Forum

Making Industrial Policy Work for Decarbonization

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Abstract

Industrial policy has begun to move into the center of debates on climate policy. This represents a shift away from climate policy as we know it—as classic environmental policy. Industrial policy and environmental policy differ in their policy goals, policy instruments, and distributional effects, one primarily concerned with economic development, the other with cutting greenhouse gas emissions. This raises questions about policy interactions between industrial and environmental policy in broader climate policy mixes and how these affect global decarbonization. This article identifies complementary and conflictual dynamics between industrial policy and environmental policy in both domestic and international climate politics. It shows how green industrial policy can advance climate goals and cooperation but can also present challenges to deepening climate cooperation and reducing greenhouse gas emissions. Developing an understanding of policy interactions is central to leveraging the potential of industrial policy to accelerate global decarbonization.

The European Union's Green Deal and the Green New Deal agenda in the United States have moved green industrial policy into the center of climate and economic policy making. Green industrial policy is not new. At least since the early 2000s, most countries have adopted some kind of green industrial policy, with China and European economies in the lead. And governments' stimulus responses to the 2008–2009 financial crisis included green investments. However, the current moment is one of scaling up the policy effort and making it more central to climate policy. Global investments in low-carbon technologies grew fifteen-fold between 2004 and 2020 (BloombergNEF 2021).

Climate policy writ large is a broad policy mix of economy-wide and sector- and technology-specific policies (Rogge and Reichardt 2016). Within this broad policy mix, the rise of industrial policy represents a qualitative shift

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Table 1
Industrial Versus Environmental Logics in Climate Policy

	Industrial Policy	*Environmental Policy*
Goals	Competitiveness/growth + GHG abatement	GHG abatement
Instruments	Targets, regulation, investments, focus on "public investment + standards"	Targets, regulation, investment, focus on "pricing + standards"
Distributional effects	Concentrated benefits	Concentrated costs

GHG = greenhouse gas.

away from climate policy as we know it—as classic environmental policy. It reflects a diversification of policy goals and instruments in climate policy making, a greater focus on sectoral policies, and a stronger role of the state in driving low-carbon transitions (Cullenward and Victor 2020; Mazzucato 2021).

Industrial policy and environmental policy differ in their policy goals, policy instruments, and distributional effects. One is primarily concerned with economic development, the other with cutting greenhouse gas (GHG) emissions. At the same time, they are highly interrelated in the context of policy mixes for low-carbon transitions. This raises questions about policy interactions and how these affect global decarbonization. In this Forum article, I identify complementary and conflictual dynamics between industrial policy and environmental policy in both domestic and international climate policy making. Developing an understanding of policy dynamics is central to identifying the opportunities and challenges for industrial policy in advancing decarbonization.

This Forum unfolds in three steps. First, I compare industrial policy and environmental policy in terms of goals, instruments, and distributional effects. Second, I identify complementarities and conflict across four arenas of climate policy. The last section assesses emerging policy challenges and related research questions.

Policy Features: Similarities and Differences

The similarities and differences of green industrial policy and environmental policy come into perspective along three dimensions: policy goals, policy instruments, and distributional effects (Table 1).

Green industrial policy is primarily economic policy that seeks to advance national competitiveness and economic growth. It can do so through different paths. Supply-side industrial policy focuses on developing new technologies and industries for export or import substitution.[1] Demand-side industrial policy

1. Supply-side green industrial policy can further be differentiated in more upstream innovation policy focused on research, development, and demonstration and more downstream policy support for manufacturing.

aims to promote the deployment of low-cost technologies, for example, to reduce the cost of electricity for domestic production and consumption (Matsuo and Schmidt 2019). Unlike macroeconomic policies, such as monetary policy, industrial policy alters "the structure of an economy, encouraging resources to move into particular sectors that are perceived as desirable for future development" (Altenburg and Rodrik 2017, 2). Historically, industrial policy was thought to target sectors with the greatest potential for productivity gains (Vogel 2021). Industrial policy has also, however, long been used to achieve secondary policy goals, such as reducing regional disparities in economic development and advancing environmental protection. In contrast, environmental policy has the primary goal of reducing pollution, in our case, GHGs.

In terms of policy instruments, industrial policy and environmental policy have some overlap. Both realms of policy making employ similar policy instruments, including targets; regulation; and public investment, including subsidies. Yet different policy instruments feature to varying extent in industrial policy versus environmental policy. Both realms of policy making use policy targets. In green industrial policy, targets tend to be deployment targets for clean technologies, as opposed to emissions targets in climate policy. For example, a number of jurisdictions have adopted deployment targets for electric vehicles. Both fields of policy deploy command-and-control regulation, such as deployment (e.g., renewable portfolio standards) and performance mandates (e.g., fuel economy standards). Meanwhile, market-based policies, such as carbon pricing, are central to environmental policy, while they play a marginal role in green industrial policy. Finally, public investment in the form of subsidies, tax rebates, and government procurement is particularly widely used in green industrial policy mixes. This also includes investment for technology demonstration projects (Nemet et al. 2018). Put simply, the formula for green industrial policy is "public investment + standards" compared to "pricing + standards" in environmental policy. Importantly, industrial policy occurs at the sector or firm level, suggesting a higher level of direct government intervention than, for instance, broader carbon pricing policies.

The two sets of policies differ most with regard to distributional effects (Hughes and Urpelainen 2015). In terms of its direct effects, green industrial policy tends to provide concentrated benefits to a specific industry. Environmental policy, by contrast, tends to impose concentrated costs on emitting industries. Policies, however, also have secondary effects, such as green industrial policies leading to a loss of market share for some firms and industries, such as incumbent electric utilities losing out to independent power producers of renewable electricity. These are then concentrated benefits. As a first approximation, however, green industrial policies are more likely to mobilize some political support from economic groups than costly climate policies.

Historically, industrialized countries largely abandoned explicit industrial policy in the 1980s–1990s, while late industrializers pursued industrial policy strategies to develop globally competitive industries (Amsden 1989; Johnson

1982). The rise of China, the economic crisis of 2008–2009, and emerging problems, such as climate change, have since led to a revival of industrial policy in OECD countries, including the United States (Aiginger and Rodrik 2020; Wade 2012). Green industrial policy emerged in the discourse on global climate policy in the mid-2000s, becoming a prominent set of ideas over the last decade, next to classic policy ideas on carbon pricing (Meckling and Allan 2020). The domestic politics of the United States also reflects this shift. For example, the emerging climate policy platform of the Democratic Party in the United States centers on industrial policy and infrastructure investment (Roberts 2020). While green industrial policy has been on a slow rise for two decades, the stimulus responses to the 2008–2009 and 2020–2021 economic crises led to a particular focus on green industrial policy (Hepburn et al. 2020). While some have criticized green industrial policy approaches for picking winners and being vulnerable to rent seeking (Morris et al. 2012), others have shown how central industrial policy is to technological innovation and how good industrial policy can manage the challenges its critics raise (Hepburn et al. 2020; Rodrik 2014; Schmitz et al. 2015).

Lastly, a word on terminology. While the term *green industrial policy* is gaining traction, the terms *innovation policy* and *technology policy* have referred to similar policy activities. The term *innovation policy* tends to relate mostly to research, development, and demonstration policies, rather than the deployment of technologies (Edler and Fagerberg 2017; MacNeil 2017).

Policy Dynamics: Complementarity and Conflict

The empirical reality is that industrial policy and environmental policy coexist in climate policy approaches. Thus, the central question arises how these two sets of policies—with their respective differences in goals, instruments, and distributional effects—interact and how these interactions affect decarbonization. To get a heuristic handle on these interactions, I introduce the notion of four games, adapting Robert Putnam's notion of a two-level game (Putnam 1988). In climate policy making, green industrial policy and environmental policy are separate policy realms and processes with distinct logics. These policy games unfold at both the domestic and international levels (see Figure 1). The interactions across these four games, I posit, condition decarbonization outcomes (arrows in Figure 1). Either *conflict* or *complementarity* characterizes these interactions, thus hindering or facilitating decarbonization. In the following, I discuss conflictual and complementary dynamics along several of the axes across the four games of climate policy making.

Complementarity

Research has shown that broader climate policy mixes evolve over time, with green industrial policies often preceding more ambitious environmental policies.

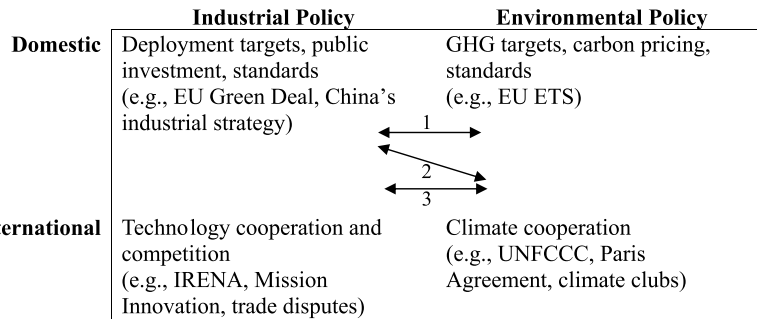

Figure 1
The Four Games of Climate Policy Making

Green industrial policies can facilitate environmental goals (arrow 1, Figure 1), such as GHG targets, and the adoption of environmental policies, such as carbon pricing (Meckling et al. 2015). Two central mechanisms are at play in policy interactions over time. First, industrial and technology policies can reduce the technology cost for achieving emission reduction targets. This may reduce the opposition to adopting climate targets by powerful groups, given the lower compliance cost. Second, industrial policy nourishes economic beneficiaries that may form advocacy coalitions for climate goals. The evolution of climate policy mixes in California and Germany reflects such dynamics. Such positive spillovers on decarbonization are, of course, subject to successful green industrial policy. Green industrial policy success hinges on a range of conditions as international experience shows, including lessons learned from the 2009 stimulus packages (Aldy 2013; Carley 2016; Hart 2018; Rodrik 2014).

While we know that industrial policy can support environmental policy goals, the other direction of policy interactions may also play a role. For example, the more ambitious GHG targets get, the more achieving these goals may depend on the adoption of green industrial policies. As I discuss later, countries have adopted more industrial policy–type measures to achieve their Paris commitments than classic environmental policy instruments. Climate policy may thus lead to a deepening and/or sectoral broadening of green industrial policy interventions. For instance, Germany's failure to reach its 2020 climate target has precipitated a broader policy strategy that includes industrial policy interventions in transport, heating, and industry. Similarly, environmental policies focused solely on GHG emission reductions may be important backstop or directional correctives for industrial policy measures. In California, for example, the emissions trading system is primarily a backstop policy to prevent backsliding of emissions reductions achieved through sectoral industrial policies.

Internationally, green industrial policy can affect environmental policy cooperation through the same mechanisms as in domestic politics: reducing technology costs and mobilizing interest groups. In addition, demonstration effects may play an important role. These policy interactions can unfold along

several axes: first, industrial policy (country A) → environmental policy (country B) (arrow 1); second, industrial policy (country A) → global environmental cooperation (arrow 2); and third, global industrial cooperation → global environmental cooperation (arrow 3). I explain each of these dynamics in the following.

First, the adoption of green industrial policy in one jurisdiction may incentivize the adoption of green industrial policies and subsequently environmental goals and policies in other countries, notably competitor countries. Thus, industrial policy and technology competition facilitate the cross-national adoption of green industrial policies (Myllyvirta 2021). This process is best understood as a strategic sequence of policy adoption, rather than cross-country diffusion of the same policy (Meckling and Hughes 2018). Countries leverage competitive advantages in industrial policies (Anadón 2012), and follower countries may not adopt the same policy as first movers. The classic example is the global development of the solar photovoltaics industry (Nemet 2019). Innovation policies in the United States helped develop the technology; deployment policies in Japan created a niche market; large-scale subsidies in Germany led to the emergence of a mass market; and manufacturing policy in China scaled global production, helping to reduce prices. Depending on technology complexity, follower countries may engage more in policies targeted at "scaling up," such as subsidies to expand manufacturing capacity, or "innovating up," such as R&D policies (Hughes and Meckling 2018). The mechanisms at work are likely based on interest groups and/or demonstration effects. For example, local governments in China responded to foreign markets for solar photovoltaic (PV) by supporting the expansion of manufacturing capacity, engaging in regional competition (Hochstetler and Kostka 2015). Importantly, such spillover effects through technology competition depend largely on the existence of global supply chains that transmit incentives to join global technology competition as illustrated in the PV case (Nahm 2017). Ultimately, such domestic–domestic spillovers in green industrial policy may then affect the ambition of GHG targets and related environmental policies in follower countries as these countries develop economic strategies focused on clean energy technologies.

Second, green industrial policy in one large country can help facilitate global environmental cooperation, primarily by reducing the adjustment cost for other countries (Hale and Urpelainen 2014). This works only if lead markets are large enough to drive down technology cost through economies of scale. Historical evidence on wind and solar PV technologies as well as electric vehicles suggests that a small group of lead markets can facilitate such cost reductions. For example, industrial policies by countries such as Germany and Denmark helped reduce the cost of renewable energy technologies, which facilitated European climate cooperation (Kim and Urpelainen 2013). Furthermore, a comparison of the outcomes of the climate summits in Copenhagen (2009) and Paris (2015) suggests that the same dynamic applies to global climate cooperation. Copenhagen is widely seen as a relative failure in its climate policy ambition, whereas Paris was more successful. Over this six-year time period,

the cost of solar PV and wind technology dropped precipitously. In the Intended Nationally Determined Contributions (INDCs) that countries submitted to the Paris summit, the deployment of renewable energy was the most frequently mentioned priority area: 90 percent of all INDCs listed it. One caveat remains: when states have significantly different capabilities to capture new technology markets through industrial policy—as between industrialized and developed countries—climate cooperation may fail (Kim and Urpelainen 2013).

Third, apart from technology competition, global technology cooperation may also facilitate global environmental cooperation. Here, the mechanism is again public investments that lead to cost reductions in low-carbon technologies. Scott Barrett (2006) argued early on that global cooperation should focus on technology development. Beyond reducing the technology cost itself, global green industrial cooperation can also support climate cooperation by reducing the transaction costs in global technology markets. This includes, for example, cooperation on technical standards, such as plugs for electric vehicles. Empirically, multilateral cooperation on technology cooperation is a limited phenomenon focused primarily on information sharing and target setting. Mission innovation is a plurilateral initiative that seeks to expand public investments in research and development of low-carbon technologies (Sanchez and Sivaram 2017). The United States–China Clean Energy Research Center is an instance of bilateral R&D cooperation (Lewis 2014a). Theoretically, this can lead to significant technological breakthroughs and cost reductions in the long term. Other forms of cooperation, such as the International Solar Energy Alliance, focus more on the near-term deployment of technologies. Beyond cooperation on investment, countries can also work together to reduce other barriers to global market development, such as different technology standards. The Electric Vehicles Initiative under the umbrella of the International Energy Agency is such an example. So, to date, technology competition, rather than technology cooperation, has been the dominant force of complementary dynamics between industrial policy and climate cooperation.

The predominant direction of complementary international policy interactions is from green industrial policy to environmental policy: technology development and diffusion enable emission reduction targets. However, emerging evidence suggests that climate policy can also incentivize greater adoption of green industrial policies. Many of the signatories of the Paris Agreement had some form of green industrial policy in place. Others, especially developing countries, had not yet adopted industrial and technology policies. Committing to emission reduction activities in international negotiations then incentivized the adoption of domestic green industrial policies. Research has shown that, in particular, for developing countries, participation in international climate agreements leads to greater adoption of renewable energy policies (Cia Alves et al. 2019). In other words, if countries commit to GHG reduction targets, they may follow up with policies that offer the greatest economic cobenefits, such as green industrial policies.

Conflict

In national climate policy mixes, industrial policy and environmental policy can also exhibit conflictual dynamics. Arguments relate to cost-effectiveness and political dynamics.

Some economists have argued that renewable energy policies undermine the prices in a carbon pricing system, as they shift emission reductions to outside the pricing system (Fankhauser et al. 2010) (arrow 1, Figure 1). As renewable energy policies are understood as second-best policies in terms of cost-effectiveness compared to pricing policies, they thus increase the overall cost of abatement. Other economists, instead, suggest that the combination of renewable energy policy and carbon pricing leads to a more effective design of the pricing scheme and enhances overall efficiency of climate policy (Gawel et al. 2014; Lehmann and Gawel 2013).

Politically, green industrial policy can mobilize industries in support of more ambitious emissions reduction targets as it grows clean energy industries. Sometimes this also translates into support for carbon pricing, but not necessarily so. For clean energy firms, subsidies and standards may offer much greater benefits in terms of increasing demand for their products and services than low-level carbon pricing. This preference may only lead to political conflict if other major constituencies prefer carbon pricing over green industrial policy. Polluting industries in both Europe and the United States have shown some level of support for carbon pricing, while opposing industrial policy measures like renewable energy mandates and subsidies (Vormedal 2011). For example, in US climate politics, the oil industry–backed Climate Leadership Council advocates a carbon pricing scheme along with rollback of various "complementary" policies, meaning subsidies and standards.

Internationally, industrial policy and technology competition can also lead to conflict between economic and environmental goals (arrow 2). The rise of trade disputes in emerging clean energy technologies reflects international conflict that can challenge global climate cooperation. Since about 2010, the number of trade disputes in clean energy technologies has been growing (Lewis 2014b). These are trade remedy cases directed against subsidies, local content rules, and price dumping, in particular in the solar PV industry but extending to wind and general renewable energy support schemes.

We are only beginning to understand the potential ramifications of green trade disputes for climate negotiations. They can slow down the global diffusion of clean technologies by increasing technology costs and undermine diplomatic efforts to advance global climate cooperation. For instance, tariffs imposed by the United States in the United States–China solar trade dispute, the largest conflict to date by trade volume, increased the cost of solar PV deployment, thus potentially slowing down deployment in the United States. The dispute was also in full swing when the United States and China negotiated a bilateral deal prior to the 2015 Paris summit. The deal succeeded, but trade tensions presented a diplomatic challenge.

Efforts to mitigate the rise of green trade disputes have failed so far. Negotiations on the Environmental Goods Agreement under the World Trade Organization (WTO) have stalled. Eighteen participants representing forty-six WTO members started negotiations in 2014 but have failed to come to an agreement. Developing countries did by and large not participate in negotiations (de Melo and Solleder 2020). The failure to negotiate the agreement reflects the magnitude of the challenges to developing an open trade regime for green goods and services.

While trade disputes in green industries are a salient and prevalent form of conflict, other forms, such as competition over standards, exist as well. For example, a dispute over standards for charging plugs has challenged the development of the global electric vehicle industry. European and US car makers developed their own standards to slow down Japanese producers, which had a market lead (Hughes 2020). The extent to which economic and technology competition in clean energy industries challenges global cooperation on climate remains inconclusive. For now, it is important to highlight the potential for negative feedback on climate negotiations as the economic stakes increase in green industries and economic nationalism is on the rise.

Policy Challenges and Research Questions

Managing the relationship between industrial policy and environmental policy requires enabling complementary dynamics, while mitigating conflict. Here, I discuss emerging policy challenges at the domestic and international levels and propose related research questions.

In domestic politics, the rise of green industrial policy raises questions on what makes good green industrial policy and how even more complex interactions will play out as social policy and macroeconomic policy begin to be tied to climate goals. First, the rise of green industrial policy in both industrialized and developing nations is likely to be a persistent trend. At the same time, we know very little about what makes for good green industrial policy in different institutional and economic settings. The question pertains to the performance of green industrial policy with regard to both productivity goals and environmental goals. In a recent special issue, the economists Karl Aiginger and Dani Rodrik suggest that modern-day industrial policy is different from its 1970s predecessor in at least several ways, including a more systemic approach, designed to be a search process and tied to societal goals (Aiginger and Rodrik 2020). A central question is how to design green industrial policy to avoid rent seeking and policy paths that do not contribute to or undermine emission reduction goals. The case of continued government support for early-generation biofuels despite increasing evidence of the lack of climate benefits continues to echo as a warning.

Responding to the economic crisis in the wake of the COVID-19 pandemic, governments have adopted stimulus packages that include green spending to

varying extents. These are industrial policy efforts intended to scale up investments in low-carbon technologies. Some governments have begun to embed environmental policy goals into industrial policy through "climate conditionalities." For example, the French government tied its bailout of Air France to the condition that the company develop an emission reduction strategy. This may only be the beginning of a new field of creative policy making where industrial efforts are more clearly tied to decarbonization goals, thus further blending industrial and environmental policy.

Second, emerging trends foreshadow even more complex policy dynamics, going beyond industrial policy–environmental policy interactions. The US debate on a Green New Deal has tied green industrial policy to social policy goals. Furthermore, while industrial policy has been the realm of economic policy making where we have witnessed the greatest amount of climate-related policy activity, it is but one type of economic policy. Climate goals are also beginning to feature in macroeconomic policies, including fiscal, financial, and monetary policies (Krogstrup and Oman 2019). For instance, central banks are beginning to engage in financial regulatory policies to tackle climate risks. In other words, as climate policy becomes more embedded in central policy fields, its scope broadens to economic and social policy making. This cross-policy integration reflects, on one hand, the mainstreaming of climate mitigation, while it increases the complexity of policy dynamics and raises coordination challenges across policy goals, on the other hand. At its core, the question, then, is how and when such broad policy packages and underlying political bargains advance emission reduction goals, and when they do not.

In international politics, there is considerable uncertainty on how the rise of industrial policy in general and green industrial policy in particular will unfold. The re-emergence of industrial policy along with economic nationalism could result in a mercantilist green technology race. This could end up in protectionist policies that challenge the global development and diffusion of clean technologies. An alternative scenario envisions a global division of labor (Lachapelle et al. 2016), in which industrialized nations in the West shift from engaging with China in trade wars to leveraging economic opportunity (Ball 2019). The path to such a scenario is likely contingent on macro developments in global politics, in particular the United States–China rivalry.

Yet opportunities exist to foster technology competition and cooperation that advance global clean technology diffusion and climate policy development. This includes firm-to-firm cooperation across global supply chains, government-to-government cooperation in international fora, and hybrid forms of cooperation that bring together governments and firms (Gallagher 2014; Victor et al. 2019). For example, some analysts also see potential for a cross-sectoral global forum for industrial policy coordination to capitalize on positive spillovers and mitigate negative spillovers. Such a forum could facilitate coordination around trade and investment rules, securing property rights, social standards, and the promotion of low-carbon technologies (Aiginger and Rodrik 2020).

Taken together, the rise of green industrial policy has broadened the climate policy repertoire in essential ways, most importantly moving structural economic change into the center of climate policy. This broadening has introduced industrial policy logics next to environmental policy logics in climate policy making. Overall, this offers a large upside to advancing decarbonization through the many complementary interactions discussed herein. The potential for conflictual policy interactions is more limited but needs to be on the radar of policy makers and scholars to avoid misguided green industrial policies that fail to advance decarbonization.

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