Policy*.

[5] Hänsel, Martin C.et al. 2020. "Climate economics support for the UN climate targets." *Nature Climate Change*.

[6] Ricke, Katharine., Drouet, L., Caldeira, K. et al. 2018. "Country-level social cost of carbon." *Nature Climate Change*.

[7] Obama Whitehouse Archives. 2016. "United States Mid-Century Strategy for Deep Decarbonization."

[8] Baron, Jonathan. 2017. "The Discount Rate for the Social Cost of Carbon." *The Regulatory Review*.

[9] Bünger, Björn. & Astrid Matthe. 2019. *Methodenkonvention 3.0 zur Ermittlung von Umweltkosten—Kostensätze*. Umweltbundesamt.

[10] Kaufman, Noah *et al.* 2020. "A near-term to net zero alternative to the social cost of carbon for setting carbon prices." *Nature Climate Change.*

Revenue Usage

The manner in which carbon pricing revenues are used can have a large impact on the policy's effectiveness and political feasibility. For example, dedicating a portion, or all the revenue towards clean energy projects, R&D, and complementary public infrastructure investments (smart grids, charging station networks, mass transit, etc.) can spur further decarbonization. Using revenues towards other public policy goals, such as broad tax reform or deficit reduction, may soften the economic and political costs of a carbon price but does not lead to further decarbonization. How revenue is used can also have significant distributional impacts across households, firms, and regions with implications for equity.[11] Here, too, a hybrid approach may be best to balance competing imperatives—using carbon pricing revenue both to invest in low-carbon technologies and complementary public infrastructure, and rebate some revenues to households to offset rising energy costs, especially for low-income households.[12] Funds could also be used to aid in the energy transition, providing support for displaced workers and affected communities. The use of revenues also heavily influences the sectoral and geographic distribution of economic winners and losers, thus shaping the political economy of carbon pricing.

In theory, the economic consequences of carbon pricing policy for individuals and households, and any resulting negative political sentiment, could be minimized through the use of rebates. Survey experiments within the US find that tax rebates generally increase support for carbon taxation,[13] and when respondents learn that rebates can be used to offset negative economic effects for the bottom 70% of the income distribution, support for the policy can increase.[14] However, in their actual implementation within Canada, rebates do not appear to have the political effects that proponents had hoped. For example, Canadians systematically underestimated the amount of the rebate they were receiving. Even when they were provided with individualized information about their rebate, they continued to believe that they were net-losers—having to pay more through the downstream impacts of a carbon price than what they received in return through a rebate.[15]

Just Transition

Revenue usage and climate policy design more broadly are also fundamental in addressing transition costs from a fossil fuel-based economy toward a low-carbon one.

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[11] Hafstead, Marc. 2019. "Carbon Pricing 102: Revenue Use Options." *Resources for the Future*.

[12] Barbier, Edward B. 2020. "Greening the post-pandemic recovery in the G20." *Environmental and Resource Economics*.

[13] Beiser-McGrath, Liam F. and Bernauer, Thomas. 2019. "Could revenue recycling make effective carbon taxation politically feasible?"*Science Advances*.

[14] Beiser-McGrath, Liam F., & Bernauer, Thomas. 2020. "How Do Pocketbook and Distributional Concerns Affect Citizens' Preferences Over Costly Policies? Evidence from experiments on support for carbon taxation." Working Paper.

[15] Mildenberger, Matto, Lachapelle, Erick, & Harrison, Kathryn. 2020. "Climate Rebates Did Not Substantially Increase Support for Canadian Carbon Pricing." Working Paper.

The concept of a “just transition” refers to smoothly facilitating the transition from a fossil fuel-based economy to a clean energy-based economy, and prioritizing communities that will be economically affected by the transition or have been negatively impacted historically by energy industries.

While the growth of clean energy sectors could lead to a net increase in energy-related employment, there are likely geographic and temporal mismatches between growing employment and contraction in fossil fuel sectors. This can result in employment dislocation and negative economic outcomes in certain regions. For example, some jurisdictions with large fossil fuel extraction sectors, such as West Virginia, or Alberta, Canada, may not see sufficient clean energy jobs to replace the large number of existing fossil fuel jobs, with impacts extending well beyond the energy sector. Some local governments are heavily reliant on revenue from fossil fuel extraction, or fossil-fueled power plants.[16] Local economies, including real estate values, service sector employment, and other outcomes can also be closely tied to the fate of these local keystone industries. Allocation of carbon pricing revenues or other complementary policies, including economic development investments, securitization of fossil assets retired prior to repayment of capital, and compensation programs for affected workers and/or local governments, could help mitigate the negative impacts of energy transitions.

Transition costs also include lingering environmental impacts from fossil fuel projects. A portion of the revenue associated with a carbon pricing policy could be used to cover the costs of reclamation and restoration of mined or drilled land, which can also provide new employment opportunities to affected communities.

Carbon Pricing as a Decarbonization Tool

A carbon price can either be economy-wide or sectoral. The EU Emissions Trading System (EU ETS), for example, applies only to large emitters, including in the electricity, aviation, and several other industry sectors, covering approximately 50% of the EU’s CO_2 emissions. British Columbia’s carbon tax applies broadly to the purchase and use of fossil fuels across sectors and covers approximately 70% of provincial GHG emissions. California’s ETS covers around 85% of the state’s GHG emissions. Globally, meanwhile, only around 15% of CO_2 emissions are subject to carbon prices, most well under the \$40-80/tCO_2 range that the High-Level Commission on Carbon Prices says are necessary to meet the Paris Agreement targets.[17]

Overall, large-scale cross-country analyses show how carbon pricing can help reduce emissions.[18] Isolating the effects of carbon pricing is difficult, given the confounding effect of other policies, including support for clean energy and other mitigation

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[16] Morris, Adele, Noah Kaufman & Siddhi Doshi. 2020. “Revenue at Risk in Coal-Reliant Counties.” *NBER.*

[17] World Bank. 2020. “State and Trends of Carbon Pricing.”

[18] Best, Rohan, Burke, Paul J. & Jotzo, Frank. 2020. “Carbon Pricing Efficacy: Cross-Country Evidence.” *Environmental & Resource Economics*.

approaches. Some evidence suggests carbon pricing can be effective at driving fuel switching from coal to natural gas,[19] but this substitution is far from ideal in terms of deep decarbonization. Other studies have shown modest cuts in carbon emissions from carbon pricing.[20]

Ultimately, carbon pricing, by and large, has not resulted in significant decarbonization at the low price levels and narrow sectoral applications implemented to date.[21] This low price is likely due to the political economy of carbon pricing, in which distributional losers lobby to keep prices low, for example through overallocation of allowances.[22] High income inequality can result in an unequal carbon tax burden unless complementary policies assist low income households. This threat of public backlash likely inclines policymakers toward a modest carbon price, or no price at all. Like with many climate policies, the costs associated with a carbon price are often narrowly felt and opposed by organized special interests; benefits, on the other hand, are often distant and diffuse.

Thus, carbon pricing policies alone have thus far failed to internalize the full negative externalities of carbon pollution and have ultimately been unable to drive rapid and deep decarbonization. This is not to say that carbon pricing designed to meet short-term or sectoral emissions goals haven't been successful, nor that the combination of carbon pricing mechanisms with complementary policies cannot adequately address climate change. It does demonstrate, though, that carbon pricing alone has failed to be a 'fix-all' solution to the multi-dimensional climate problem. A well designed climate policy portfolio is multifaceted, allowing carbon pricing mechanisms to pick up the slack where complementary policies are insufficient, and vice versa.

[19] Wilson, I.A.Grant Staffell, Iain. 2018. "Rapid fuel switching from coal to natural gas through effective carbon pricing." *Nature Energy.*

[20] Murray, Brian & Rivers, Nicholas. 2015 "British Columbia's revenue-neutral carbon tax: A review of the latest 'grand experiment' in environmental policy." *Energy Policy*; Andersson, J. 2019. "Carbon Taxes and CO2 Emissions: Sweden as a Case Study." *American Economic Journal: Economic Policy.*

[21] Cullenward, Danny & David Victor. 2020. "*Making Climate Policy Work*." Polity Press.

[22] Mildenberger, Matto. 2020. "*Carbon Captured*." MIT Press.

Lessons Learned from Around the World

Like other climate policies implemented to date, carbon prices around the world routinely fall short in fully internalizing the social cost of climate damages. Disparate distributional impacts and other political economy challenges of carbon pricing create several constraints that often limit price levels and bind real-world implementation of carbon pricing policies. However, some cases, such as in Sweden, the European Union and Canada, stand out as examples of successful carbon pricing policy enactment and implementation.

Carbon pricing cases from around the world can help us answer important questions about policy design. Within a government's climate policy portfolio, is carbon pricing a complement, or the central policy mechanism? While there is evidence that it can drive incremental changes and fuel-switching, does it drive deep decarbonization? What role should border adjustments play? Is it better to begin with a broad but 'shallow' policy or with a narrow and 'deep' one? How important are revenue-sharing systems to the political feasibility of carbon pricing? Should emission revenues be earmarked toward clean energy investments or used for other policy priorities? How should we expect the political landscape to change in response to carbon pricing policy? The cases below provide some insight into other countries' experiences with the policy, which speak to these and other policy design questions.

Sweden's Carbon Tax

Sweden currently has the highest carbon tax in the world, helping drive national decarbonization efforts. Implemented in 1991, the initial $30 per ton carbon tax was paired with a reduction in fuel taxes and exemptions for energy-intensive, trade-exposed industries (e.g. pulp-and-paper, mining, and industrial horticulture). These design choices helped garner broad political support. Sweden's tax increased gradually over time to around $130/ton and exemptions for covered industries were gradually reduced and then fully eliminated in 2018.[23] As an EU member state, Sweden adjusted its policy to align with the EU Emissions Trading System (EU ETS) introduced in 2005, with sectors covered by EU ETS (electricity and most industrial emissions) no longer facing Sweden's (much higher) tax. Today, 95% of carbon emissions in Sweden are either covered by the tax or by the EU ETS, and the majority of carbon tax revenues come from the transportation sector. Revenues are not earmarked for specific climate-related projects and instead fund the general budget, which, in turn, funds a variety of public transport, energy efficiency, and other projects.[24]

[23] Johansson, Bengt. "Economic Instruments in Practice 1: Carbon Tax in Sweden." *Swedish Environmental Protection Agency*; Sweden, Ministry of Finance, Tax and Customs Department. 2018. "Lessons Learned from 25 Years of Carbon Taxation in Sweden."
[24] Government Offices of Sweden. 2020. "Sweden's Carbon Tax."

Research estimates that the Swedish carbon tax, in conjunction with the country's Value Added Tax, are responsible for an 11% reduction of transportation emissions since the early 90s.[25] The Swedish Environmental Protection Agency estimates that the full suite of carbon taxation policy has resulted in a 26% reduction in domestic CO2 emissions over the same period.[26] Additionally, there is no evidence that the Swedish carbon tax has had any negative effect on GDP. Hence there is evidence that "decoupling" is taking place: Sweden's GDP increased while carbon emissions decreased.[27]

Beyond emissions reductions and economic impact, the distributional effects of Sweden's carbon tax should also be of great interest to policymakers. Research indicates that rising inequality does make a carbon tax more regressive as it places a higher economic burden on low-income segments of the population, who spend a larger percentage of their income on energy, primarily on transportation fuels. When Sweden's carbon tax was enacted, disposable income, and thus the carbon tax burden was largely proportional to incomes, possibly even progressive. However, since the 1990s, income inequality has steadily grown, and the carbon tax has become more regressive.[28] These lessons indicate that carbon pricing will be more regressive in countries with high income inequality and higher per capita carbon emissions such as Japan, Germany, Canada, Australia, and the United States.

The European Union Emissions Trading System (EU ETS)

Established in 2005, the European Union Emissions Trading System (EU ETS) --is the world's largest carbon pricing program, covering around 50% of the EU's CO_2 and around 45% its GHG emissions.[29] The program limits emissions from over 11,000 large energy-using entities, primarily power plants and large industrial emitters. It was expanded to cover intra-European aviation in 2012.[30] In 2018, the annual reduction rate in allowances was increased to 2.2%, in an attempt to meet 2030 targets.

Unlike the Swedish carbon tax, the earlier phases of the EU ETS presented a challenge to long-term research and development (R&D) investments. Initially low prices and generous allowances did little to spur renewable and clean energy investments, and may even have worked against them.[31] Research indicates that more stringent

[25] Andersson, J. 2019. "Carbon Taxes and CO2 Emissions: Sweden as a Case Study." *American Economic Journal: Economic Policy.*
[26] *Ibid.*
[27] *Ibid.*
[28] Andersson J & Atkinson G. 2020. "The distributional effects of a carbon tax: The role of income inequality." *Centre for Climate Change Economics and Policy.*
[29] Delbeke, Jos, and Peter Vis (Eds.). 2015. "*EU climate policy explained.*" *Routledge*.
[30] "EU Emissions Trading System. 2017. "Climate Action - European Commission."
[31] Rogge, Karoline, Schneider, Malte & Hoffmann, Volker H. 2010. "The innovation impact of EU emission trading: findings of company case studies in the German power sector." Working Paper.

subsequent ETS phases helped spur clean energy innovation but were only marginally responsible for firms adopting lower or no-emission technologies.[32]

Emissions covered by the EU ETS have fallen as planned and will be 21% below 2005 levels by 2020. By 2030, GHG emissions are predicted to be 43% below 2005 levels.[33] A policy mix of long-term emissions reduction targets, sectoral efficiency programs, clean energy targets, R&D support, and deployment policies have all played important roles in driving decarbonization across the EU.[34] Chief among them was a massive scale-up in renewable energy deployment, led by policies such as the German feed-in tariff.[35] Revenue certainty provided by feed-in tariffs has enabled projects to be financed with high debt shares, which combined with low interest rates over the past decade, has made renewable energy financing, and consequently, renewable energy generation, in Europe relatively cheap.[36]

Canada's Federal Carbon Tax

In 2008, the Liberal Party in Canada ran on a platform that included a carbon pricing system that was roundly rejected by the public. A decade later, in 2019, the Liberal Party was re-elected on a carbon price platform. Canada's national carbon pricing approach allows each province to design and implement their own policy, or to rely on a federal backstop should they fail to develop a system. Across Canada, there are thus a number of lessons that can be learned based on the carbon pricing experiences of the different provinces. In Ontario, a carbon price was sold as an effective remedy for skyrocketing childhood asthma rates. Learning from the Yellow Vests movement in France, Canadians have also designed their carbon price to be progressive, avoiding many of the distributive impact concerns of carbon taxation.[37]

The Canadian case also highlights the importance of political framing and messaging. Where carbon pricing failed to take hold in 2008, framed by conservatives as a job-killer, in 2015 (and in subsequent policy negotiations), complementary policies with more positive outcomes picked up the political slack. The Canadian revenue-sharing system between federal and provincial governments appeared a more equitable way to use the funds, as well as linking the tax revenue to politically popular areas like funding mass transit.[38]

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[32] Schmidt, Tobias S., et al. 2012. "The Effects of Climate Policy on the Rate and Direction of Innovation: A Survey of the EU ETS and the Electricity Sector." *Environmental Innovation and Societal Transitions*.
[33] European Commission. 2017. "EU Emissions Trading System."
[34] Rogge, Karoline, Schneider, Malte & Hoffmann, Volker H. 2010. "The innovation impact of EU emission trading: findings of company case studies in the German power sector." Working Paper.
[35] Nemet, Gregory F. 2019. *"How Solar Became Cheap." Routledge.*
[36] Friedmann, Julio, et al. 2020. "Capturing Investment: Policy Design to Finance CCUS Projects in the U.S. Power Sector." *Columbia Center on Global Energy Policy.*
[37] Mildenberger, Matto, Lachapelle, Erick., & Harrison, Kathy. 2020. "Climate Rebates Did Not Substantially Increase Support for Canadian Carbon Pricing." Working Paper.
[38] Leach, Andrew. 2018. "The Federal Output-Based Carbon Pricing System Works Because It's Not an Exemption." *Rescuing the Frog Blog.*

Canada has had several other provincial carbon pricing policies over the past decade. Since 2008, British Columbia has had a carbon price in place. It is likely one of the most successful policies in the world, with estimates that it reduced emissions 5-15% in less than a decade, between 2008-2015.[39]

Alberta's Carbon Tax

In November 2015, Alberta, Canada, enacted a suite of climate policies centered on a carbon price. The carbon price started at $30/ton across the economy—affecting consumers and large emitters alike—and was set to be increased over time. The complementary policies included renewable energy incentives, methane regulations, and a coal phaseout. Alberta's tax also included competitiveness protections with output-based allocations for trade-exposed sectors and electricity, as well as an opt-in choice for smaller emitters.

Initially, the Albertan program succeeded in lowering emissions in the electricity sector, but it soon met significant public opposition.[40] In 2019, the newly elected United Conservative government slashed the consumer-facing carbon tax (on transportation and heating fuels), but maintained the carbon tax on large emitters, methane regulations, and the coal power phase out. This policy rollback is likely attributed to legitimacy concerns and poor timing: opponents questioned its effectiveness, and Alberta was experiencing well-below-average economic activity at the time of implementation. Finally, market access for petroleum products from Alberta's oil sands, as well as political circumstances at the time of the tax policy, are speculated to have played a role in the climate policy package's limited success. By repealing the policy and thus failing to meet federal guidelines, Alberta is now subject to the national carbon-pricing plan in place throughout Canada, mentioned above.

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[39] Murray, Brian & Rivers, Nicholas. 2015 "British Columbia's revenue-neutral carbon tax: A review of the latest 'grand experiment' in environmental policy." *Energy Policy.*

[40] Aldy, Joseph E, and Robert N. Stavins. 2011. "The Promise And Problems Of Pricing Carbon: Theory And Experience." *NBER*.

Lessons Learned from The United States

Several American states currently have some sort of carbon pricing program, and a plethora of federal legislative proposals were introduced in 2018-19, though efforts stalled in 2020. The debate between pursuing a set of sectoral policies—such as performance standards, and investment programs—as opposed to a carbon tax and price system, continues to pervade the policy and public space in the U.S. Scholars supporting a carbon pricing mechanism argue that the lack of a revenue source in regulatory policy leaves less room to address the systemic regressivity and income inequality present in today's economic landscape. Some say that tools such as Section 111(d) under the Clean Air Act, for example, have become esoteric compared to a clear carbon price tool. Some also argue that a carbon price may have a better chance at winning bipartisan support in climate policy by appealing to market-friendly principles—although many others argue there is no evidence to date that this is true. By contrast, advocates for standards and investments argue that these policies can more effectively achieve the designed outcome on the timelines necessary. These policies can be more saliently and directly linked to desired and popular outcomes. Investments financed by a progressive tax system can also be used to ensure that the energy transition does not impose as many consumer facing costs.

State-level policies are often considered to be informal experiments for federal policies. The Regional Greenhouse Gas Initiative (RGGI) implemented by several Northeast and Mid-Atlantic states, was developed, in part, to serve as a template for federal policy expansion. Combining state-level and federal policies puts policy interactions to the fore.[41] For example, a clean electricity standard can be blended with carbon pricing. Meanwhile, timing is another important consideration. Although climate policy can be at least partially driven through regulation, the timeline of implementing regulation can be prolonged, especially considering potential legal battles. A carbon price could, theoretically, be implemented more quickly.

The Regional Greenhouse Gas Initiative (RGGI)

The Regional Greenhouse Gas Initiative (RGGI) is a partnership of (soon to be) 11 Northeast and Mid-Atlantic states. It regulates GHG emissions from power plants under an emissions trading system. Established in 2008, RGGI became the first mandatory market-based emissions reduction system in the US. Since the initiative's inception, carbon prices under the program have remained well below $10/tonne throughout the policy's history.[42] Research indicates that while power plant emissions covered by the program have decreased by nearly 50%, much of that reduction occurred because of the economic recession, the availability of low-cost shale gas, and state and federal

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[41] Stokes, Leah C. 2020. "*Short Circuiting Policy*." *Oxford University Press.*

[42] Regional Greenhouse Gas Initiative (RGGI). "Allowance Prices and Volumes." https://www.rggi.org/auctions/auction-results/prices-volumes

policies encouraging wind, solar, and energy efficiency deployment.[43] There is less evidence that RGGI is driving emission reductions, which is unsurprising given the current price is $5-6/tonne. Yet, the program stands alone as a model for cooperation between state governments pursuing shared emissions reduction goals.

As a lesson to interested policymakers, low allowance prices and the use of a public benefit framing model were both instrumental to RGGI's success. RGGI's policy entrepreneurs reframed the atmosphere as a public good to be used only for broad public benefit. The program framing went beyond the idea that the "polluter should pay" and focused on "who should benefit." The new design involved the auction revenue delivering tangible consumer benefits to most of the public.[44] This allowed for subsidies in energy efficiency and renewable energy programs, investments that help reduce the cost of low-carbon energy, as well as lower energy bills, both of which polled well with the public. RGGI has since been strengthened in significant ways as the emissions cap was reduced from an initial 188 million tons, to 165 million, and is now below 100 million tons; the emissions target for 2030 is 30% below 2020 levels.[45] The most recent amendment exceeds even the Paris Climate Agreement goals. Virginia's General Assembly voted in 2020 to join RGGI, and Pennsylvania Governor Tom Wolf has begun agency processes to join the partnership as well.

California's Cap-and-Trade System

Within the United States, California has made the most progress of any state in implementing policies towards deep decarbonization. To achieve its carbon reduction targets, the state adopted a wide range of sectoral strategies as well as an overarching cap-and-trade program. California's cap-and-trade program was launched in 2013 and is among the largest emissions markets in the world. By relying primarily on its sector-by-sector regulatory standards (and lower-than-anticipated economic growth), California achieved its 2020 climate goal early, with carbon pricing playing a supporting role.[46] In theory, California's experience could provide a model for other large economies on how carbon pricing can support a comprehensive climate policy strategy. However, the system is not without challenges, as the most recent legislative modifications made significant concessions to the oil industry, the policy is threatened by poor macroeconomic conditions, and it has a price floor that is too low.

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[43] Murray, Brian C. & Peter T. Maniloff. 2015. "Why Have Greenhouse Emissions in RGGI States Declined? An Econometric Attribution to Economic, Energy Market, and Policy Factors." *Energy Economics*.

[44] Raymond, Leigh. 2016. "Reclaiming the Atmospheric Commons: The Regional Greenhouse Gas Initiative and a New Model of Emissions Trading." *MIT Press.*

[45] Center for Climate and Energy Solutions. 2020. "Regional Greenhouse Gas Initiative."

[46] Guri Bang et al. 2017. "California's Cap-and-Trade System: Diffusion and Lessons." *Global Environmental Politics*; Michale D. Mastrandrea et al. 2020. "Assessing California's progress toward its 2020 greenhouse gas emissions limit." *Energy Policy*.

California's cap-and-trade program was initially authorized only through 2020 and required a difficult two-thirds vote to re-authorize it through 2030.[47] In order to secure the oil industry's support for this bill, California policymakers gave away key regulatory authorities. Specifically, California's AB 398 preempted local air districts from establishing new GHG reduction requirements on stationary pollution sources and prevented the state's lead air pollution agency from adopting new refinery regulations and oil and gas production standards.[48] Although the legislation required the regulator to reduce allowance supplies to address market overallocation (which has led to credits being traded at the price floor), the California Air Resources Board did not take significant action to tighten program caps.

Overallocation of allowances remains a problem, possibly extending through 2030—even before accounting for the macroeconomic effects of the Covid-19 pandemic.[49] Overallocation was much less of a concern in the state's plan for its 2020 climate target because that strategy relied on regulatory efforts to deliver about 80% of the necessary reductions. For its 2030 strategy, however, California expects that a binding cap-and-trade program will deliver nearly half of the necessary emission reductions for a much deeper target. In that context, an overallocated market with a low price floor raises significant concerns. As a result of market overallocation, macroeconomic uncertainty, and an auction design that puts state-owned allowances last in the queue to be sold in undersubscribed auctions, the revenue stream from the California cap-and-trade system has been volatile.[50] Recent auction prices have been in the range of $15-17/tonne. Ultimately, the state may be overconfident in emission trading's ability to reach its ambitious 2030 emissions targets, especially considering the lack of evidence that the policy has been effective thus far.

Washington State's Carbon Tax

The state of Washington has also made great progress toward reducing GHG emissions, even though proposed market-based mechanisms have proved politically unviable. For example, Washington state's Clean Air Rule, issued in 2016, by Governor Inslee, instituted what is essentially cap-and-trade on large stationary emission sources, but elements of the rule face continuing legal challenges, and full deployment of the emissions trading system has stalled. Governor Inslee's additional efforts to pass a cap-and-trade bill in the Washington state legislature all failed due to stiff fossil-fuel industry

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[47] Coghlan, Andy & Danny Cullenward. 2016. "State Constitutional Limitations on the Future of California's Carbon Market," *Energy Law Journal*.
[48] Kaswan, Alice. 2018. "A Broader Vision for Climate Policy: Lessons from California," *San Diego Journal of Climate & Energy Law.*
[49] Cullenward, Danny et al. 2019. "Tracking banking in the Western Climate Initiative cap-and-trade program," *Environmental Research Letters*; Inman, Mason et al. 2020. "An open-source model of the Western Climate Initiative cap-and-trade programme with supply-demand scenarios to 2030." *Climate Policy*.
[50] California Legislative Analyst's Office. 2020. "The 2020-21 Budget: Addressing Revenue Uncertainty in the 2020-21 Cap-and-Trade Expenditure Plan."

and Republican opposition. In 2016, and again in 2018, Washington voters also rejected carbon tax ballot initiatives.[51]

Governor Jay Inslee, meanwhile, pursued a series of sectoral initiatives, including a clean energy standard, building efficiency standards, and electric vehicle incentives, among others. These state statutes secured legislative support and incorporate alternatives to carbon pricing such as standards and regulatory mechanisms, investments, ending subsidies, and promoting environmental justice efforts. This standards, investment and justice approach could provide an alternative model to market-based mechanisms for federal climate action.

Political Challenges of Carbon Pricing

In practice, passing and implementing a carbon price has proven politically difficult. Political science and research from related fields can help explain these dynamics, by examining public opinion and interest group politics, and by exploring the role that concerns about equity, fairness, and environmental justice have played.

Public Support for Carbon Pricing

Carbon pricing can be easily misunderstood by the public and is generally less popular than other climate policy approaches that foreground benefits.[52] Public opinion polls show highest support for clean energy standards and clean energy R&D, followed by a cap on carbon emissions, and then carbon taxes. From the perspective of public opinion, a carbon tax is the least popular policy.[53]

In response, an emerging literature has explored how the design of a carbon tax can overcome public opposition. This research, often using survey experiments, has found that carbon dividends, income tax reductions, and the funding of infrastructure and renewables are the most popular forms of revenue usage in the US.[54] Furthermore, publics are generally unaccustomed to the logic of Pigouvian taxes meant to internalize external damages or discourage certain behavior and perceive taxes as intended to generate revenue for government purposes.[55] Survey experiments thus find that simply

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[51] Worland, Justin. 2018. "Washington State Rejected a Carbon Tax, But Fight Remains." *Time Magazine*.
[52] Bergquist, Parrish, Mildenberger Matto & Stokes, Leah C. 2020. "Combining Climate, Economic, and Social Policy Builds Public Support for Climate Action in the US." *Environmental Research Letters*.
[53] Marlon, Jennifer et al. 2020. "Yale Climate Opinion Maps." *Yale Program on Climate Change Communication*.
[54] Beiser-McGrath, Liam F. & Thomas Bernauer. 2019. "Could revenue recycling make effective carbon taxation politically feasible?" *Science Advances*.; Carattini, Stefano; Kallbekken, Steffen and Anton Orlov. 2019. "How to win public support for a global carbon tax." *Nature*.
[55] Kallbekken Steffen & Marianne Aasen. 2010. "The Demand for Earmarking: Results from a Focus Group Study," Ecological Economics 69: 2183–2190. Baranzini, Andrea & Stefano Carattini. 2017.

providing clear information on the use of carbon tax revenues can increase support for the policy, and that border adjustments and knowledge that other countries have implemented similar policies also increase public support for a carbon tax in the US.[56] That said, recent research shows that escalating carbon prices—a cornerstone of most policy designs—are particularly unpopular.[57]

Carbon dividends are the most prominently discussed form of revenue use from a carbon tax. A carbon dividend—paid directly to households—may help shore up public support by distributing revenue from a carbon price to offset household costs.[58] Survey experiments in the US find that a carbon dividend can bolster support for a carbon tax, particularly amongst lower income groups.[59] However, when dividends are implemented, research shows less support than predicted. In Canada, carbon dividend recipients systematically underestimated the size of dividends they received. Overall, dividends did not substantively increase support for the government's carbon pricing policy.[60]

Given significant and growing income inequality in the United States, over one third of citizens struggle to pay their electricity bills each month. This challenge has only increased during the pandemic, with many Americans building up significant electricity bill arrears.[61] A carbon tax can increase the price of electricity, natural gas, and transportation fuels, therefore putting an additional burden on already slim pocketbooks.

Where a carbon tax has been passed without strong public support, the policy has often been rescinded shortly afterward. In Australia, a carbon tax was passed in 2012 but was rescinded in 2014 after the opposition party led a campaign against the carbon tax even though GHG emissions were falling with no discernible negative economic impact.[62] Public attention to climate change had waned and the opposition party accordingly took advantage of it. In contrast, Ireland passed a carbon tax in 2010 in part due to growing public attention to climate change. The carbon tax then facilitated the adoption of other climate policies including a comprehensive Climate Action Plan that garnered the support of a cross-party Parliamentary Committee, as well as the Citizens' Assembly.

"Effectiveness, Earmarking and Labeling: Testing the Acceptability of Carbon Taxes with Survey Data," Environmental Economics and Policy Studies 19: 197–227.

[56] Beiser-McGrath, Liam F. & Thomas Bernauer. 2019. "Could revenue recycling make effective carbon taxation politically feasible?" *Science Advances*.

[57] Bechtel, Michael M., Scheve, K.F. & van Lieshout, Elisabeth. 2020. "Constant carbon pricing increases support for climate action compared to ramping up costs over time." *Nature Climate Change.*

[58] Klenert, David et al. 2018. "Making carbon pricing work for citizens." *Nature Climate Change*.

[59] Beiser-McGrath, L. F., & Bernauer, T. 2020. "How Do Pocketbook and Distributional Concerns Affect Citizens' Preferences Over Costly Policies? Evidence from experiments on support for carbon taxation." Working Paper.

[60] Mildenberger, Matto, Lachapelle, Erick, & Harrison, Kathryn. 2020. "Climate Rebates Did Not Substantially Increase Support for Canadian Carbon Pricing." Working Paper.

[61] Konisky, David & Sanya Carley. 2020. "Survey of Household Energy Insecurity in Time of COVID." Working Paper.

[62] Mildenberger, Matto. 2020. "*Carbon Captured*." MIT Press.

The carbon tax on fuel was recently increased in 2020.[63] In Canada, climate change was one of the top issues in the 2019 federal election, with the governing party running on the policy. They successfully retained their government and kept the policy.[64]

Interest Group Politics

Interest group politics play an important role in carbon pricing, as the economic "losers"—fossil fuel companies, energy-intensive trade-exposed industries, carbon intensive unions, etc.—work hard to block these policies. Collective action theory posits that concentrated interests that are negatively impacted by policies are effective at organizing to block implementation or to "capture" the policy, altering its design to their benefit. In the case of carbon pricing, interest groups are effective at lobbying for policy designs that weaken effectiveness: low carbon prices, exemptions for specific sectors, and excess allowances in cap-and-trade markets. When carbon markets are linked across jurisdictions, there is a risk that organized interests in a single sector can constrain policy ambition in all linked sectors.[65]

In practice, political coalitions working to stymie carbon pricing and emissions regulations span the political spectrum.[66] For example, labor constituencies rely on carbon-intensive jobs and often mobilize against reforms. Essentially, carbon polluters benefit from "double representation" wherein industrial unions, fearful of job loss on the left, align with industrial business associations fighting policy costs from the right.[67] These interest groups are able to wield great influence on policy design, as they are able to highlight the costs to the public in an effort to mobilize opposition. After a carbon price is implemented, the risk of backlash and retrenchment grows. As with any policy, supportive coalitions are needed to keep carbon prices in place and stave off retrenchment.[68] In practice, carbon pricing opponents may be better organized and more able to influence the public than carbon pricing advocates.

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[63] O'Sullivan, Kevin. 2020. "Climate and The Budget: Carbon Tax Hike and Funding for Sustainable Transport." *The Irish Times.*

[64] Harrison, Kathryn. 2012. "A Tale of Two Taxes: The Fate of Environmental Tax Reform in Canada." *Review of Policy Research.*

[65] Green, Jessica F. 2017. "Don't link carbon markets." *Nature*; Green, Jessica F., Thomas Sterner and Gernot Wagner. "A balance of bottom-up and top-down in linking climate policies." *Nature Climate Change*.

[66] Mildenberger, Matto. 2020. "*Carbon Captured*." *MIT Press.*

[67] *Ibid*.

[68] Stokes, Leah. 2020. "*Short Circuiting Policy*." *Oxford University Press.*

Environmental Justice

Environmental justice issues raise important considerations for climate policy design. Currently, communities of color are disproportionately burdened by pollution.[69] Market-based policies such as carbon pricing may be economically efficient, but they may not be effective at addressing these inequities. Many advocates are concerned that polluting facilities located in these communities could have the option of maintaining or increasing emissions by purchasing allowances or paying the tax, leading to pollution "hotspots." Carbon pricing could thus perpetuate or increase racial disparities and reduce public health benefits relative to other, more direct, emission reduction policies. That said, recent research suggests that in California, the cap-and-trade system has likely decreased the environmental justice gap by 21-30%, disproportionately cutting pollution in disadvantaged communities.[70]

Frontline communities have also been skeptical about how revenues from carbon pricing will be used, reflecting concerns about transparency and a lack of effective political representation in the policy making process, which has often led to historic distrust.[71] These concerns could potentially be ameliorated by explicitly apportioning a share of carbon pricing revenues or complementary investments to frontline groups. For example, the advocacy efforts of the New York Renews campaign resulted in statutory language in the Climate Change and Community Protection Act, enacted in 2019, committing the state to allocate not less than 35% of the overall benefits of spending on clean energy and energy efficiency programs, projects, or investments to frontline communities (with a goal of reaching 40% of such investments).[72]

Innovation and Industrial Policy

Across the world, innovation and industrial policies are far more widespread than carbon pricing policies. While carbon pricing seeks to impose costs on carbon pollution as a negative externality, innovation and industrial policy seek to subsidize positive externalities, such as knowledge spillovers associated with research and learning by doing and public health benefits of clean energy technology. Developed and developing countries, from Germany to China, have instituted a wide array of innovation and industrial policies that have benefited the clean energy sector.[73]

The interactive effect between the two policy types must be studied further. Early signs show that there are clear linkages, as in the case of the European Union where the EU

[69] Tessum, Christopher W. et al. 2019. "Inequity in consumption of goods and services adds to racial–ethnic disparities in air pollution exposure." *PNAS*.
[70] Hernandez-Cortes, Danae & Meng, Kyle C. 2020. "Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market." *NBER*.
[71] Kurman-Faber, Jonah. 2019. "Carbon Pricing in a Just Transition." *Climate-XChange.*
[72] New York State. 2019. "Senate Bill S6599: Climate Leadership & Community Protection Act."
[73] Nemet, Gregory F. 2019. *"How Solar Became Cheap." Routledge.*

carbon price, complemented by a mix of national industrial policy measures, has induced clean energy innovation.[74] In addition to traditional forms of industrial policy (e.g. standards and subsidy programs), ownership structures also play a role in industrial policy. For example, in China, environmental policy has been primarily driven through state-owned entities, with a role carved out for private investment.[75]

Domestic Manufacturing Policy

Long-term policy planning is often required to drive major domestic manufacturing booms. For example, the development of China's automobile industry started with a 1994 auto industry plan.[76] Effective manufacturing policy requires cheap, low-cost financing, clear performance targets, and reciprocal control mechanisms for the government to pull back support for an industry, should performance targets not be met. In Taiwan, export limitations for manufacturers serve as control mechanisms.[77] The US does not have analogous policies in the manufacturing sector. Developing a robust manufacturing sector also requires the cultivation of human resources. China has for years sent students to study in other countries with the expectation that their knowledge will be brought back.

In China, environmental policy is often couched in industrial policy with industry-specific goals. For example, solar photovoltaics (PV) requirements and deployment supports ultimately led to innovation and a decline in manufacturing costs.[78] With direct government support and industry-specific prioritization, China's contributions to solar PV technology and affordability transformed the global solar market.[79] These experiences suggest that industrial policy may drive technology cost decreases, which could lead to carbon pricing being enacted later on, changing the assumed sequencing of policy. In fact, there is evidence that cheaper solar and battery storage options have enabled carbon pricing by reducing the real and perceived cost of compliance, and, accordingly, increasing the policy's viability.[80]

Industrial Policy for 'Hard-to-Abate' Sectors

While many sectors of the economy have more flexibility in adapting to a carbon price, some require targeted industrial policy to lower technological cost curves for emissions abatement. Unfortunately, concerns over carbon leakage—the relocation of energy-

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[74] *Ibid*.

[75] Guluzade, Amir. 2019. "Explained, the Role of China's State-Owned Companies." *World Economic Forum*.

[76] Tang, Rachel. 2009. "The Rise of China's Auto Industry and Its Impact on the U.S. Motor Vehicle Industry." *Congressional Research Service.*

[77] Gallagher, Kelly Sims. 2006. "China Shifts Gears Automakers, Oil, Pollution, and Development." *MIT Press.*

[78] Fialka, John. 2016. "Why China Is Dominating the Solar Industry." *Scientific American*.

[79] Nemet, Gregory F. 2019. *"How Solar Became Cheap." Routledge.*

[80] Jenkins, Jesse. 2019. "Why Carbon Pricing Falls Short." *Kleinman Center for Energy Policy*.

intensive industrial production to countries with less-stringent regulations—have led to these industries receiving exemptions from many economy-wide climate policies, such as the EU ETS.

Some sectors, thus, will be hard to abate because of competitiveness issues and politics, some because even a high carbon price would do little.[81] In order to fully decarbonize global economies, special attention to emissions reduction mechanisms will be needed in “hard-to-abate” sectors such as heavy industry (materials and chemical production), and the freight, shipping, and aviation sectors. Targeted industrial policy and investments in these sectors early can create path dependencies and yield cheaper outcomes in the long run.[82] A combination of direct investment in the form of grants or loan guarantees can be effective in early stages of low-carbon technological development.

Pathways to Carbon Pricing

Many factors can influence the introduction of a carbon price including public sentiment, political windows of opportunity, and policy linkages. Indeed, these factors are co-dependent as public sentiment for a carbon price, for example, can be shaped by the success of precursor policies, including green industrial policies like standards and investments. Likewise, public support for climate action or economic stimulus can provide the initial impetus for green industrial policies. Jurisdictions with carbon pricing policies across the world have arrived at such policies through various pathways. The study of these pathways can provide insight on how other jurisdictions can follow suit should they choose to pursue carbon pricing policies.

Sequencing Climate Policies

Historically, green industrial policies—direct investment in and subsidization of low-carbon industries—have served as a precursor to carbon pricing policy in a majority of the places where carbon pricing schemes were adopted.[83] Most of the world has some form of existing green industrial policy, and could benefit from this distinct sequencing approach. A recent example is China, where a nationwide ETS followed years of industrial investments and sector wide restructuring policies.

The adoption of targeted, sector-specific climate policies may lead to a positive policy feedback loop and grant policymakers the leverage necessary to institute a carbon price down the road.[84] Research indicates that these initial industry supports can mobilize

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[81] Hallegatte, Stephane, Marianne Fay & Adrien Vogt-Schilb. 2013. “Green Industrial Policies: When and How.” World Bank.
[82] Gillingham, Kenneth & James H. Stock. 2018. "The Cost of Reducing Greenhouse Gas Emissions." *Journal of Economic Perspectives*.
[83] Meckling, Jonas, Thomas Sterner & Gernot Wagner. 2017 “Policy sequencing toward decarbonization,” Nature Energy.
[84] Wagner, Gernot, et al. 2015. “Energy policy: Push renewables to spur carbon pricing.” *Nature*.

"low-carbon industries, which brings economic constituencies into coalitions for decarbonization, as well as giving feedback that drives progress towards more comprehensive climate policy", including a carbon pricing system.[85] There is ample room, and need for, further study on how to design sectoral investments and standards that can further create interests—or institutions—over time in support of deeper emission cuts while weakening opposing interests.

Institutional Windows of Opportunity and Coalition Building

The emergence of green parties in countries with proportional (or parliamentary) electoral systems has sometimes created windows of climate policymaking opportunity. These open windows can create space for carbon pricing advocates to push the policy through government. For example, Australia's 2012 climate reform package included a carbon tax, the result of a climate package negotiated between the Labor Party and the Green Party. Ireland passed its carbon tax in 2010 under a coalition government of the Green Party, Fianna Fáil (a center-right party), and the Progressive Democrats. In the United States, political polarization increasingly structures most climate reform efforts, including conversations about the implementation of a federal carbon price. With the exception of a few former Republican officials, few Republican members of Congress support any significant climate mitigation policies. While Democrats are broadly committed to climate reforms, variation remains within the party on carbon pricing preferences specifically. Entrenched political and interest group opposition to carbon pricing also remains a critical barrier to policy enactment.

Leading with an Economic Rationale

As an alternative to justifying a carbon tax simply on environmental grounds, governments can also make an economic case. Ireland, for example, enacted a carbon tax to raise revenue to respond to an economic recession. Similarly, France passed a carbon tax to raise revenue to counter an economic reform bill that the parliament was considering.[86] In British Columbia, a "revenue-neutral" approach paired a tax on carbon with complementary tax cuts on individuals and businesses.[87]

Successful and longer running carbon pricing programs have frequently provided short-term, tangible benefits for citizens or governments to improve their political durability. For example, state governments have come to rely on revenues from RGGI. In a number of recent cases, carbon pricing policy failures have been driven by (often misperceived) increases in consumer energy costs. This experience has led some to suggest that greater attention to providing and highlighting programs that protect

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[85] Meckling, Jonas, et al. 2015. "Winning Coalitions for Climate Policy: Green Industrial Policy Builds Support for Carbon Regulation." *Science.*

[86] Harrison, Kathryn. 2018. "The Politics of Carbon Pricing." *Nature Climate Change*.

[87] Carl, Jeremy & David Fedor. 2016. "Tracking Global Carbon Revenues: A Survey of Carbon Taxes versus Cap-and-Trade in the Real World." *Energy Policy*.

consumers from higher energy prices may also be important to creating a more sustainable pathway for carbon pricing.[88]

Conclusion and Policy Recommendations

There are clear tradeoffs between environmental ambition, economic cost-effectiveness, and political feasibility. Existing carbon pricing policies do reduce emissions, but they do so too slowly to stand on their own. Where higher carbon prices *do* put pressure on polluters to reduce their carbon emissions, policies are threatened by public backlash or interest group retrenchment.

Comprehensive climate policy needs to go well beyond carbon pricing alone, with carbon pricing serving as a backstop to other policies, which in turn help strengthen pricing mechanisms.[89] Such a comprehensive approach sometimes comes under the heading of "Standards, Investments, and Justice," a policy framework that includes a variety of industrial policies and innovation investments, public investment programs, and redistributive policies that are intended to front-load the benefits of climate policy.[90] Climate policy efforts may also be combined with broader social policy reforms in an effort to secure a more expansive and durable coalition.[91] There is evidence that an approach that centers on industrial policy and salient near-term benefits may increase public support for sweeping climate policy.[92] In the United States, carbon pricing may yet find its place in such a much broader regulatory and policy portfolio.

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[88] Raymond, Leigh. 2019. "Policy perspective: Building political support for carbon pricing—Lessons from cap-and-trade policies." *Energy Policy.*

[89] Cullenward, Danny & David Victor. 2020. "*Making Climate Policy Work*." *Polity Press*.

[90] Roberts, David. 2020. "At last, a climate policy platform that can unite the left." *Vox*.

[91] Barbier, Edward B. 2010. "*A Global Green New Deal: Rethinking the Economic Recovery*." *Cambridge University Press*. Barbier, Edward B. 2019. "How to make the next Green New Deal work." *Nature*.

[92] Bergquist, Parrish, Mildenberger Matto & Stokes, Leah C. 2020. "Combining Climate, Economic, and Social Policy Builds Public Support for Climate Action in the US." *Environmental Research Letters*.

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Workshop Agenda

March 19 to 20, 2020

Panel 1: Setting the stage: motivations and goals for the workshop – taking stock of the past decade(s) of experience and research on the economic, political and technological effects of carbon pricing and innovation in a world of political constraints — **Gernot Wagner**, **Leah Stokes** & **Jesse Jenkins**

Respondents: **Bracken Hendricks** & **Barry Rabe**

Panel 2: Lessons learned from around the world

Europe: **Julius Anderson** & **Tobias Schmidt**

Canada: **Gerald Butts** & **Andrew Leach** - ***Leah moderates***

Respondents: **Stephane Hallegate** & **Carolyn Fischer**

Lunch conversation with **John Podesta** and **Jerry Taylor** with moderation from **Robinson Meyer**: policymaking during times of crisis - lessons from the past decade

Panel 3: US federal context and lessons learned from the US experience

Federal regulatory context: **Ricky Revesz**

Regional Greenhouse Gas Initiative: **Leigh Raymond**

California: **Danny Cullenward**

Washington State: **Sam Ricketts**

Respondent: **Adele Morris**

Panel 4: Carbon pricing design and political feasibility given empirical evidence: what do we know about the limits to household willingness to pay for climate policy, and how is this affected by instrument choice, policy framing, and public communication strategies? How is the politics of carbon pricing impacted by economic crises and recession and expansion periods? - **Kathryn Harrison, Matto Mildenberger, Liam Beiser-McGrath and Marc Hafstead**

Respondent: **Noah Kaufman**

Panel 5: The role of innovation and industrial policy in a politically-constrained context: how can policy accelerate cost reductions for clean energy and climate mitigation options? - **Valerie Karplus, Greg Nemet, Wei Peng, Ken Gillingham and Kelly Sims Gallagher**

Respondent: **Erin Baker**

Panel 6: Policy sequencing, policy design, and equity. - **Kate Ricke**, **Jessica Green**, **Kerene Tayloe and Jonas Meckling**

Respondent: **Julian Brave NoiseCat**

List of Participants

Economists:

Julius Andersson, LSE

Ed Barbier, Colorado State

Simon Black, World Bank

Carolyn Fischer, VU-Amsterdam/RFF

Ken Gillingham, Yale

Marc Hafstead, RFF

Stephane Hallegatte, World Bank

Noah Kaufman, Columbia

Andrew Leach, Calgary

Adele Morris, Brookings

Gernot Wagner, NYU

Political Scientists:

Michaël Aklin, University of Pittsburgh

Sydney Bartone, UCSB

Liam Beiser-McGrath, ETH Zurich

Santiago Cunial, UPenn

Jessica Green, University of Toronto

Kathryn Harrison, UBC

Alex Hertel-Fernandez, Columbia

Jared Finnegan, Princeton

Matto Mildenberger, UCSB

Jonas Meckling, Berkeley

Barry Rabe, University of Michigan

Leigh Raymond, Purdue

Leah Stokes, UCSB

Energy Systems and Innovation:

Erin Baker, UMass Boston

Michael Davidson, UCSD

Jesse Jenkins, Princeton

Valerie Karplus, MIT

Greg Nemet, University of Wisconsin-Madison

Wei Peng, Penn State

Jacquelyn Pless, MIT

Kate Ricke, UCSD

Tobias Schmidt, ETH Zurich

Kelly Sims Gallagher, Tufts

Lawyers:

Danny Cullenward, Stanford Law School

Michael Gerrard, Columbia Law

Alice Kaswan, USF Law

Ricky Revesz, NYU

Narayan Subramanian, Columbia Law

Michael Wara, Stanford Law School

NGOs, government, foundations, advocacy:

Elke Asen, Tax Foundation’s Center for Global Tax Policy

Heather Boushey, Washington Center for Equitable Growth

Julian Brave NoiseCat, Data for Progress

Alex Brill, Matrix Global Advisors

Gerald Butts, Canadian Political Consultants

Austin Clemens, Washington Center for Equitable Growth

Adam Falk, Sloan Foundation

Jane Flegal, The Hewlett Foundation

Josh Freed, Third Way

David Hawkins, NRDC

Bracken Hendricks, Urban Ingenuity & Evergreen Action

Jerry Hinkle, Citizens Climate Lobby

Suzi Kerr, EDF

Jacob Leibenluft, Center for American Progress

Joseph Majkut, Niskanen Center

Natalie Mebane, 350.org

Evan Michelson, Sloan Foundation

Caroline Normille, Bay Area Air Quality Management District

Shuting Pomerleau, Niskanen Center

John Podesta, Center for American Progress

Sam Ricketts, Evergreen Action & Center for American Progress

Catrina Rorke, Climate Leadership Council

Casey Schoeneberger, Washington Center for Equitable Growth

Kerene Tayloe, WE ACT for Environmental Justice

Jerry Taylor, Niskanen Center

Lee Wasserman, Rockefeller Family Fund

Journalists (Chatham House Rules):

Rob Meyer, The Atlantic

David Roberts, Vox

Lisa Song, ProPublica

David Wallace-Wells, NY Mag