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Supply-Side crediting for accelerated decarbonization: A political economy perspective

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Mehling

Abstract

Climate policy ambition lags behind committed decarbonization targets, due in large measure to the unfavorable political economy of climate policies that require a reduction in emissions or increase their cost, such as phase-out mandates or carbon pricing. This paper describes a policy innovation, supply-side crediting, that can improve the political economy of climate action, catalyze innovation, and contribute to the objective of a just transition. By creating a revenue stream for the decommissioning of fossil fuel reserves, supply-side crediting alters the incentive structure and generates political buy-in from key stakeholders in the energy economy. Revenue from supply-side crediting can scale up climate finance and accelerate the commercialization of necessary low-carbon solutions, such as carbon dioxide removal technologies. Through various impact channels, supply-side crediting can help overcome resistance against climate policy ambition and address socioeconomic impacts of the energy transition. Over time, supply-side crediting can thus unlock a virtuous sequence that enables increased viability of demand-side carbon constraints such as carbon pricing.

Reference Details

CWPE	2346
Published	29 December 2023
Key Words	Supply-side approaches; fossil fuels; offset credits; political economy
JEL Codes	H23, O30, P18, Q54
Website	www.econ.cam.ac.uk/cwpe

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EPRG Working Paper 2314

Cambridge Working Paper in Economics CWPE2346

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Publication June 2023
Financial Support Ontario Teachers' Pension Plan

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This version: June 2023

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* I acknowledge financial support for this research from Onyx Transition, a venture backed by Ontario Teachers' Pension Plan. I am grateful to Michael Braun, Caitlin Cranmer, Michael Jakob, Jonas Meckling, Darius Nassiry, and Parham Peiroo for valuable comments on earlier versions of this manuscript. All views expressed and any errors are mine.

1. Introduction

Despite the recent proliferation of commitments to achieve net-zero emissions around the middle of the century, actual policies implemented to date have proven unable to halt or reverse the continued accumulation of greenhouse gas emissions in the atmosphere. One reason for the lack of climate policy ambition are daunting political economy challenges that have so far impeded action at a scale and pace commensurate with pledged temperature stabilization targets. Conventional policy options that seek to curb emissions through mandates, standards or pricing – collectively referred to here as carbon constraints – distribute costs and benefits unevenly across time and space, concentrating near-term costs on a subset of articulate and highly organized stakeholder in order to secure diffuse long-term benefits for the broader public.

Inertia in the global energy system further complicates decarbonization efforts, with a large share of existing and all planned assets related to fossil fuel extraction, transportation and processing at risk of becoming stranded (Semieniuk et al., 2022). Fossil fuel producers are thus incentivized to oppose or delay meaningful climate action, as they lock in future emissions with each newly commissioned asset. Supply-side crediting, a policy innovation that generates credits when economically viable fossil fuel reserves are left unextracted, can alter this incentive structure. It does so by creating a new revenue stream that is aligned with energy system decarbonization, scaling up investment in the commercialization of mitigation technologies and a just energy transition, and lowering barriers for future introduction of necessary demand-side constraints.

The remainder of this article sets out the current climate policy ambition gap and underscores the urgent need to decarbonize the energy sector with its long-lived assets and resulting inertia. It then proceeds to describe the political barriers facing climate action, and notably carbon constraints aimed at reducing emissions through mandates and pricing. By contrast, policies that support low-carbon technology investments enjoy greater political support, but suffer from other shortcomings. Supply-side crediting is then introduced as a policy option that can expand the climate policy toolbox and improve the political economy of climate action, harnessing a virtuous political economy sequence that leverages the benefits of both carbon constraints and support policies.

2. Fossil fuels, systemic inertia, and the urgency of decarbonization

Despite individual areas of progress, current efforts to decarbonize the global economy remain woefully inadequate. Although greenhouse gas emission flows dropped temporarily due to the global COVID-19 pandemic, atmospheric concentrations of these gases have reached new highs and are now at their highest levels in over 4.1 million years (NOAA, 2022). As a result, global average surface temperatures have already increased 1.1°C above preindustrial levels, causing widespread disruption in every region through stronger storms, longer heatwaves and droughts, more extreme precipitation, rapid sea level rise, loss of sea ice and ice sheets, and thawing permafrost (IPCC, 2022a). Current rates of ocean acidification exceed, by at least an order of magnitude, rates last experienced 56 million years ago, when they were associated with large perturbations of the global carbon cycle (WMO, 2022). Even if greenhouse gas emissions were to decline abruptly in the near term, inertia of the climate system, exacerbated by complex feedback mechanisms, already commits the world to further irreversible climate impacts (Steffen et al., 2018).

Far from ensuring an abrupt decline of greenhouse gas emissions, however, currently pledged climate action places the world on track for a global temperature rise of 2.6°C by the end of the century (UNEP, 2022). In its most recent assessment of mitigation pathways to date, the Intergovernmental Panel on Climate Change (IPCC) concluded that global greenhouse gas emissions would need to peak in the next three years to limit the increase in global average temperature to 1.5°C (IPCC, 2022b), an aspirational target more than 190 nations have committed to under the international Paris Agreement (UNFCCC, 2015). Exceeding 1.5°C risks triggering multiple climate tipping points beyond which changes in a part of the climate system become self-perpetuating, potentially leading to abrupt, irreversible, and dangerous impacts (Armstrong McKay et al., 2022). While a growing number of countries has announced plans to achieve net-zero emissions before the end of the century, such long term pledges are rarely underpinned by commensurate policies and measures for the near term (IEA, 2021).

Aspirational targets without equally ambitious implementation are, in other words, insufficient to reverse current emissions trends; instead, a wholesale transformation of the global economy is needed that will be unprecedented in both pace and scale (IPCC, 2018). This transformation will also be unparalleled in terms of its investment requirements, cost, and returns to society. According to a recent estimate, the economic transformation needed to achieve net-zero emissions by 2050 requires US$ 9.2 trillion in annual average spending on physical assets, an increase of US$ 3.5 trillion over current levels (Krishnan et al., 2022). Other estimates confirm the scale of incremental investment to achieve committed climate objectives (IEA, 2021; IPCC, 2018, 2022b). According to a leading stocktake of climate finance flows, current mitigation finance would have to increase sevenfold by the end of this decade to meet agreed climate objectives, yet growth in investment flows has actually been slowing in recent years (Naran et al., 2022). Although there is sufficient liquidity in financial markets to close the global investment gaps, numerous barriers impede redirecting capital to climate action (IPCC, 2023; Naran et al., 2022).

Ironically, public and private finance benefitting fossil fuels continues to outpace investments in climate change adaptation and mitigation (IPCC, 2022b). Yet addressing fossil fuel investments will be of particular importance to meet the decarbonization challenge. Not only do oil, gas and coal continue to account for over 80% of global primary energy consumption (BP, 2021), but their extraction, processing and combustion still contribute more than 80% of global greenhouse gas emissions (IPCC, 2022b). Absent decisive policy intervention, historic supply and demand trends suggest that the world is unlikely to discontinue fossil fuel use in the foreseeable future (Covert et al., 2016). Already, the greenhouse gas emissions associated with existing and planned fossil fuel infrastructure would by themselves exceed the estimated emissions budget remaining to limit a global average temperature increase to 2°C (McGlade & Ekins, 2015).

Achieving the more stringent 1.5°C temperature stabilization target contained in the Paris Agreement would even require that 60% of currently viable oil and fossil methane gas reserves as well as 90% of coal reserves be left unextracted, and that oil and gas production decline globally by 3 per cent each year until mid-century (Welsby et al., 2021). Almost 40% of already developed fossil fuel reserves would have to remain unextracted to meet the 1.5°C target, requiring premature decommissioning of existing fossil fuel assets and infrastructure (Trout et al., 2022). Nevertheless, the absence of sufficiently robust near-term climate policy signals continues to enable investment in long-lived fossil fuel infrastructure (Bertram et al., 2015), perpetuating energy system inertia and locking in greenhouse gas emissions well into the future (Seto et al., 2016; Unruh, 2000).

If existing climate policy commitments are to be met, widespread stranding of fossil fuel assets may thus become inevitable, extending the cost and timeline of decarbonization. Not only would the premature obsolescence of capital stock constitute a major wealth loss in and of itself, it may also incite legal challenges with concomitant delays and compensation claims (van der Ploeg & Rezai, 2020), while price corrections in debt and equity markets could pose a systemic risk for the stability of global financial markets (Grant, 2018; Monasterolo, 2020). Time is of the essence: on average, every decade of delay in taking the necessary action is estimated to increase net mitigation costs by approximately 40% (Council of Economic Advisers, 2014). At this point, deferring the required measures by another decade would potentially result in US$ 7.7 trillion in additional stranded assets by 2050 (IPCC, 2022b). Inertia of the energy system also means that all pathways limiting warming to 1.5°C rely heavily on carbon removal technologies, such as biogenic and geological sequestration of greenhouse gases and direct air capture technologies that draw greenhouse gases directly out of the atmosphere, to compensate for emissions overshoot because emissions will not decrease rapidly enough to stay on a pathway to committed emission reduction targets (IPCC, 2022b).

Against this background of continued emissions growth, with atmospheric concentrations exceeding 420 parts per million (ppm) for the first time in human history (NOAA, 2022), a persistent gap in climate finance and investment, and the time-sensitivity born out of the inertia of ecological and socioeconomic systems, new and innovative policy solutions are urgently needed. That efforts to date have failed to overcome these challenges has a variety of causes, but none is arguably as important as the unfavorable political economy of climate action. Time and again, conventional climate policy options – and especially carbon constraints that mandate a reduction in emissions or increase their cost, such as carbon pricing – have lost political support because of how they distribute attendant costs and benefits. The shape and implications of these political economy constraints are described in greater detail in the next section.

3. The political economy of carbon constraints

As the previous section has shown, both the scale and pace of current climate action have to increase dramatically if committed decarbonization targets are to be met. One of the central reasons holding back greater progress is concern about the economic cost of greater climate ambition. Estimates vary, but all are substantial. In its latest assessment report, the IPCC estimates the cost of economic transformation across all sectors to stay within 2°C of global warming to range between US$ 2.4 and 4.8 trillion per year until 2050 (IPCC, 2022b). In the energy sector alone, the International Energy Agency (IEA) sees a need to increase annual investments from currently around US$ 2 trillion to almost US$ 5 trillion by 2030 and US$ 4.5 trillion by 2050 (IEA, 2021). Similarly, McKinsey Global Institute calculates incremental costs of US$ 3.5 trillion each year to achieve net zero emissions by the middle of the century, equivalent to half of global corporate profits and one-quarter of total tax revenue in 2020 (Krishnan et al., 2022).

Although these costs are outweighed by the benefits of avoided climate change (Hoegh-Guldberg et al., 2019; Stern, 2007), climate impacts are, by their very nature, uncertain and will occur sometime in the future, whereas the costs of climate action are tangible and begin accruing in the present. The costs and benefits of climate action are not only distributed unfavorably across time, but also across different regions and stakeholders. In the case of carbon constraints that curb greenhouse gas emissions through mandates, standards, or pricing, the costs are disproportionately borne by a limited number of articulate, politically influential emitters in energy intensive sectors, whereas the ensuing mitigation of climate change – a weakly valued, incremental benefit (van der Linden et al., 2015) – is spread out globally across a diffuse and poorly organized constituent: the general public.

For the political economy of climate action, the foregoing characteristics have important implications: first, collective action to address climate change is hampered by freeriding incentives because emitters will prefer to let others bear the costs of climate change mitigation – a public good – while still enjoying its attendant benefits (Nordhaus, 2015; Olson, 1965). In the ensuing context of uneven climate action, a second concern arises, that of emissions leakage, where greenhouse gas emissions from production and consumption patterns relocate to regions, sectors or activities that face lower costs as a result of weaker policy signals (Felder & Rutherford, 1993). Third, and partly as a result of both previous implications, climate action incurs distributional conflict with winners and losers, for instance when it recalibrates the parameters of economic activity in favor of disruptive over incumbent technologies (Aklin & Mildenberger, 2020).

While these characteristics are common to all policies that impose constraints – and thus costs – on greenhouse gas emissions, they are most evident in the context of carbon pricing, widely considered the first-best climate policy option by economists (CLC, 2019; EAERE, 2019). Carbon pricing denotes different policy approaches that impose an explicit price on greenhouse gas emissions, for instance through a carbon tax or an emissions trading system (World Bank, 2023a). According to economic theory, a carbon price helps internalize the social cost of greenhouse gas emissions, thereby correcting the main market failure underlying climate change (Stern, 2007). By focusing mitigation efforts where abatement is cheapest and leveling mitigation cost across all emitters, carbon pricing can theoretically achieve greenhouse gas mitigation targets at the lowest possible economic cost (Baranzini et al., 2017; Fischer & Newell, 2008).

Despite its theoretical merits, however, carbon pricing faces steep political economy challenges, explaining its limited impact to date in terms of prevailing price levels, emissions scope and geographic coverage (World Bank, 2023b). By rendering the cost of compliance visible in the form of an explicit price, it focuses stakeholder opposition like few other climate policies, contributing to the repeal or weakening of carbon pricing systems in a number of jurisdictions (Crowley, 2017; Rabe, 2018; Raymond, 2020). Although the actual incidence of carbon pricing is subject to debate (Dorband et al., 2019; Goulder et al., 2019; Ohlendorf et al., 2021), it is also widely perceived as regressive (Lamb et al., 2020; Maestre-Andrés et al., 2019) or otherwise detrimental to vulnerable communities (Gilbertson, 2017). Proposals to invest revenue as a means to enhance its social license (Carattini et al., 2018; Klenert et al., 2018) display only limited impacts on public support (Mildenberger et al., 2022), with carbon pricing consistently polling last among mainstream climate policy instruments (Fairbrother, 2022; Rhodes et al., 2017).

Such features render carbon pricing and other demand-side constraints highly susceptible to regulatory capture, where policy makers are influenced to prioritize particular interests over the general interest of the public (Stigler, 1971). Often, such influence will come from both sides of the political spectrum, with labor unions fearful of employment losses joining trade or industry associations motivated by competitiveness concerns in their opposition to more forceful climate action (Mildenberger et al., 2022). Given their disproportionate exposure to climate constraints, fossil fuel producers have played an outsized role in mobilizing such opposition (Brulle, 2018; Farrell, 2016), and their lobbying efforts have vastly outpaced lobbying in support of climate action (Meng & Rode, 2019). For shareholders and other investors in fossil fuel activities, the energy transition poses a significant market risk (Semieniuk et al., 2022), although resistance against climate action can also be observed among workers and other communities who depend on the fossil fuel value chain (Cha, 2020; Newell & Mulvaney, 2013). Fossil fuel producers and other incumbent interests can thus hold an effective veto power to delay or weaken the energy transition (Bayulgen & Ladewig, 2017).

Ultimately, such opposition has contributed to rejection or delays of meaningful emissions constraints, posing a formidable obstacle to climate action consistent with committed temperature stabilization targets. Policy solutions that lower or reverse such opposition will thus be critical to unlock political will for greater climate ambition. The next section identifies two complementary approaches that can have a bearing on the political economy of climate action: technology support policies, such as fiscal subsidies for renewable energy deployment, and policy sequencing, in which costlier support policies are introduced first, drive down technology cost, and thereby pave the way for subsequent adoption of less popular, but necessary policy approaches. Limits to the scope and effectiveness of these options are also discussed, highlighting the need for additional solutions, one of which – supply-side crediting – is then introduced in the following section.

4. Policy sequencing and the role of technology support policies

As an obstacle to greater climate policy ambition, the importance of political economy can hardly be overstated. Policy options that help lower resistance against climate action are therefore vital to meet committed temperature stabilization targets. So far, such options have primarily consisted of fiscal incentives and other subsidies that promote the development and deployment of low-carbon technologies. These policies tend to be costly (Marcantonini & Ellerman, 2015), targeting a narrow subset of abatement opportunities in a context of imperfect or asymmetrical information (Fischer et al., 2017), but they conceal this cost by distributing it across taxpayers and consumers. Benefits, meanwhile, are concentrated on the suppliers of low-carbon technologies, securing their political support and vesting interest in climate policy progress (Meckling et al., 2017; Wagner et al., 2015). Not only do technology support policies therefore enjoy greater support from those they directly benefit, but opinion surveys have also confirmed that they are more popular with the general public (Krosnick & MacInnis, 2013).

Aside from altering the political economy of climate policy, technology support policies can help correct additional market failures that underlie climate change. Next to the unpriced externality of greenhouse gas emissions, the most important market failure involves innovation spillovers and network effects (Gillingham & Stock, 2018; Jaffe et al., 2005). Innovation in low-carbon technologies and the creation of enabling networks are both costly and create benefits to society that are not priced into their delivery. Known as a positive externality, this inability to capture private returns that reflect the full value of innovation and network infrastructure prevents optimal investment in research and deployment of low-carbon technologies (Gallagher et al., 2006; Margolis & Kammen, 1999), as well as in infrastructure needed by some technologies to scale up and reach commercial maturity (Li et al., 2017).

By exerting both a supply push and demand pull for low-carbon technologies, these policies accelerate the technology learning curve to a point where learning by doing and economies of scale effects – reflected in deepening supply chains, growing competition, and managerial, regulatory and engineering optimization – bring down their cost (Kavlak et al., 2018; Nemet, 2019; Ziegler et al., 2021). At that point, technology support policies can expand the window of opportunity for less popular policy mandates, such as demand-side carbon constraints (Schmidt & Sewerin, 2017; Wagner et al., 2015): once low-carbon technologies have dropped sufficiently in cost to approach parity with incumbent technologies, their deployment becomes a viable alternative, allowing them to crowd out those emissive technologies and lower or avoid any compliance costs arising from carbon constraints.

From this virtuous dynamic follows the possibility of a sequential approach, in which costlier, but more popular support policies targeting specific technologies help lower political resistance against broader and more efficient policy options such as carbon pricing (Meckling, 2019; Pahle et al., 2018). Empirical research affirms a consistent pattern of policy sequencing towards carbon constraints in the data (Linsenmeier et al., 2022).

Still, technology support policies suffer from constraints that limit their ability to catalyze policy change. First, when implemented in the form of public subsidies, they commit considerable resources and entail a burden on public budgets, making them harder to sustain in a context of high stocks of public debt, large structural budget deficits, and rising interest rates. Where technology support policies are financed through redistribution of cost across consumers, such as electricity ratepayers, they add to inflationary pressures. Both approaches risk being regressive (Böhringer et al., 2022; Borenstein & Davis, 2016), and neither option mobilizes private investment, which is essential to close the current climate finance gap, yet has been lagging behind public investment (Naran et al., 2022; Prasad et al., 2022).

Second, while they can contribute to the emergence of coalitions that support greater climate ambition, policies targeting low-carbon technologies do not directly alter the incentive structure for incumbent actors such as fossil fuel producers. Promoting low-carbon technologies such as renewable energy or energy storage helps unlock long-term transition opportunities for the broader economy, but disadvantages incumbent energy producers in the near term by reducing the relative cost of alternative technologies and rendering these more competitive. If anything, the prospect of future renewable energy cost parity may create an incentive to maximize profits by accelerating fossil fuel extraction until such parity is reached, an effect known as the Green Paradox (Sinn, 2008; van der Ploeg & Withagen, 2015).

Third, communities depending on incumbent technologies and the underlying value chains will not automatically benefit from advances in low-carbon technologies, which may materialize in geographically distant locations and impose other limits on economic participation, for instance by requiring different types of skills and work experience (Pollin & Callaci, 2019). Likewise, the geographical relocation of economic activity may undermine the tax base of jurisdictions (Morris et al., 2019). A policy innovation described in the next section, supply-side crediting, can help secure the political economy benefits of technology support policies and policy sequencing without being exposed to the foregoing vulnerabilities. It can generate political buy-in by realigning incentive structures in the fossil fuel sector, scale up and redirect climate finance, and stimulate the commercialization of critical low-carbon technologies.

5. Supply-Side crediting: Policy innovation to overcome political gridlock

As discussed earlier in this article, fossil fuel producers represent a critical constituency in efforts to mitigate climate change due to the outsized contribution of fossil fuels to greenhouse gas emissions and the vulnerability of the entire sector to economic disruption from decarbonization. Overcoming opposition to climate policy ambition from fossil fuel producers could have significant spillover effects and greatly accelerate the energy transition. A growing body of policy proposals has therefore argued in favor of supply-side interventions, which – unlike demand-side measures that seek to curb the use of fossil fuels – would take effect further upstream in the value chain and target their exploration, extraction, processing, and distribution (Asheim et al., 2019; Vallejo et al., 2015). That these can be an important complement to demand-side measures has long been established in the literature (going back to Bohm, 1993; Green & Denniss, 2018; Harstad, 2012; Prest, 2022; Sinn, 2012).

Some proposed supply-side approaches call for internationally coordinated (Newell & Simms, 2020; van Asselt & Newell, 2022) or nationally mandated curbs on fossil fuel production (Jenkins et al., 2021, 2023), but these face substantial political opposition (Rayner, 2021), as illustrated by the recent failure to agree even on modest language calling for an aspirational fossil fuel phase out in the international climate negotiations (Green & van Asselt, 2022). A voluntary supply-side crediting mechanism based on the non-extraction of economically viable fossil fuel reserves, by contrast, would not depend on a political mandate or consensus between sovereign nations. It would also avoid the politicization Its project-based approach would also distinguish it from large-scale and highly politicized efforts such as the failed Yasuní-ITT initiative, in which Ecuador would have been compensated for not exploiting the Ishpingo Tambococha Tiputini (ITT) oilfields in the Amazon Region (Sovacool & Scarpaci, 2016).

Supply-side crediting generates a revenue stream to incentivize the permanent decommissioning of fossil fuel activities so that economically viable reserves remain undeveloped, avoiding the greenhouse gas emissions that would have been released if these fuels were extracted, processed, distributed, and finally combusted. Avoided emissions can be quantified and credited using proven engineering methodologies to determine mine or well productivity and the size of fossil fuels reserves shut in with each decommissioned field (Jing et al., 2020; Masnadi et al., 2018). Because entire fields would be shut down, with existing wells plugged, capped, and abandoned, surface equipment removed, and land reclaimed, remaining reserves would typically lose economic viability.

By tightening fossil fuel supplies, supply-side crediting increases fossil fuel prices, exerting downward pressure on fossil fuel demand and thus on emissions. Given supply elasticities, higher prices may stimulate increased fossil fuel production elsewhere, partly offsetting the emission reductions from decommissioning a particular reserve. Still, such leakage effects are limited by constraints on available infrastructure, differences in crude composition, and the timeline of new investments, with increasingly sophisticated economic analyses allowing calculation of expected leakage rates so that only net avoided emissions are credited (Schaufele, 2021).

Climate benefits from retired fossil fuel reserves are immediate, unlike alternative solutions such as biogenic carbon capture and sequestration, which take years to scale up and absorb carbon to achieve their full mitigation potential. That matters, because it helps prevent new investment in fossil fuel production assets and thereby reduces carbon lock-in and Green Paradox effects, and in doing so also lowers the risk – and economic cost – of future stranded assets. Because of non-linear dynamics in the carbon cycle and climate sensitivity, this focus on avoided emissions offers a greater mitigation effect than subsequent removal of the same amount of emissions (Zickfeld et al., 2021).

Like other types of offset credits, supply-side crediting would need to adhere to the procedural and material requirements of existing offset crediting standards, including independent third-party verification as well as a requirement that emission reductions be permanent and additional. Permanence can be ensured through legal commitments – such as conservation easements, land trusts or transfer of title – and physical interventions that guarantee the irreversibility of the resource retirement. Additionality would be secured through established methods to identify fossil fuel reserves that are economically viable under a wide range of fossil fuel and carbon price scenarios. Credits would only be issued as long as the decommissioned field is, and remains, profitable during the crediting period.

Unlike support policies that target specific technologies and often suffer from information asymmetries, create inframarginal incentives, and do not equalize abatement costs (Aldy et al., 2022), supply-side crediting relies on market forces to identify the resources whose retirement offers the greatest marginal benefit to society. It does so by channeling private investment, moreover, yielding credits that help meet demand and provide liquidity in carbon markets projected to see further tightening of credit supplies and thus increasing credit prices (Shell & BCG, 2023). If participation in supply-side crediting is made conditional on reinvestment of proceeds in low-carbon technologies, such as carbon dioxide removal, it will additionally generate positive spillover benefits and help close the climate finance gap.

Perhaps most importantly, however, supply-side crediting alters the incentive structure facing fossil fuel producers. Factoring in capital and operating expenses, taxes and royalties, and abandonment costs, the value of avoided carbon – especially in the case of highly emissive fossil fuels, such as unconventional heavy oil – could already exceed net profits from oil production with existing offset credit prices. If one further considers the long-term regulatory and financial risks and political uncertainty facing fossil fuel production as the world decarbonizes (Bond et al., 2020), the near-term revenue stream from supply-side crediting could offer a viable alternative to the conventional business model. Supply-side crediting could thus help engage a key segment of the global economy, mobilizing the considerable technical, financial and human resources available in the conventional energy sector to help advance the energy transition. If a share of credit proceeds are assigned to land owners, local communities, and – through taxation of proceeds – local governments, moreover, supply-side crediting can also align multiple stakeholders, creating a buy-in effect for operational and investment decisions that lock in future emission reductions and advance a just transition.

This recalibration of the incentives facing fossil fuel producers occurs through the following impact channels:

- first, mineral right owners gain access to a new revenue stream that helps offset lost income from forgone emitting activities, weakening or counteracting the economic rationale to oppose climate action;
- second, because the demand for, and thus the value of, offset credits is tied to climate policy ambition more generally, fossil fuel producers gain an interest in advancing climate policy ambition, with that interest increasing alongside credit flows;
- Third, credits generated through decommissioned fossil fuel projects ease the current supply shortage in key segments of the carbon market (Shell & BCG, 2023), enabling emissions from existing activities to be offset at lower cost and thereby broadening the landscape of viable transition pathways;
- fourth, revenue from offset credit generation and sales can be committed to investments in low-carbon technology development and deployment, abating operational emissions, diversifying revenue streams, and – over time – contributing to technology cost declines that accelerate achievement of cost parity and lower the overall burden of the energy transition; and
- fifth, revenue from offset credit sales can also fund investments in a just transition, defraying the transition costs of vulnerable communities, such as worker relocation and retraining expenses, but also enabling some of the rents from decarbonization to accrue to developing countries that depend on energy resources for their economic advancement (Richter et al., 2018).

Taken together, these impact channels allow supply-side crediting to initiate a similar virtuous policy sequence to that described in the previous section, but without many of the longer term limitations faced by traditional technology support policies. Over time, supply-side crediting can thus foster the emergence of constituencies that have a vested interest not only in accelerating climate action more generally, but also in deploying less popular, but more scalable carbon constraints such as carbon pricing (Wagner et al., 2015).

A rising price on carbon would not only increase the rents obtained from supply-side credits, but also lower the overall cost of demand-side mitigation, ensuring that every dollar spent goes to its most efficient use, which is why carbon pricing has been described as an "indispensable part of a strategy for reducing emissions in an efficient way" (Stiglitz & Stern, 2017). Applying supply-side and demand-side measures simultaneously leverages the strengths of both approaches to maximize the scale of emission reductions available at a given marginal cost (Harstad, 2012). Because of the potential distributional effects of a supply-side approach, however, criteria to guide the distribution of projects may be needed to avoid equity impacts on entire regions or countries (Sanchez & Linde, 2023).

6. Conclusions

As this paper has shown, climate policy ambition currently lags far behind committed decarbonization targets, due in large measure to the unfavorable political economy of demand-side carbon constraints. A policy innovation, supply-side crediting, can improve the political economy of climate action by offering a revenue stream for the decommissioning of fossil fuel reserves and altering the incentive structure of key stakeholders in the energy economy. Incumbent energy producers and mineral rights holders gain a financially attractive option to discontinue fossil fuel extraction, diversify their portfolios, and leverage their considerable resources and capabilities to advance decarbonization technologies. Revenue from supply-side crediting, in turn, can accelerate the commercialization of necessary low-carbon solutions, such as carbon dioxide removal technologies, and also help address socioeconomic impacts of the energy transition.

Over time, supply-side crediting can thus unlock a virtuous sequence that strengthens overall climate ambition, scales up investment in low-carbon technologies, promotes the objectives of a just transition domestically and abroad, and helps unpopular, but necessary carbon constraints such as carbon pricing become politically more viable. Properly designed and governed, supply-side crediting can thus become a valuable complement to existing climate policy portfolios, and may even be critical to overcome political economy barriers that have contributed to lacking climate ambition in the past. In view of the substantial shortfall in political commitments to near- and medium-term decarbonization, as well as persistent gaps in climate policy implementation and climate financing, policy innovations that can simultaneously reduce emissions from fossil fuel use, yield revenue for investments in necessary abatement technologies, and help overcome entrenched opposition merit consideration as decision makers consider all options at their disposal.

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