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Editorial

Why Ambitious and Just Climate Mitigation Needs Political Science

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Abstract
A large-scale transformation of the energy system, which climate mitigation entails, is a global and highly politicized problem. This thematic issue brings together scholars who work with Integrated Assessment Models (IAMs)—which are used for Intergovernmental Panel on Climate Change (IPCC) reports and other key analyses of future climate trajectories—and social scientists working on climate and energy issues to highlight how the two strands of research could benefit from combining insights across different disciplines and methods. One of the key messages across almost all contributions is that the more technical perspectives could benefit from adjusting their assumptions to reflect the patterns observed in quantitative and qualitative social science. Combining different disciplines is methodologically challenging but promising to ensure that the mitigation strategies developed are considered technically and politically feasible, as well as just.

Keywords
climate mitigation; Integrated Assessment Models; interdisciplinary

Issue
This editorial is part of the issue "Exploring Climate Policy Ambition" edited by Elina Brutschin (International Institute for Applied Systems Analysis) and Marina Andrijevic (International Institute for Applied Systems Analysis).

1. Introduction

The window to keep 1.5 °C alive is rapidly closing (Intergovernmental Panel on Climate Change [IPCC], 2022). Avoiding more serious impacts associated with raising temperature requires a substantial improvement in the level of the current policy ambition because the current national pledges still put the world on a trajectory to 2.1 °C global mean temperature above the preindustrial level (Climate Action Tracker, 2022). Global process-based Integrated Assessment Models (IAMs), a well-established and frequently used tool to derive long-term climate policy goals and recommendations, show that there are many different mitigation options and combinations of them that would get us to the 1.5 °C target (IPCC, 2022). Yet, many recent studies have questioned whether the rate of decarbonization assumed in the models is feasible from the socio-political perspective (Brutschin et al., 2021; Cherp et al., 2021; Vinichenko et al., 2021).

IAMs represent a set of stylized assumptions rooted in economic and technology diffusion theories. The core objective function (i.e., the main guiding principle to find optimal solutions given a set of constraints) in many IAMs is cost minimization (Żebrowski et al., 2022), implying that policymakers are assumed to rely on the most cost-efficient technologies and solutions. Because having a regional differentiation of the carbon price would be economically inefficient, most IAMs also assume a globally unified carbon price as the main mitigation lever. Given the core structure of the IAMs, it is thus not surprising that the outputs from scenarios that IAMs produce are often at odds with the patterns observed in empirical work and with justice principles that focus on equity of efforts. This could be unproblematic—as long as the model users are aware of the underlying assumptions—because the main purpose of models is not necessarily a representation of the world as it is. However, they are meant to be a useful tool to explore different options and what-if scenarios (i.e., what would happen if a more ambitious approach to climate mitigation were taken). Yet, given the urgency to mitigate, the outputs of IAMs at the regional level are gaining more attention to either justify major policy targets (i.e., the year when net-zero CO_2 or greenhouse gas emissions should be reached) or to calculate ex-post based on global emissions output which effort allocation principles are more just (van den Berg et al., 2020). In this thematic issue, we want to highlight that for regional IAM outputs to be more meaningful, the insights from political science need to be taken into account in some of the core assumptions and in how the IAM results are communicated and interpreted.

Calls for better integration of different disciplines, especially of political science, when studying energy transitions and different climate mitigation options already exist (Geels et al., 2016; Peng et al., 2021), though within political science there is also a need for better integration of different streams and theories (Jordan et al., 2022). There are generally three core contention points that make interdisciplinary work particularly challenging: difference in terminology, difference in the levels of analysis, and difference in goals and methods. This thematic issue shows that while some major methodological challenges prevail, there are many entry points where insights from political science could inform IAMs in order to generate more policy-relevant scenarios and to make them more useful for policy-makers. Overall, the issue addresses the following questions: (a) What additional global and regional mitigation patterns should be explored in IAMs? (b) Which additional issues should be given more consideration? and (c) How should the insights be communicated?

2. What Additional Global and Regional Patterns of Mitigation Should Be Explored in Integrated Assessment Models?

One way to bring in political science is to explore a set of scenarios that adds political rationale to the economic and technological constraints at the regional as well as the global levels. From a political science perspective on global governance, implementing a unified carbon price is very unlikely. In this issue, Hickmann et al. (2022) develop four global climate governance archetypes: (a) a revitalized top-down approach, (b) a hybrid approach with a strong joint commitment by national governments, (c) a hybrid approach with a weak joint commitment by national governments, and (d) a breakdown of international cooperation on climate change. Hickmann et al. (2022) find that in the current set of IAMs scenarios, such hybrid approaches, where governments have a common goal as well as effective coordination of effort-sharing, are not well represented. This is, for example, a call for more scenarios that implement a regionally differentiated carbon price.

There are countless examples where policymakers implement policies that do not seem to follow economic efficiency rationale, such as the deployment of nuclear technology in certain countries (Brutschin et al., 2021) or persistent subsidies for coal mining in the European Union during periods when coal mining elsewhere was more cost-efficient. Yet, this does not mean that policymakers are not rational in the classical economic sense: They simply optimize their prospects of staying in power rather than minimizing the overall costs of policies that they implement. In political science, it has been shown that this “logic of political survival” (Mesquita et al., 2005) can explain policy outputs across a wide range of political systems, but also that institutions (broadly defined) have a strong mediating role regarding which political behavior is incentivized and rewarded. For example, in a political system with a free press and democratic elections, policymakers are attentive to public opinion on key issues; in an authoritarian system, more attention is given to political elites that consolidate economic or military power. The main insight from this strand of research is that we need to focus more on key interest groups in a given region and on strategic state capacity (Meckling & Nahm, 2021), which proxies states’ ability to implement policies even against strong opposition from key interest groups.

A more general view of how to link political science and IAMs is presented in this issue by Pianta and Brutschin (2022). They identify variables that have been shown to affect climate policies and propose a new framework that shows how empirical political science insights could inform integrated assessment modeling to take into account regional heterogeneity, including state capacity, vested interests, and public opinion considerations. Additionally, the article demonstrates how to reconcile the methodological difficulties stemming from the differences in the level of analysis: Global IAMs operate based on regional data, while most political science analyses are conducted at country or individual levels of analysis. Nonetheless, even though certain nuances may be lost, individual and national level data can be aggregated to the regional level, and some of the insights gained through the analysis of national level data can be transferred to the regional level.

A possible concrete implementation of this logic is shown in this issue by Brutschin et al. (2022). They find a correlation between higher levels of state capacity and more ambitious levels of coal phase-out, and also trace specific strategies implemented by countries with higher levels of state capacity to prematurely retire coal power plants. This insight could be used to adjust some of the assumptions in IAMs regarding regional differences in the speed and scale of coal phase-out. In this context, the issue of correlation versus causation remains a methodological challenge, particularly in the domain of IAMs that social sciences are concerned with, given the ever-present endogeneity issues with variables such as GDP per capita and measures of institutional quality. However, Pianta and Brutschin (2022) argue that insights based on correlations can still be extremely useful if this means that regional differences in mitigation capacity can be better proxied as compared to the original IAM assumptions.

3. Which Additional Issues Should Be Given More Consideration?

Another key area that has a long tradition in political science, but is rarely taken into account in IAMs, is the question of policy implementation. Public policy scholars generally tend to assess the effectiveness of different policy instruments, as the link between the stated policy goals and the final outcome is not straightforward and often depends on the type of political system (Knill et al., 2012; Knill & Tosun, 2020). In this issue, the importance of understanding the "implementation gap"—insufficient design or stringency of concrete policy instruments in place—is highlighted by Perino et al. (2022). Using Germany and the European Union, the authors show that there are substantial obstacles to the implementation of the announced pledges, even within highly ambitious political entities. Perino et al. (2022) suspect that among key obstacles are distributional conflicts that might be stronger during the implementation stage as compared to the goal-setting stage, and additionally emphasize the importance of a better understanding of the role of climate litigation for reducing the implementation gap.

To explore the links between stated goals, policy outputs, policy instruments, and policy outcomes, better coverage of existing climate policies at the national level is essential. As a way to measure the level of policy ambition through policy density in quantitative research, Schaub et al. (2022) discuss three climate policy databases that cover the period from 2000 to 2019: (a) the Climate Change Laws of the World Database (CCLW), produced by the Grantham Research Institute at the London School of Economics and Political Science; (b) the Climate Policy Database (CPD), published by the NewClimate Institute; and (c) the Policies and Measures Database (PMD), provided by the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA). Schaub et al. (2022) explore the usefulness of each data source for different types of research question and call for more effort to add more detailed data that would further improve the efforts to understand patterns in levels of climate ambition and implementation.

Finally, the article of Plaček et al. (2022) explores the possible gender-differentiated agency of policymakers that are relevant to environmental policy. Using a survey in the Czech Republic, they show that upper-level female bureaucrats are more likely to promote green public procurement. Overall, this calls for more exploration regarding what role gender equality could play in the speed and scale of future global mitigation. For example, a Shared Socio-Economic Pathway (SSP) narrative (Riahi et al., 2017) that assumes much faster convergence in gender equality could be developed and used to explore alternative mitigation pathways.

4. How Should Insights Be Communicated?

Given that policymakers are often the target audience of IAMs, it is essential to understand how they use insights from climate mitigation scenarios and communicate about climate ambition. In this issue, Kinski and Ripoll Servent (2022) discuss the results of quantitative analysis of debates in the European Parliament to trace how politicians discuss climate policy ambitions and whose interests they represent. Apart from a major methodological contribution on how to operationalize climate ambition in political debates, this article has a finding that is of high relevance for the work of climate scientists. Kinski and Ripoll Servent (2022) highlight that while many politicians are well informed about what needs to be done, certain concepts such as "justice" and "feasibility" might be politicized and used as a justification for delayed mitigation. This brings us back to the motivation behind this thematic issue of the *Politics and Governance* journal: Climate change mitigation scenarios should incorporate key feasibility and justice concerns and thereby avoid long-term scenarios being mis-used to delay urgent mitigation action.

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References

Brutschin, E., Pianta, S., Tavoni, M., Riahi, K., Bosetti, V., Marangoni, G., & van Ruijven, B. J. (2021). A multidimensional feasibility evaluation of low-carbon scenarios. *Environmental Research Letters*, *16*(6), Article 064069. https://doi.org/10.1088/1748-9326/abf0ce

Brutschin, E., Schenuit, F., van Ruijven, B., & Riahi, K. (2022). Exploring enablers for an ambitious coal phaseout. *Politics and Governance*, *10*(3), 200–212.

Cherp, A., Vinichenko, V., Tosun, J., Gordon, J. A., & Jewell, J. (2021). National growth dynamics of wind and solar power compared to the growth required for global climate targets. *Nature Energy*, *6*(7), 742–754. https://doi.org/10.1038/s41560-021-00863-0

Climate Action Tracker. (2022). *Temperatures*. https://climateactiontracker.org/global/temperatures

Geels, F. W., Berkhout, F., & van Vuuren, D. P. (2016). Bridging analytical approaches for low-carbon transitions. *Nature Climate Change*, *6*(6), 576–583. https://doi.org/10.1038/nclimate2980

Hickmann, T., Bertram, C., Biermann, F., Brutschin, E., Kriegler, E., Livingston, J. E., Pianta, S., Riahi, K., van Ruijven, B., & van Vuuren, D. (2022). Exploring global climate policy futures and their representation in

integrated assessment models. *Politics and Governance*, *10*(3), 171–185.
Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Mitigation of climate change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
Jordan, A., Lorenzoni, I., Tosun, J., i Saus, J. E., Geese, L., Kenny, J., Saad, E. L., Moore, B., & Schaub, S. G. (2022). The political challenges of deep decarbonisation: Towards a more integrated agenda. *Climate Action*, *1*(1), Article 6. https://doi.org/10.1007/s44168-022-00004-7
Kinski, L., & Ripoll Servent, A. (2022). Framing climate policy ambition in the European Parliament. *Politics and Governance*, *10*(3), 251–263.
Knill, C., Schulze, K., & Tosun, J. (2012). Regulatory policy outputs and impacts: Exploring a complex relationship. *Regulation & Governance*, *6*(4), 427–444. https://doi.org/10.1111/j.1748-5991.2012.01150.x
Knill, C., & Tosun, J. (2020). *Public policy: A new introduction*. Bloomsbury Publishing.
Meckling, J., & Nahm, J. (2021). Strategic state capacity: How states counter opposition to climate policy. *Comparative Political Studies*, *55*(3), 493–523. https://doi.org/10.1177/00104140211024308
Mesquita, B. B. D., Smith, A., Siverson, R. M., & Morrow, J. D. (2005). *The logic of political survival*. MIT Press.
Peng, W., Iyer, G., Bosetti, V., Chaturvedi, V., Edmonds, J., Fawcett, A. A., Hallegatte, S., Victor, D. G., van Vuuren, D., & Weyant, J. (2021). Climate policy models need to get real about people—Here's how. *Nature*, *594*(7862), 174–176. https://doi.org/10.1038/d41586-021-01500-2
Perino, G., Jarke-Neuert, J., Schenuit, F., Wickel, M., & Zengerling, C. (2022). Closing the implementation gap: Obstacles in reaching net-zero pledges in the EU and Germany. *Politics and Governance*, *10*(3), 213–225.
Pianta, S., & Brutschin, E. (2022). Emissions lock-in, capacity, and public opinion: How insights from political science inform climate modeling efforts. *Politics and Governance*, *10*(3), 186–199.
Plaček, M., del Campo, C., Valentinov, V., Vaceková, G., Šumpíková, M., & Ochrana, F. (2022). Gender heterogeneity and politics in decision-making about green public procurement in the Czech Republic. Politics and Governance, *10*(3), 239–250.
Riahi, K., van Vuuren, D. P., Kriegler, E., Edmonds, J., O'Neill, B. C., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., Lutz, W., Popp, A., Cuaresma, J. C., Kc, S., Leimbach, M., Jiang, L., Kram, T., Rao, S., Emmerling, J., . . . Tavoni, M. (2017). The shared socioeconomic pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, *42*, 153–168. https://doi.org/10.1016/j.gloenvcha.2016.05.009
Schaub, S., Tosun, J., Jordan, A., & Enguer, J. (2022). Climate policy ambition: Exploring a policy density perspective. *Politics and Governance*, *10*(3), 226–238.
van den Berg, N. J., van Soest, H. L., Hof, A. F., den Elzen, M. G. J., van Vuuren, D. P., Chen, W., Drouet, L., Emmerling, J., Fujimori, S., Höhne, N., Kõberle, A. C., McCollum, D., Schaeffer, R., Shekhar, S., Vishwanathan, S. S., Vrontisi, Z., & Blok, K. (2020). Implications of various effort-sharing approaches for national carbon budgets and emission pathways. *Climatic Change*, *162*, 1805–1822. https://doi.org/10.1007/s10584-019-02368-y
Vinichenko, V., Cherp, A., & Jewell, J. (2021). Historical precedents and feasibility of rapid coal and gas decline required for the 1.5°C target. *One Earth*, *4*(10), 1477–1490. https://doi.org/10.1016/j.oneear.2021.09.012
Żebrowski, P., Dieckmann, U., Brännström, Å., Franklin, O., & Rovenskaya, E. (2022). Sharing the burdens of climate mitigation and adaptation: Incorporating fairness perspectives into policy optimization models. *Sustainability*, *14*(7), Article 3737. https://doi.org/10.3390/su14073737

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Article

Exploring Global Climate Policy Futures and Their Representation in Integrated Assessment Models

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Abstract

The Paris Agreement, adopted in 2015, paved the way for a new hybrid global climate governance architecture with both bottom-up and top-down elements. While governments can choose individual climate goals and actions, a global stocktake and a ratcheting-up mechanism have been put in place with the overall aim to ensure that collective efforts will prevent increasing adverse impacts of climate change. Integrated assessment models show that current combined climate commitments and policies of national governments fall short of keeping global warming to 1.5 °C or 2 °C above preindustrial levels. Although major greenhouse gas emitters, such as China, the European Union, India, the United States under the Biden administration, and several other countries, have made new pledges to take more ambitious climate action, it is highly uncertain where global climate policy is heading. Scenarios in line with long-term temperature targets typically assume a simplistic and hardly realistic level of harmonization of climate policies across countries. Against this backdrop, this article develops four archetypes for the further evolution of the global climate governance architecture and matches them with existing sets of scenarios developed by integrated assessment models. By these means, the article identifies knowledge gaps in the current scenario literature and discusses possible research avenues to explore the pre-conditions for successful coordination of national policies towards achieving the long-term target stipulated in the Paris Agreement.

Keywords

climate action; climate policy; global climate governance architecture; integrated assessment models; Paris Agreement; scenario analysis

Issue

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1. Introduction

After almost three decades of international climate negotiations, national governments have still not yet adopted effective means of implementation to cope with the problem of climate change. While the Covid-19 pandemic led to a temporary decline in global greenhouse gas (GHG) emissions (Bertram, Luderer, et al., 2021; Le Quéré et al., 2021), current collective efforts to mitigate global warming remain insufficient for the overall ambition stipulated in the Paris Agreement to keep global warming "well below 2 °C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5 °C" (United Nations Framework Convention on Climate Change [UNFCCC], 2015, Article 2).

Although major GHG emitters, such as China, the European Union, India, the United States under the Biden administration, and several other countries, have recently made new pledges to take more ambitious climate action, it is highly uncertain where global climate policy is heading within the next decade. An official analysis of all revised plans for nationally determined contributions (NDCs) found only a small effect on GHG emission trajectories until 2030 (UNFCCC, 2021). Whilst a further analysis of updated pledges done in preparation for the 26th Conference of the Parties (COP26) in Glasgow tentatively suggests a stronger foundation for achieving the long-term goals of the Paris Agreement (Ou et al., 2021), deep GHG emission cuts would still be required to keep the door open to limiting peak warming to 1.5 °C (Intergovernmental Panel on Climate Change [IPCC], 2018).

The adoption of the Paris Agreement in 2015 marked a watershed moment in the overall global climate governance architecture. The Paris Agreement established a new legal framework that for the first time entailed responsibilities for virtually all countries to introduce measures to mitigate climate change (Streck et al., 2016). Moreover, in contrast to the Kyoto Protocol which involved a top-down governance approach with quantified GHG emission reduction targets for a certain set of industrialized countries, the Paris Agreement is based on bottom-up pledges by national governments combined with common principles for accounting, transparency, a periodic global stocktake, and a ratcheting-up mechanism to ensure that combined national efforts avoid increasing adverse impacts of climate change. The Paris Agreement is based on a "pledge and review" logic and its success depends on the continuous strengthening of national ambitions to reduce GHG emissions and attain carbon neutrality (Falkner, 2016).

While a couple of recent exceptions exist (e.g., Bauer et al., 2020; Bosetti et al., 2013; Deetman et al., 2015; van Soest et al., 2021), most mitigation scenarios used in integrated assessment models (IAMs) focus on so-called cost-optimal reduction pathways. This means that they start from the notion that climate action will accelerate over time and consensus will emerge among national governments about how to share efforts to mitigate climate change. Moreover, most IAM scenarios suppose that climate policies can be implemented in all regions and sectors irrespective of national and local circumstances (Rogelj et al., 2018). In addition, they often apply uniform carbon prices across world regions with different socio-political conditions (Bauer et al., 2020). This assumption is still far from reality and the prospect of the further evolution of the global climate governance architecture is ambiguous. While IAM scenarios are primarily meant to identify possible cost-optimal strategies (and thus do not really represent an assumption of a realistic policy environment), we argue that it is crucial to draw upon plausible assumptions regarding future trajectories of global climate cooperation in order to build the next generation of policy-relevant climate scenarios.

In this article, we adopt a forward-looking perspective on the possible futures of global climate governance architectures. In particular, we develop four global climate governance archetypes that differ according to their degree of coordination. They are: (a) a revitalized top-down approach, (b) a hybrid approach with a strong joint commitment by national governments, (c) a hybrid approach with a weak joint commitment by national governments, and (d) a breakdown of global cooperation on climate change. We match these governance archetypes with existing sets of scenarios from IAMs to illustrate to what extent existing models depict these possible governance futures. By these means, we seek to identify knowledge gaps in the current scenario literature and point to possible research avenues to explore the preconditions for successful coordination of national policies towards achieving the targets stipulated in the Paris Agreement. Thus, this article nurtures the debate about which type of global climate governance architecture is most conducive to reaching the 1.5 °C target.

The article is structured as follows. In Section 2, we clarify the concept of governance architecture and describe crucial changes in the global climate governance architecture over the past three decades. In Section 3, we explain the development of possible futures of the global climate governance architecture and how we matched them with existing IAM scenarios. In Section 4, we develop and elaborate on the four governance archetypes which form the basis for the following analysis. In Section 5, we assess the scenario literature and explore to what extent existing sets of IAM scenarios cover the different governance archetypes. In Section 6, we discuss identified knowledge gaps and point to options for closing them, before we draw our conclusions in Section 7.

2. The Changing Global Climate Governance Architecture

The term "governance architecture" refers to the metaphor of buildings that comprise "copious rooms, lavish apartments, winding staircases and meandering corridors, [that are] all part of one interrelated system while keeping independent roles and spaces" (Biermann & Kim, 2020, pp. 7–8). Over the past few years, the concept of governance architectures has received increasing attention among scholars concerned with global policymaking (e.g., Biermann & Kim, 2020; Biermann et al., 2010; van Asselt & Zelli, 2014; Zelli, 2011). It is used as an umbrella term to denote the evolving institutional structure in a given policy domain composed of public and private entities operating at different governmental levels and scales.

While authors previously concentrated their analysis primarily on single institutions and their dyadic interactions (e.g., the international climate regime and interactions with for instance the World Trade Organization), the concept of governance architecture takes a holistic perspective and looks at the vast multiplicity and overarching framework of actors and institutions in a certain policy domain. In the following paragraphs, we sketch the evolution of the global governance architecture in the field of climate change.

After mounting scientific evidence in the late 1980s that the earth was warming as a result of increasing atmospheric GHG concentrations , national governments adopted the UNFCCC at the Earth Summit in 1992 (United Nations, 1992). This Convention did not contain any binding targets for nation-states to reduce their GHGs but laid the foundation for the negotiation of the Kyoto Protocol which was agreed upon in 1997.

The Kyoto Protocol introduced obligations for a certain set of industrialized countries to limit their GHG emissions (UNFCCC, 1997), but it did not foresee any mitigation obligations for developing countries which at that time accounted only for a smaller share of overall GHG emissions. After intense negotiations about a rulebook and procedures for a market-based instrument, the Kyoto Protocol came into force in 2005. This top-down governance approach (Hare et al., 2010) was largely modeled on the success story of the Montreal Protocol, which effectively scaled down the global production and consumption of chlorofluorocarbons and other ozone-depleting substances (e.g., Oberthür, 2001; Parson, 2003).

However, in the years following the Kyoto Protocol's entry into force, there was little progress, with many key industrialized countries either not meeting their individual Kyoto targets or not ratifying the protocol in the first place. At the same time, GHG emissions increased substantially in developing countries, especially in Asia (Lamb et al., 2021). As a result, multilateral treaty-making as the means to tackle climate change came under intense scrutiny (Bernstein et al., 2010). Some scholars even questioned whether international climate negotiations were still necessary for addressing the problem of climate change (e.g., Hoffmann, 2011; Rayner, 2010; Victor, 2011). This frustration came to a peak following the failure of the international community to agree on a new international treaty at the Copenhagen Climate Summit in late 2009. Despite extensive preparations and the participation of more than 120 heads of state or government, the meeting was not successful in establishing a legally binding replacement for the Kyoto Protocol as anticipated, not least by thousands of civil society activists in and around the conference venue (Bodansky, 2010).

After several years of uncertainty and further rounds of negotiations, national delegates led by a coalition of committed governments and backed by the United Nations, with the support of the UNFCCC Secretariat and numerous non-governmental organizations, adopted the widely celebrated Paris Agreement in 2015. Its adoption generated a shift away from top-down targets for nation-states towards bottom-up pledges that are combined with centralized principles for accounting, transparency, and a periodic global stocktake, hence representing a new type of hybrid global climate governance (Dubash, 2020). The bottom-up nature ensured a new governance framework that envisages obligations for almost all countries to take action against climate change (Streck et al., 2016). The Paris Agreement also foresees a key role for non-state actors to take part in the review of ambition levels, implementation, and compliance by national governments (e.g., Bäckstrand et al., 2017; van Asselt, 2016).

While the latest rounds of international climate negotiations under the UNFCCC in Glasgow in November 2021 have shown some progress, there is no clear road towards meeting the long-term temperature targets as stipulated in the Paris Agreement. Countries announced new commitments to curb methane emissions, phase-down coal-fired power plants, and halt continued deforestation (United Nations, 2021; see also Masood & Tollefson, 2021). Nevertheless, collective commitments still fall far short of the required steps needed to effectively tackle climate change. Recent projections and databases show an increasing GHG emissions gap between aggregate pledged near-term trajectories and what is needed to keep global warming to 1.5 °C or 2 °C (Roelfsema et al., 2020; United Nations Environment Programme, 2018; Vrontisi et al., 2018).

Furthermore, many countries with ambitious mitigation targets for 2030 currently lack progressive climate policies to ensure target achievement, exhibiting a clear lack of implementation (den Elzen et al., 2019). In response to the Paris Agreement's invitation to submit long-term strategies and the 2018 special report of the IPCC with its emphasis on carbon neutrality, we witnessed a "wave of net-zero emission targets" (Höhne et al., 2021, p. 820) by countries. This suggests that so far it is easier for countries to formulate medium-to-long-term targets than to enact legislation and adopt policies that lead to corresponding near-term effects. This has been framed as a "credibility gap" (Climate Action Tracker, 2021).

At the UNFCCC COP26 , the two largest GHG emitters—China and the United States—released a joint statement promising to increase cooperation on climate action ("UN chief welcomes China–US pledge," 2021). Likewise, the European Union has refined its strategy to become climate neutral by 2050 and put forward a plan to reduce its GHG emissions compared to 1990 by at least 55% until 2030 (European Union, 2021). Yet, it remains largely unclear whether these pledges will materialize and how global cooperation on climate change will develop further. Hence, this article describes possible future developments of the global climate governance architecture within the next decade and assesses how such governance futures are depicted in existing IAMs.

3. Methodology

The analysis in this article was undertaken in two consecutive steps. Firstly, we developed four archetypes of the evolution of the global climate governance architecture. Secondly, we conducted a mapping exercise with existing IAM scenarios. The different governance archetypes are the result of discussions which took place in a series of expert workshops combined with a review of the relevant academic literature in the field of global climate governance. The categorization of four archetypes is necessarily a simplification depicting broad future policy pathways.

The development of the four governance archetypes informed the matching of the different possible global climate policy futures with existing IAM scenarios. Building upon the categorization of the four governance archetypes, the main purpose of the matching has been to identify gaps in the scenario literature. We, therefore, aim in this article to depict a broad overview of stylized pathways and illustrative modeling exercises as opposed to discussing all IAM scenarios in detail as this would have gone beyond the scope of the article.

In sum, the matching of the four governance archetypes with IAM scenarios tries to draw a rough picture, with illustrative nuances. To further contextualize the article in the broader scenario literature, we compiled a table that summarizes the different criteria used for our matching of the four governance archetypes with existing sets of IAM scenarios. This table includes a comparison of our four archetypes with the representative scenarios from the IPCC *Sixth Assessment Report* (AR6; see Table S1 in the Supplementary File).

4. Looking Forward: Developing Four Governance Archetypes

Drawing on the literature on global climate governance, we now develop and elaborate four archetypes for different possible futures of the global climate governance architecture within the next decade. The four archetypes range from (a) a revitalized top-down approach, (b) a hybrid approach with a strong joint commitment by national governments, and (c) a hybrid approach with a weak joint commitment by national governments to (d) a breakdown of global cooperation on climate change (see Table 1 for an overview of these governance archetypes and their main features).

In our usage of the term global climate governance architecture, we focus primarily on the actions of states and the UNFCCC process. However, we recognize the importance of sub-national authorities and non-state actors in contributing to GHG emissions reduction and the role they play in global climate policy (e.g., Green et al., 2014; Hickmann, 2017; van Asselt, 2016). The role of city networks, business self-regulation, and non-governmental initiatives in supporting and demanding state-level international cooperation is incorporated in the governance archetypes as outlined below. Yet, we note that the coverage of such climate actions launched

Table 1. Summary of key assumptions for each of the four governance archetypes.

1. Revitalized top-down approach ("return to Kyoto" approach)	2. Hybrid approach with strong joint commitment (Paris Agreement targets reached)
• Top-down approach with strong legal and mandatory institutional characteristics • Strong accounting, monitoring, and verification as well as sanctions in case of non-compliance • Strict enforcement of national policies to ensure achievement of the 1.5 °C target	• Hybrid approach with clear goal orientation and effective coordination on effort-sharing among governments • Based on individual national pledges and common principles leading to a joint understanding of effort-sharing • Idealized continuation of current global climate governance architecture, enabling near-term GHG reductions and the possibility of upscaling
3. Hybrid approach with weak joint commitment (Paris Agreement targets missed)	**4. Breakdown of global climate cooperation (UNFCCC process failed)**
• Hybrid approach without clear goal-orientation and effective coordination on effort-sharing among governments • Failure to strengthen national climate actions and accelerating the global mitigation ambition over time • Prolongation of status quo with soft coordination of national climate policies, but failure of effective ratcheting-up	• Gradual erosion of global climate policy with steady withdrawal of countries from multilateral treaties and agreements • A decline of national climate pledges leading to an anarchical international setting • All key principles, norms, rules, and decision-making procedures of global climate policy fall apart

and pursued by actors other than national governments is limited in current IAM scenarios and requires further exploration.

Above all, the four governance archetypes are not meant as accurate pictures of reality but rather bold descriptions to allow for matching with different IAM scenarios and to identify knowledge gaps. At the same time, they help to systematically compare the level of global cooperation ambition needed to achieve the Paris Agreement.

4.1. Governance Archetype One: Revitalized Top-Down Approach

The first governance archetype constitutes a top-down or centralized approach with strong legal and mandatory institutional characteristics. It can be seen as the Kyoto model and envisages clear legally binding targets within a multilaterally agreed process for all national governments to reduce their GHG emissions by a certain date, including strong accounting, monitoring, and verification procedures as well as sanctions for national governments in case of non-compliance (e.g., Hare et al., 2010). In other words, this governance archetype entails strict enforcement of public policies on a global level that aim to ensure the achievement of the long-term climate stabilization target as stipulated by a new universal climate treaty.

This archetype suggests that within the next decades, impactful measures will be adopted by a large number of countries due to the growing threat of climate change. These countries not only regularly meet at the global level, but also adhere to stringently defined overarching targets and the allocation of individual GHG emission budgets based on recent academic analysis (Messner et al., 2013). This archetype assumes that all governments of major GHG-emitting countries will adopt an explicit climate change mitigation effort-sharing agreement that guides national climate actions. In line with such an agreement, countries adopt ambitious climate policies and accelerate them step by step based on scientific advice and a high and increasing carbon price (uniform across regions or differentiated based on the agreed effort-sharing principle) and similar wide-ranging instruments to reduce global GHG emissions (Weitzman, 2014).

4.2. Governance Archetype Two: Hybrid Approach With a Strong Joint Commitment

A second governance archetype constitutes a hybrid approach with a strong joint commitment by national governments leading to a "race to the top." It entails a goal-oriented effort-sharing approach among most national governments to tackle climate change through accelerated ambitions and climate actions over time representing the idealized future of the current architecture set in place with the Paris Agreement (Falkner, 2016). This governance archetype is based on individual pledges by nation-states and common principles for accounting and monitoring. They are developed in an open and transparent process under the auspices of the United Nations in a multilateral setting and a convergence of understanding of fair effort-sharing. Such an agreement is based on the principle of common but differentiated responsibilities enshrined in the UNFCCC (Morgan et al., 2014; Weikmans et al., 2020).

This governance archetype can be seen as flexible but productive coordination of national climate policies. Even in the absence of a clear and overarching global GHG emission cap and without strong enforcement measures, such a global climate governance architecture would be largely effective and further developed in international climate negotiations (Dimitrov et al., 2019). In this global climate policy future, international coordination through a joint transparent global stocktake, climate clubs of pioneering governments, and demonstration effects from sub-national authorities and non-state actors that GHG emission reductions can be achieved are expected to ratchet up the ambition level of climate policies within the next decade (Abbott, 2012; Nordhaus, 2015; Widerberg & Pattberg, 2015). A common understanding of key principles of fair effort-sharing ensures an acceptable degree of heterogeneity of national targets. Similarly, financial and technical assistance for developing countries is ramped up to support actions. Overall, this results in strong GHG emission cuts, keeping long-term targets of carbon neutrality by 2050 within reach.

4.3. Governance Archetype Three: Hybrid Approach with a Weak Joint Commitment

A third governance archetype constitutes a hybrid approach with a weak joint commitment by national governments. It starts from the same preconditions as the second archetype and is also based on individual pledges by nation-states to mitigate climate change in their jurisdictions (Bodansky, 2016). Yet, this governance archetype does not foresee a goal-oriented approach with effective effort-sharing. National governments would still present renewed pledges in international climate negotiations, enact laws to reduce GHG emissions, and undertake related initiatives to address climate change in their jurisdictions. These national actions would however not be guided by strong principles for accounting and monitoring that would subsequently not generate a continuous strengthening of ambitions, making it difficult to attain the goal to keep global warming below 2 °C (Climate Action Tracker, 2021).

This governance archetype resembles the prolongation of the status quo situation with only soft coordination of national climate policies that are not bolstered by a clear global GHG emission cap and strong enforcement measures. In this global climate policy future, the ratchet-up mechanism of the Paris Agreement does not exert a meaningful impact as intended in the institutional design (Allan, 2019; Sachs, 2019; Young, 2016). While some national governments might in this global climate governance archetype seek to adopt a range of climate change mitigation policies leading to a moderate reduction of global GHG emissions, a lack of coordination and competitiveness concerns limit the pace of decarbonization, which will thus likely be too slow to meet peak warming targets.

4.4. Governance Archetype Four: Breakdown of Global Climate Cooperation

A fourth governance archetype constitutes the gradual erosion of global cooperation on climate change with a steady withdrawal by national governments from multilateral agreements and a "race to the bottom." This governance archetype is based on a deterioration of pledges by nation-states, while potentially a number of influential philanthropists propose and support technology-oriented solutions to address the most adverse effects of global warming (Held & Roger, 2018; Victor, 2011). Eventually, all key principles, norms, rules, and decision-making procedures of global climate policy would slowly fall apart, and governments would fail to reduce GHG emissions on a global scale.

This governance archetype can be seen as non-global governance. It assumes that previously adopted agreements will not be implemented due to national competition, the rise of populist parties, and lack of consensus on the right approach, among other reasons (Hale et al., 2013). Such a development is not very likely but remains a possibility. In this governance archetype, global GHG emissions will continue to rise following a business-as-usual trajectory in many countries, possibly at a certain point being countered by last-minute technological interventions for dealing with global warming conducted by countries most affected by climate change impacts, such as geoengineering (Schenuit et al., 2021).

4.5. Summing Up and Contextualization

As previously stated, the four governance archetypes described above are simplified and bold descriptions of the possible future trajectories of the global climate governance architecture. The governance archetypes developed in this article are closely related to past efforts within the shared socioeconomic pathways (SSP), which strive to lay out a coherent set of narratives about future socio-economic pathways, including prospects of global cooperation (e.g., Kriegler et al., 2014; Riahi et al., 2017; van Vuuren et al., 2017). Our approach to the development of four governance archetypes and the SSP framework have similar starting points and both have the ambition to depict possible global policy futures.

However, a major difference is that the SSPs basically serve as reference scenarios without explicit assumptions about global or national climate policies (Kriegler et al., 2014), while the four governance archetypes specifically focus on the further evolution of the global climate governance architecture. The added value of these four governance archetypes lies in their solid foundation and development in a series of expert workshops and a review of the existing governance literature. We argue that our categorization of four governance archetypes can complement the SSP framework as well as similar studies that seek to describe broader socio-economic developments.

5. Matching Possible Governance Futures With Existing Integrated Assessment Model Scenarios

After developing the four archetypes of the future development of the global climate governance architecture, we now match them with existing sets of scenarios from process-oriented IAMs that are also included in the IPCC's *Sixth Assessment Report* (IPCC, 2022). This mapping exercise serves as a first approximation between studies in global climate governance and the scenario literature to identify knowledge gaps and novel research directions for integrating possible global climate policy futures into climate models (see Table 2).

IAM scenarios are designed by different research teams around the world to inform policymakers about trajectories of global and national GHG emissions and related global mean temperature changes. In essence, these sophisticated and process-oriented models build upon various strands of knowledge to illustrate how human development and societal choices interact with and affect the natural world. Due to the focus of this article on global climate governance architectures, we here concentrate the analysis on global IAM scenarios.

While existing sets of IAM scenarios draw mainly on economic, technological, and biophysical processes that produce GHG emissions, less attention is paid to insights from political science (Shen, 2021, p. 1) although in the last few years a few scenarios with a stronger political science orientation have been published (e.g., Andrijevic et al., 2020; Brutschin et al., 2021; van Sluisveld et al., 2020). In any case, IAM scenarios play an essential role in current political debates related to the choices of GHG emission reduction strategies and policies leading to carbon neutrality, especially through the IPCC reports (Skea et al., 2021; van Beek et al., 2020). The special report of the IPCC on global warming of 1.5 °C received especially wide global media coverage and public attention (e.g., Boykoff & Pearman, 2019). It has also substantially influenced both political and scientific debates on the timing of reaching net-zero CO_2 emissions around 2050 (Rogelj et al., 2021). Given the high relevance of the insights from IAM scenarios for policymaking, it is important that the scenario literature takes key assumptions regarding future developments of global climate cooperation into account.

5.1. Scenarios Depicting a Revitalized Top-Down Approach

Scholars have for a long time developed IAM scenarios that depict the ideal situation, in which national governments agree on clear legally binding targets to reduce GHG emissions within a multilaterally agreed process. An example is the set of "optimal carbon price" scenarios which assume a uniform global price for CO_2 emissions to reach specific long-term climate targets with more or less perfect foresight. Similarly, recursive models project similar kinds of scenarios in which carbon prices, while not inter-temporally optimal, are uniform across regions and are adjusted by the modelers (or some heuristic or algorithm) so that specified long-term GHG emission reduction targets are attained.

A different set of scenarios departs from the uniform carbon price paradigm, allowing for regional differentiation of carbon prices to reflect alternative effort-sharing paradigms without financial transfers (van den Berg et al., 2020), or the limited use of transfers due to sovereignty or other concerns (Bauer et al., 2020). These scenarios however assume either an explicit agreement on a quantitative sharing of the remaining carbon budget among national governments (van den Berg et al., 2020) or an implicit coordination mechanism that leads to equal relative welfare losses across regions compared to a counterfactual assumption (Bauer et al., 2020).

5.2. Scenarios Depicting the Hybrid Archetype With Strong Joint Commitment

There are currently no comprehensive scenarios in the academic literature that explicitly represent a highly coordinated hybrid approach to global climate policy that leads to a strong joint commitment of national governments to tackle climate change. The closest approximations are often called "bridge" scenarios (e.g., Kriegler et al., 2018; van Soest et al., 2021). Within the next decade, they foresee a strengthening of climate change mitigation ambition based on good practice policies (Fekete et al., 2021; Roelfsema et al., 2018) that generate a ratcheting up of climate actions by national governments.

While some regional differentiation is assumed in these scenarios, the exact policy assumptions are not necessarily reflective of domestic political developments. Moreover, they are only loosely tied to requirements for attaining long-term goals. To achieve long-term climate change mitigation targets, these scenarios after 2030 abruptly or gradually shift back to the approach described in the previous section depicting governance archetype one. Therefore, existing "bridge" scenarios are not mirroring a successful implementation of the Paris Agreement concerning the further evolution of the global climate governance architecture.

Another set of existing scenarios, which are even less reflective of the institutional design set in place with the Paris Agreement, but can nevertheless best be put into this category, are so-called "delayed" scenarios (e.g., Bertram, Riahi, et al., 2021; Luderer et al., 2018). They assume the continuation of either current international climate policy or existing national targets until 2030, and then also sharply shift to the policy paradigm of the "top-down governance" archetype. In comparison, they presume an even more disruptive change of policy in 2030 compared to the "bridge" scenarios, and they are thus rather far away from real developments in contemporary global climate governance, as it is unclear how such an abrupt change should come about.

A third category of existing IAM scenarios that could best be categorized in this type is "climate club" scenarios (e.g., Paroussos et al., 2019). They envisage an explicit forming of sub-global coordination and cooperation, but they do not assume the attainment of long-term climate change mitigation goals. While these scenarios show further potential for cooperation among progressive actors, they do not yet span the full solution space and do not sufficiently inform about potentially successful coordination strategies.

5.3. Scenarios Depicting the Hybrid Archetype With Weak Joint Commitment

While the different sets of IAM scenarios in the previously described governance archetype expect a steady acceleration of climate change mitigation ambitions and respective actions over time, there are also scenarios that portray less positive and dynamic developments. They take into account that national governments do not adjust and strengthen their commitments to tackle climate change in their jurisdictions and adopt effective policies to reduce GHG emissions over time.

The prime examples of such scenarios are the so-called NDC or NDC2100 scenarios (the most up-to-date scenarios in this category are published as part of the ENGAGE project at https://data.ene.iiasa.ac.at/engage; see also Bertram, Riahi, et al., 2021; Riahi et al., 2021; Roelfsema et al., 2020). They foresee the achievement of the current set of NDCs in 2030 and use different heuristics to extrapolate "comparable ambition" levels for the period from 2030 to 2100.

The two extreme types of extrapolations do not represent "comparable ambition": Assuming automatic long-term achievement of GHG emission reduction targets like in the delayed scenarios above is clearly too optimistic, while assuming a complete reversal to a baseline without any climate policies and carbon prices is too pessimistic. In between these two extremes, there are various options that can equally qualify for categorization as "comparable ambition" but have diverging long-term results. It is for instance unclear whether GHG emissions in NDC scenarios while staying nearly stable from 2020 to 2030, start to increase, remain roughly constant, or eventually start declining after 2030. This depends on further political developments as well as population trends, growth rates of national economies, and technology innovations required for meeting NDC targets in 2030.

This group of scenarios, therefore, comprises IAM scenarios with various assumptions about the degrees of coordination among national governments and their commitments to take action on mitigating climate change beyond 2030. Those scenarios resulting in GHG emission increases after 2030 are probably best associated with a failure of the Paris Agreement, whereas those scenarios resulting in GHG emission declines show at least a partial functioning of the current NDC process and the ratcheting up mechanism. The latter scenarios however still represent an inadequacy of the global stocktake to eventually ensure trajectories in line with the Paris Agreement's long-term target.

5.4. Scenarios Depicting a Breakdown of Global Climate Cooperation

Lastly, for risk-managing purposes, it is important for the transition scenario literature to also keep on exploring climate scenarios in which global climate cooperation fully fails and collapses. Scenarios best reflective of such an extreme future of the global climate governance architecture are the so-called "no new policies" scenarios (Roelfsema et al., 2020). To more realistically assess the implications of a breakdown of global cooperation to tackle climate change, further alternatives could be explored. In particular, various scenarios of regional policy dial-back could be studied based on existing legislative progress in different countries. Models with an integrated representation of damages could be used for studies of Nash equilibria, typically used for describing the non-cooperative behavior of actors, to explore plausible pathways for self-interested climate policy for large, heavily impacted countries like China or India.

6. Discussion: Knowledge Gaps and Options for Future Climate Modeling

The development of the four governance archetypes and their combination with existing sets of IAM scenarios in

Table 2. Matching possible global climate policy futures with existing sets of IAM scenarios.

	Possible global climate policy future	Examples of existing sets of IAM scenarios	Judgement of current representation
Governance archetype one	Top-down approach with strong legal and mandatory institutional characteristics	Optimal carbon price scenarios and differentiated carbon prices based on explicit effort-sharing or implicit coordination	Relatively well represented in existing sets of IAM scenarios
Governance archetype two	Hybrid approach with a strong joint commitment by governments	Bridge scenarios, delayed scenarios, and climate club scenarios	Not adequately represented in existing sets of IAM scenarios as existing scenarios assume a shift from archetype three to one around 2030 without clear consideration of why this shift could come about and its requirements (bridge and delayed scenarios) or foresee only limited cooperation (climate club scenarios)
Governance archetype three	Hybrid approach with a weak joint commitment by governments	NDC or NDC2100 scenarios	Relatively well represented in existing sets of IAM scenarios
Governance archetype four	Breakdown of global climate cooperation	No new policies scenarios	Not adequately represented in existing sets of IAM scenarios as existing scenarios do not reflect ongoing research into technological solutions and self-interests for mitigation efforts due to adverse climate impacts

Notes: The table gives an overview of how existing IAM scenarios depict the four governance archetypes and points to knowledge gaps in the scenario literature; a more detailed table with information on the different criteria for the matching of the four governance archetypes with existing sets of IAM scenarios and references to groupings of climate models in the most recent *Sixth Assessment Report* of the IPCC can be found in the Supplementary File.

this article point to important knowledge gaps in the representation of possible global climate policy futures in the current scenario literature. Presupposing successful global climate cooperation, many existing scenarios make a detailed exploration of the requirements for the technological transformation of the energy and land-use systems and related behavioral and institutional changes on the demand side (like modal shifts in transportation). Scenarios moreover contribute to informing national policy debates about the role of different economy-wide and sectoral policy instruments, and they lay out the effects of failed cooperation among national governments on global GHG emission trends and mid- to long-term temperature trends.

However, the relation between global climate governance and national policies is two-way: While national climate policies are required for credible commitments to mitigate climate change, some form of effective cooperation between key actors at the global level and agreements among the major GHG emitting players are needed to enable and foster more ambitious national policies (e.g., Hickmann, 2016, 2017), not least to alleviate problems of carbon leakage and free-riding (Jakob, 2021; Nordhaus, 2015). The scenario literature so far provides only little information on global climate governance pathways and the requirements for national climate change mitigation targets to be ramped up in line with long-term GHG emission reduction targets.

In the present article, we have introduced governance archetype one (a mostly top-down approach) and governance archetype four (a purely bottom-up approach) as the two extreme variants of the further evolution of global climate governance architectures. These governance archetypes are both not likely to happen, although the Covid-19 pandemic or the war in Ukraine, and an increasingly antagonistic geopolitical environment among the major world powers have shown that large-scale global changes are indeed a possibility and not unthinkable.

Nevertheless, we argue that it is crucial to focus on the differences between the hybrid governance archetypes two (with a strong joint commitment by governments) and three (with a weak joint commitment by governments). While they at first glance seem to be quite similar, the two different global climate policy futures would imply very different outcomes with regard to the overall goal of climate stabilization. Thus, based on our analysis in this article, we urge global climate governance scholars and the IAM scenario community to put particular efforts into investigating the different pathways and crucial differences between effective and ineffective global climate cooperation.

To build a new generation of scenario modeling aligned with the hybrid governance architecture put in place through the adoption of the Paris Agreement in 2015, climate modelers could explore different ways of defining regular strengthening of climate change mitigation ambition. They could be based on criteria that are directly measurable, like for instance a per capita gross domestic product (GDP; many modeling studies employ concepts that are hard to measure, such as welfare reductions compared to a counterfactual scenario).

A first option could be to run models recursively with periodically adjusted near-term climate change mitigation ambition levels, taking into account countries' past performances of GHG emission trajectories, both domestically, but potentially also with feedback from the performance of other countries. For instance, the pledges of national governments could be assumed to require strengthening if the GHG emissions of countries have not yet started to decrease for countries above a certain development threshold measured on the basis of GDP. While these interaction effects are difficult to incorporate into models, the political science literature highlights the importance of diffusion across countries (Jordan & Huitema, 2014) and governmental levels (Fuhr et al., 2018).

A second option that could be relatively easily included in models, while not fully aligned with the current developments of the UNFCCC negotiations, would be to implement generalizable, but also differentiating rules of a minimum carbon price based on countries' GDP and emission track records. In contrast to scenarios with differentiated carbon prices discussed in the previous section (Bauer et al., 2020; van den Berg et al., 2020), these carbon prices would however not emerge from an intertemporal perspective, but only develop recursively based on past GDP and GHG emission trends. Such new scenarios would thus be ex-ante determined (so that the same mechanism could be directly operationalized into national policies as part of the global stock-take), in contrast to existing target-meeting scenarios that feature perfect foresight, or some other form of policy definition that only works in the model setup.

The heuristics for adjustment could then be implemented in a very strict form, ensuring the achievement of an overall emission budget by meandering around an optimal global GHG emissions curve, which however would require very strong reactions of carbon prices. This would make such an approach challenging. More lenient heuristics of adjustment would in turn not ensure the achievement of a certain budget or a precise year for reaching net-zero GHG emissions globally but could nevertheless be enough to achieve ambitious climate change mitigation targets, at least under a subset of assumptions regarding overall socio-economic and technology development.

A third option could also be to define sectoral decarbonization roadmaps to which countries (differentiated by income group) need to gradually adhere if the Paris Agreement's goals should be achieved. This could also be combined with perspectives on activities by non-state actors, like industry groups, setting their own targets and thus contributing to GHG emission reductions that can go beyond national commitments (Hsu et al., 2018). The good-practice scenarios could serve as the starting point for a hybrid model combining both carbon pricing and sectoral elements if they are enriched with a stronger dynamic evolution of global climate policy coordination.

Other scenario designs that balance the requirements for national bottom-up determinations (based on the sovereignty principle) and the overall global cap on cumulative GHG emissions needed to achieve climate change mitigation targets could include different forms of climate clubs (Hovi et al., 2016; Nordhaus, 2015).

7. Conclusions

The future of global climate policy is uncertain and not sufficiently represented in current IAM scenarios that display various pathways towards decarbonization. In this article, we sought to rectify this by firstly developing four governance archetypes and identifying how they are depicted by existing sets of IAM scenarios. The four governance archetypes include: (a) a revitalized top-down approach, (b) a hybrid approach with strong joint commitment, (c) a hybrid approach with weak joint commitment, and (d) a breakdown of global climate cooperation. We have shown that, while governance archetype one and archetype three are well covered within the scenario literature, archetype two and archetype four are not adequately portrayed.

Considering recent developments in global climate policy, the hybrid governance approach with a strong joint commitment is likely the most feasible and desired evolution of the overall global climate governance architecture. Yet, it is currently far from certain that we are heading in this direction. A continuation along the path of a hybrid governance approach with a weak joint commitment and ineffective coordination among the major GHG emitters is equally on the cards. Given the current multilateral crisis and lack of trust between many countries, even a complete deterioration of cooperation should not be entirely ruled out. Hence, a solid analysis of implications in terms of GHG emission trajectories and global mean temperature increases is important from a risk management perspective. Thus, this article underscores the urgency to improve climate modelling efforts to better depict varying global climate policy futures.

Model-based scenario work can provide a more solid foundation for policymakers aiming to enhance goal orientation in the current global stocktake and ratcheting up processes through innovative studies that go beyond the stylized scenario design in the existing scenario literature. Stronger and deeper consideration of the political framework for combating climate change at the global level and its key regulatory elements established by the Paris Agreement is needed for the next generation of IAM scenarios.

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Conflict of Interests

The authors declare no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

References

Abbott, K. W. (2012). The transnational regime complex for climate change. *Environment and Planning C: Government and Policy*, *30*(4), 571–590.

Allan, J. I. (2019). Dangerous incrementalism of the Paris Agreement. *Global Environmental Politics*, *19*(1), 4–11.

Andrijevic, M., Cuaresma, J. C., Muttarak, R., & Schleussner, C.-F. (2020). Governance in socioeconomic pathways and its role for future adaptive capacity. *Nature Sustainability*, *3*(1), 35–41.

Bäckstrand, K., Kuyper, J. W., Linnér, B. O., & Lövbrand, E. (2017). Non-state actors in global climate governance: From Copenhagen to Paris and beyond. *Environmental Politics*, *26*(4), 561–579.

Bauer, N., Bertram, C., Schultes, A., Klein, D., Luderer, G., Kriegler, E., Popp, A., & Edenhofer, O. (2020). Quantification of an efficiency–sovereignty trade-off in climate policy. *Nature*, *588*(7837), 261–266. https://doi.org/10.1038/s41586-020-2982-5

Bernstein, S., Betsill, M., Hoffmann, M., & Paterson, M. (2010). A tale of two Copenhagens: Carbon markets and climate governance. *Millennium Journal of International Studies*, *39*(1), 161–173.

Bertram, C., Luderer, G., Creutzig, F., Bauer, N., Ueckerdt, F., Malik, A., & Edenhofer, O. (2021). Covid-19-induced low power demand and market forces starkly reduce CO_2 emissions. *Nature Climate Change*, *11*(3), 193–196.

Bertram, C., Riahi, K., Hilaire, J., Bosetti, V., Drouet, L., Fricko, O., Malik, A., Nogueira, L. P., van der Zwaan, B., van Ruijven, B., van Vuuren, D., Weitzel, M., Longa, F. D., de Boer, H.-S., Emmerling, J., Fosse, F., Fragkiadakis, K., Harmsen, M., Keramidas, K., . . . Luderer, G. (2021). Energy system developments and investments in the decisive decade for the Paris Agreement goals. *Environmental Research Letters*, *16*(7), Article 074020. https://doi.org/10.1088/1748-9326/ac09ae

Biermann, F., & Kim, R. E. (Eds.). (2020). *Architectures of earth system governance: Institutional complexity and structural transformation*. Cambridge University Press.

Biermann, F., Zelli, F., Pattberg, P., & van Asselt, H. (2010). The architecture of global climate governance. In F. Biermann, P. Pattberg, & F. Zelli (Eds.), *Global climate governance beyond 2012: Architecture, agency and adaptation* (pp. 15–24). Cambridge University Press.

Bodansky, D. (2010). Copenhagen climate change conference: A postmortem. *American Journal of International Law*, *104*(2), 230–240.

Bodansky, D. (2016). The Paris Climate Change Agreement: A new hope? *American Journal of International Law*, *110*(2), 288–319.

Bosetti, V., Carraro, C., De Cian, E., Massetti, E., & Tavoni, M. (2013). Incentives and stability of international climate coalitions: An integrated assessment. *Energy Policy*, *55*, 44–56.

Boykoff, M., & Pearman, O. (2019). Now or never: How media coverage of the IPCC special report on 1.5 °C shaped climate-action deadlines. *One Earth*, *1*(3), 285–288.

Brutschin, E., Pianta, S., Tavoni, M., Riahi, K., Bosetti, V., Marangoni, G., & van Ruijven, B. (2021). A multidimensional feasibility evaluation of low-carbon scenarios. *Environmental Research Letters*, *16*, Article 064069.

Climate Action Tracker. (2021). *Glasgow's 2030 credibility gap: Net zero's lip service to climate action. Wave of net zero emission goals not matched by action on the ground*. https://climateactiontracker.org/documents/997/CAT_2021-11-09_Briefing_Global-Update_Glasgow2030CredibilityGap.pdf

Deetman, S., Hof, A. F., & van Vuuren, D. (2015). Deep CO_2 emission reductions in a global bottom-up model approach. *Climate Policy*, *15*(2), 253–271.

den Elzen, M., Kuramochi, T., Höhne, N., Cantzler, J., Esmeijer, K., Fekete, H., Fransen, T., Keramidas, K., Roelfsema, M., Sha, F., van Soest, H., & Vandyck, T. (2019). Are the G20 economies making enough progress to meet their NDC targets? *Energy Policy*, *126*, 238–250. https://doi.org/10.1016/j.enpol.2018.11.027

Dimitrov, R., Hovi, J., Sprinz, D. F., Sælen, H., & Underdal, A. (2019). Institutional and environmental effectiveness: Will the Paris Agreement work? *Wiley Interdisciplinary Reviews: Climate Change*, *10*(4), Article e583.

Dubash, N. K. (2020). Revisiting climate ambition: The case for prioritizing current action over future intent. *Wiley Interdisciplinary Reviews: Climate Change*, *11*(1), Article e622.

European Union. (2021). *European Green Deal*. https://ec.europa.eu/clima/policies/eu-climate-action_en

Falkner, R. (2016). The Paris Agreement and the new logic of international climate politics. *International Affairs*, *92*(5), 1107–1125.

Fekete, H., Kuramochi, T., Roelfsema, M., den Elzen, M., Forsell, N., Höhne, N., Luna, L., Hans, F., Sterl, S., Olivier, J., van Soest, H., Frank, S., & Gusti, M. (2021). A review of successful climate change mitigation policies in major emitting economies and the potential of global replication. *Renewable and Sustainable Energy Reviews*, *137*, Article 110602. https://doi.org/10.1016/j.rser.2020.110602

Fuhr, H., Hickmann, T., & Kern, K. (2018). The role of cities in multi-level climate governance: Local climate policies and the 1.5 °C target. *Current Opinion in Environmental Sustainability*, *30*, 1–6.

Green, J. F., Sterner, T., & Wagner, G. (2014). A balance of bottom-up and top-down in linking climate policies. *Nature Climate Change*, *4*(12), 1064–1067.

Hale, T., Held, D., & Young, K. (2013). *Gridlock: Why global cooperation is failing when we need it most*. Polity.

Hare, W., Stockwell, C., Flachsland, C., & Oberthür, S. (2010). The architecture of the global climate regime: A top-down perspective. *Climate Policy*, *10*(6), 600–614.

Held, D., & Roger, C. (2018). Three models of global climate governance: From Kyoto to Paris and beyond. *Global Policy*, *9*(4), 527–537.

Hickmann, T. (2016). *Rethinking authority in global climate governance: How transnational climate initiatives relate to the international climate regime*. Routledge.

Hickmann, T. (2017). The reconfiguration of authority in global climate governance. *International Studies Review*, *19*(3), 430–451.

Hoffmann, M. (2011). *Climate governance at the crossroads: Experimenting with a global response after Kyoto*. Oxford University Press.

Höhne, N., Gidden, M. J., den Elzen, M., Hans, F., Fyson, C., Geiges, A., Jeffery, M. L., Gonzales-Zuñiga, S., Mooldijk, S., Hare, W., & Rogelj, J. (2021). Wave of net zero emission targets opens window to meeting the Paris Agreement. *Nature Climate Change*, *11*, 820–822. https://doi.org/10.1038/s41558-021-01142-2

Hovi, J., Sprinz, D. F., Sælen, H., & Underdal, A. (2016). Climate change mitigation: A role for climate clubs? *Palgrave Communications*, *2*(1), Article 16020.

Hsu, A., Höhne, N., Kuramochi, T., Roelfsema, M., Weinfurter, A., Xie, Y., Lütkehermöller, K., Chan, S., Corfee-Morlot, J., Drost, P., Faria, P., Gardiner, A., Gordon, D. J., Hale, T., Hultman, N. E., Moorhead, J., Reuvers, S., Setzer, J., Singh, N., . . . Widerberg, O. (2018). A research roadmap for quantifying non-state and subnational climate mitigation action. *Nature Climate Change*, *9*(1), 11–17. https://doi.org/10.1038/s41558-018-0338-z

Intergovernmental Panel on Climate Change. (2018). *Global warming of 1.5 °C: IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. Cambridge University Press.

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Mitigation of climate change—Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Jakob, M. (2021). Why carbon leakage matters and what can be done against it. *One Earth*, *4*(5), 609–614.

Jordan, A., & Huitema, D. (2014). Innovations in climate policy: The politics of invention, diffusion, and evaluation. *Environmental Politics*, *23*(5), 715–734.

Kriegler, E., Bertram, C., Kuramochi, T., Jakob, M., Pehl, M., Stevanović, M., Höhne, N., Luderer, G., Minx, J. C., Fekete, H., Hilaire, J., Luna, L., Popp, A., Steckel, J. C., Sterl, S., Yalew, A. W., Dietrich, J. P., & Edenhofer, O. (2018). Short term policies to keep the door open for Paris climate goals. *Environmental Research Letters*, *13*(7), Article 074022. https://doi.org/10.1088/1748-9326/aac4f1

Kriegler, E., Edmonds, J., Hallegatte, S., Ebi, K. L., Kram, T., Riahi, K., Winkler, H., & van Vuuren, D. (2014). A new scenario framework for climate change research: The concept of shared climate policy assumptions. *Climatic Change*, *122*(3), 401–414.

Lamb, W. F., Wiedmann, T., Pongratz, J., Andrew, R., Crippa, M., Olivier, J. G. J., Wiedenhofer, D., Mattioli, G., Khourdajie, A. A., House, J., Pachauri, S., Figueroa, M., Saheb, Y., Slade, R., Hubacek, K., Sun, L., Ribeiro, S. K., Khennas, S., de la Rue du Can, S., . . . Minx, J. (2021). A review of trends and drivers of greenhouse gas emissions by sector from 1990 to 2018. *Environmental Research Letters*, *16*(7), 073005. https://doi.org/10.1088/1748-9326/abee4e

Le Quéré, C., Peters, G. P., Friedlingstein, P., Andrew, R. M., Canadell, J. G., Davis, S. J., Jackson, R. B., & Jones, M. W. (2021). Fossil CO_2 emissions in the post-Covid-19 era. *Nature Climate Change*, *11*(3), 197–199. https://doi.org/10.1038/s41558-021-01001-0

Luderer, G., Vrontisi, Z., Bertram, C., Edelenbosch, O. Y., Pietzcker, R. C., Rogelj, J., De Boer, H. S., Drouet, L., Emmerling, J., Fricko, O., Fujimori, S., Havlík, P., Iyer, G., Keramidas, K., Kitous, A., Pehl, M., Krey, V., Riahi, K., Saveyn, B., . . . Kriegler, E. (2018). Residual fossil CO_2 emissions in 1.5–2 °C pathways. *Nature Climate Change*, *8*(7), 626–633. https://doi.org/10.1038/s41558-018-0198-6

Masood, E., & Tollefson, J. (2021, November 5). COP26 climate pledges: What scientists think so far. *Nature*. https://www.nature.com/articles/d41586-021-03034-z

Messner, D., Schellnhuber, J., Rahmstorf, S., & Klingenfeld, J. D. (2013). The budget approach: A framework for a global transformation towards a low carbon economy. In H.-J. Koch, D. König, J. Sanden, & R. Verheyen (Eds.), *Climate change and environmental hazards related to shipping: An international legal framework* (pp. 9–33). Brill Nijhoff.

Morgan, J., Dagnet, Y., Höhne, N., Oberthür, S., & Li, L. (2014). *Race to the top: Driving ambition in the post-2020 international climate agreement*. World Resources Institute. https://www.wri.org/research/race-top-driving-ambition-2015-climate-agreement

Nordhaus, W. (2015). Climate clubs: Overcoming free-riding in international climate policy. *American Economic Review*, *105*(4), 1339–1370.

Oberthür, S. (2001). Linkages between the Montreal and Kyoto protocols: Enhancing synergies between protecting the ozone layer and the global climate. *International Environmental Agreements*, *1*(3), 357–377.

Ou, Y., Iyer, G., Clarke, L., Edmonds, J., Fawcett, A. A., Hultman, N., McFarland, J. R., Binsted, M., Cui, R., Fyson, C., Geiges, A., Gonzales-Zuñiga, S., Gidden, M. J., Höhne, N., Jeffery, L., Kuramochi, T., Lewis, J., Meinshausen, M., Nicholls, Z., . . . McJeon, H. (2021). Can updated climate pledges limit warming well below 2 °C? *Science*, *374*(6568), 693–695. https://doi.org/10.1126/science.abl8976

Paroussos, L., Mandel, A., Fragkiadakis, K., Fragkos, P., Hinkel, J., & Vrontisi, Z. (2019). Climate clubs and the macro-economic benefits of international cooperation on climate policy. *Nature Climate Change*, *9*(7), 542–546.

Parson, E. (2003). *Protecting the ozone layer: Science and strategy*. Oxford University Press.

Rayner, S. (2010). How to eat an elephant: A bottom-up approach to climate policy. *Climate Policy*, *10*(6), 615–621.

Riahi, K., Bertram, C., Huppmann, D., Rogelj, J., Bosetti, V., Cabardos, A. M., Deppermann, A., Drouet, L., Frank, S., Fricko, O., & Fujimori, S. (2021). Cost and attainability of meeting stringent climate targets without overshoot. *Nature Climate Change*, *11*(12), 1063–1069.

Riahi, K., van Vuuren, D., Kriegler, E., Edmonds, J., O'Neill, B., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., & Lutz, W. (2017). The shared socioeconomic pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, *42*(1), 153–168.

Roelfsema, M., Fekete, H., Höhne, N., den Elzen, M., Forsell, N., Kuramochi, T., de Coninck, H., & van Vuuren, D. (2018). Reducing global GHG emissions by replicating successful sector examples: The "good practice policies" scenario. *Climate Policy*, *18*(9), 1103–1113.

Roelfsema, M., van Soest, H. L., Harmsen, M., van Vuuren, D. P., Bertram, C., den Elzen, M., Höhne, N., Iacobuta, G., Krey, V., Kriegler, E., Luderer, G., Riahi, K., Ueckerdt, F., Després, J., Drouet, L., Emmerling, J., Frank, S., Fricko, O., Gidden, M., . . . Vishwanathan, S. S. (2020). Taking stock of national climate policies to evaluate implementation of the Paris Agreement. *Nature Communications*, *11*(1), Article 2096. https://doi.org/10.1038/s41467-020-15414-6

Rogelj, J., Geden, O., Cowie, A., & Reisinger, A. (2021).

Three ways to improve net-zero emissions targets. *Nature*, *591*(7850), 365–368.

Rogelj, J., Popp, A., Calvin, K. V., Luderer, G., Emmerling, J., Gernaat, D., Fujimori, S., Strefler, J., Hasegawa, T., Marangoni, G., Krey, V., Kriegler, E., Riahi, K., van Vuuren, D. P., Doelman, J., Drouet, L., Edmonds, J., Fricko, O., Harmsen, M., . . . Tavoni, M. (2018). Scenarios towards limiting global mean temperature increase below 1.5 °C. *Nature Climate Change*, *8*(4), 325–332. https://doi.org/10.1038/s41558-018-0091-3

Sachs, N. M. (2019). The Paris Agreement in the 2020s: Breakdown or breakup. *Ecology Law Quarterly*, *46*(3), 865–909.

Schenuit, F., Gilligan, J., & Viswamohanan, A. (2021). A scenario of solar geoengineering governance: Vulnerable states demand, and act. *Futures*, *132*, Article 102809.

Shen, S. V. (2021). Integrating political science into climate modeling: An example of internalizing the costs of climate-induced violence in the optimal management of the climate. *Sustainability*, *13*(19), Article 10587.

Skea, J., Shukla, P., Al Khourdajie, A., & McCollum, D. (2021). Intergovernmental Panel on Climate Change: Transparency and integrated assessment modeling. *Wiley Interdisciplinary Reviews: Climate Change*, *12*(5), Article e727.

Streck, C., Keenlyside, P., & Von Unger, M. (2016). The Paris Agreement: A new beginning. *Journal for European Environmental & Planning Law*, *13*(1), 3–29.

UN chief welcomes China–US pledge to cooperate on climate action. (2021, November 10). *US News*. https://news.un.org/en/story/2021/11/1105512

United Nations. (1992). *United Nations framework convention on climate change* (FCCC/INFORMAL/84). https://unfccc.int/resource/docs/convkp/conveng.pdf

United Nations. (2021). *Glasgow Climate Pact* (Decision –/CP.26). https://unfccc.int/sites/default/files/resource/cop26_auv_2f_cover_decision.pdf

United Nations Environment Programme. (2018). *Emissions gap report 2018*.

United Nations Framework Convention on Climate Change. (1997). *Kyoto Protocol to the United Nations Framework Convention on Climate Change* (FCCC/CP/1997/L.7/Add.1). https://digitallibrary.un.org/record/250111?ln=en#record-files-collapse-header

United Nations Framework Convention on Climate Change. (2015). *Adoption of the Paris Agreement* (FCCC/CP/2015/L.9/Rev.1). https://digitallibrary.un.org/record/831039

United Nations Framework Convention on Climate Change. (2021). *Nationally determined contributions under the Paris Agreement: Synthesis report by the Secretariat* (FCCC/PA/CMA/2021/8). https://unfccc.int/sites/default/files/resource/cma2021_08E.pdf

van Asselt, H. (2016). The role of non-state actors in reviewing ambition, implementation, and compliance under the Paris Agreement. *Climate Law*, *6*(1/2), 91–108.

van Asselt, H., & Zelli, F. (2014). Connect the dots: Managing the fragmentation of global climate governance. *Environmental Economics and Policy Studies*, *16*(2), 137–155.

van Beek, L., Hajer, M., Pelzer, P., van Vuuren, D., & Cassen, C. (2020). Anticipating futures through models: The rise of integrated assessment modelling in the climate science-policy interface since 1970. *Global Environmental Change*, *65*, Article 102191.

van den Berg, N. J., van Soest, H. L., Hof, A. F., den Elzen, M. G. J., van Vuuren, D. P., Chen, W., Drouet, L., Emmerling, J., Fujimori, S., Höhne, N., Kõberle, A. C., McCollum, D., Schaeffer, R., Shekhar, S., Vishwanathan, S. S., Vrontisi, Z., & Blok, K. (2020). Implications of various effort-sharing approaches for national carbon budgets and emission pathways. *Climatic Change*, *162*(4), 1805–1822. https://doi.org/10.1007/s10584-019-02368-y

van Sluisveld, M. A. E., Hof, A. F., Carrara, S., Geels, F. W., Nilsson, M., Rogge, K., Turnheim, B., & van Vuuren, D. P. (2020). Aligning integrated assessment modelling with socio-technical transition insights: An application to low-carbon energy scenario analysis in Europe. *Technological Forecasting and Social Change*, *151*, Article 119177. https://doi.org/10.1016/j.techfore.2017.10.024

van Soest, H. L., Aleluia Reis, L., Baptista, L. B., Bertram, C., Després, J., Drouet, L., den Elzen, M., Fragkos, P., Fricko, O., Fujimori, S., Grant, N., Harmsen, M., Iyer, G., Keramidas, K., Köberle, A. C., Kriegler, E., Malik, A., Mittal, S., Oshiro, K., . . . van Vuuren, D. P. (2021). Global roll-out of comprehensive policy measures may aid in bridging emissions gap. *Nature Communications*, *12*(1), Article 6419. https://doi.org/10.1038/s41467-021-26595-z

van Vuuren, D. P., Riahi, K., Calvin, K., Dellink, R., Emmerling, J., Fujimori, S., KC, S., Kriegler, E., & O'Neill, B. (2017). The shared socio-economic pathways: Trajectories for human development and global environmental change. *Global Environmental Change*, *42*, 148–152. https://doi.org/10.1016/j.gloenvcha.2016.10.009

Victor, D. G. (2011). *Global warming gridlock: Creating more effective strategies for protecting the planet*. Cambridge University Press.

Vrontisi, Z., Luderer, G., Saveyn, B., Keramidas, K., Lara, A. R., Baumstark, L., Bertram, C., de Boer, H. S., Drouet, L., Fragkiadakis, K., Fricko, O., Fujimori, S., Guivarch, C., Kitous, A., Krey, V., Kriegler, E., Broin, E. Ó., Paroussos, L., & van Vuuren, D. (2018). Enhancing global climate policy ambition towards a 1.5 °C stabilization: A short-term multi-model assessment. *Environmental Research Letters*, *13*(4), Article 044039. https://doi.org/10.1088/1748-9326/aab53e

Weikmans, R., Van Asselt, H., & Roberts, J. T. (2020). Transparency requirements under the Paris Agreement and their (un)likely impact on strengthening the ambition of nationally determined contributions (NDCs). *Climate Policy*, *20*(4), 511–526.

Weitzman, M. L. (2014). Can negotiating a uniform carbon price help to internalize the global warming externality? *Journal of the Association of Environmental and Resource Economists*, *1*(1/2), 29–49.

Widerberg, O., & Pattberg, P. (2015). International cooperative initiatives in global climate governance: Raising the ambition level or delegitimizing the UNFCCC? *Global Policy*, *6*(1), 45–56.

Young, O. R. (2016). The Paris Agreement: Destined to succeed or doomed to fail? *Politics and Governance*, *4*(3), 124–132.

Zelli, F. (2011). The fragmentation of the global climate governance architecture. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(2), 255–270.

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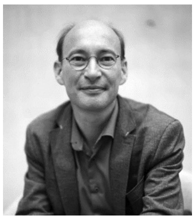

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Article

Emissions Lock-in, Capacity, and Public Opinion: How Insights From Political Science Can Inform Climate Modeling Efforts

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Abstract
The implementation of ambitious climate policies consistent with the goals of the Paris Agreement is fundamentally influenced by political dynamics. Yet, thus far, climate mitigation pathways developed by integrated assessment models (IAMs) have devoted limited attention to the political drivers of climate policymaking. Bringing together insights from the political science and socio-technical transitions literature, we summarize evidence on how emissions lock-in, capacity, and public opinion can shape climate policy ambition. We employ a set of indicators to describe how these three factors vary across countries and regions, highlighting context-specific challenges and enablers of climate policy ambition. We outline existing studies that incorporate political factors in IAMs and propose a framework to employ empirical data to build climate mitigation scenarios that incorporate political dynamics. Our findings show that there is substantial heterogeneity in key political drivers of climate policy ambition within IAM regions, calling for a more disaggregated regional grouping within models. Importantly, we highlight that the political challenges and enablers of climate policy ambition considerably vary across regions, suggesting that future modeling efforts incorporating political dynamics can significantly increase the realism of IAM scenarios.

Keywords
climate policy ambition; climate modeling; climate policymaking; climate politics; emissions lock-in; integrated assessment models; Paris Agreement; public opinion; public support; state capacity

Issue
This article is part of the issue "Exploring Climate Policy Ambition" edited by Elina Brutschin (International Institute for Applied Systems Analysis) and Marina Andrijevic (International Institute for Applied Systems Analysis).

1. Introduction

The international scientific community asserts clearly that rapid and substantial reductions in greenhouse gas (GHG) emissions are required to avert irreversible damages to the earth's climate and limit the most adverse environmental and economic impacts of climate change (Intergovernmental Panel on Climate Change [IPCC], 2021). More than 190 countries have signed the 2015 Paris Agreement, whose long-term goal is to keep the global average temperature increase to well below 2 °C compared to pre-industrial levels and to pursue efforts to keep it below 1.5 °C. Reaching this goal will require implementing ambitious climate mitigation policies. Research in different disciplines investigates the strategies that can contribute effectively to climate mitigation efforts. In this context, integrated assessment models (IAMs) are important tools that feature prominently in the reports of the IPCC. IAMs model the economic, energy, land, and climate systems and can be used to study the implications of countries' climate mitigation policies and pledges or to identify pathways that allow reaching climate mitigation goals (Bosetti, 2021). IAMs are very sophisticated in their incorporation of geophysical, technological, and economic factors. However, the academic community is increasingly paying attention to how IAM scenarios compare to real-world conditions (Brutschin, Pianta, et al., 2021; Cherp et al., in press; Jewell & Cherp, 2020; O'Neill et al., 2020; Trutnevyte et al., 2019; van Sluisveld et al., 2015; Vinichenko et al., 2021; Wilson & Grubler, 2011). In particular, IAMs have been criticized for not incorporating important social, political, and behavioral elements that fundamentally shape the low-carbon transition (Turnheim & Nykvist, 2019; Victor, 2015). This is because IAMs were originally designed to identify mitigation pathways that minimize overall mitigation costs (Żebrowski et al., 2022), which often leads them to produce scenarios where considerable mitigation effort is present in developing regions, where mitigation is less costly. In these regions, however, mitigation might be more challenging because of social or political factors, such as a lack of capacity or political support to prioritize climate mitigation goals. Incorporating political factors into IAMs can allow producing scenarios that might more closely mirror mitigation potential across regions and contribute to identifying context-specific enablers of more ambitious climate action in different countries and regions. Considering the substantial policy impact of the IAM scenarios featured in the IPCC reports, which are used by policymakers to set long-term climate mitigation goals—such as the so-called "net zero" commitments undertaken by the European Union, China, and other countries (Rogelj et al., 2021; van Beek et al., 2020)—it is essential to incorporate social and political dynamics into future IAM modelling efforts.

Climate policymaking, like other policy domains, is crucially determined by domestic political dynamics (Aklin & Mildenberger, 2020; Geels et al., 2017; Mildenberger, 2020). However, it is only recently that the climate modeling community has started to incorporate insights from political science (Dasgupta & De Cian, 2018; Peng, Iyer, Binsted, et al., 2021; Shen, 2021) and the mainstream political science literature is starting to pay more attention to the politics of climate change (Green & Hale, 2017; Javeline, 2014; Keohane, 2015). Political science research highlights how factors like state capacity, the influence of interest groups, and the role of public opinion can affect climate policy ambition. The configuration of these factors in different countries and contexts can produce different challenges for the implementation of ambitious climate policies (Bailey & Compston, 2012; VanDeveer et al., 2022).

In this article, we bring together key insights from political science and socio-technical transitions research on the challenges and enablers of ambitious climate mitigation policy and suggest how they can be incorporated into integrated assessment modeling efforts. We focus here on climate mitigation policies, defined, in line with the IPCC reports (IPCC, 2018; Roelfsema et al., 2022) as policies that aim to reduce or prevent GHG emissions, thus contributing to reaching the goals of the Paris Agreement.

We build on and extend past efforts to highlight key constraints affecting climate policy stringency and ambition (Lamb & Minx, 2020; Tørstad et al., 2020). Our goal is to provide a relatively simple framework that focuses on the drivers of policy outputs and outcomes about which there is a broader agreement in the literature. Our framework can be employed to highlight the main potential bottlenecks across countries and regions. We focus on three key factors driving climate policymaking at the domestic level: emissions lock-in, capacity, and public opinion. We do not argue that these three factors are key drivers of climate policy ambition in each context, but we stress that their incorporation in IAMs modeling efforts can allow the production of scenarios that more closely mirror likely real-world mitigation trajectories.

A first key factor shaping the speed of the low-carbon transition is the degree of entrenchment of economic systems in emission-intensive structures, usually referred to as carbon lock-in (Seto et al., 2016; Unruh, 2000), and the consequent opposition of vested interests—economic, social, or political actors who benefit from the current system and have strong incentives to oppose reforms that would alter the status quo (T. M. Moe, 2015). In energy transition research, carbon lock-in and vested interests are often proxied by measuring the entrenchment of fossil sources in the electricity and industrial sector (Erickson et al., 2015; Lamb & Minx, 2020). However, achieving climate mitigation goals will also require transformations of the agriculture, forestry, and land-use sectors. We, therefore, propose to expand the focus from carbon lock-in to the broader concept of "emissions lock-in.''

A second key enabler of climate policy ambition identified by the literature is state capacity (Hanson & Sigman, 2021; Meckling & Nahm, 2021). Capacity can be operationalized through different types of capabilities. We argue that in the context of climate policy, three types of capabilities play a fundamental role in mitigation: governance capabilities, which refer to the general ability of the state to implement goals and policies (Cingolani, 2013); economic capabilities, which refer to the economic resources and market environment that can enable investments in the transition; and technological capabilities, that can enable technological innovation and the diffusion of low-carbon technologies (Brutschin, Cherp, et al., 2021; Eskander & Fankhauser, 2020).

Finally, public support for climate policies can create significant incentives for policymakers to implement ambitious climate action. A broad political science literature has shown that public opinion has an impact on policy decisions (Burstein, 2003; Wlezien & Soroka, 2012), and research on the impact of public opinion on climate policymaking is gaining more attention (Bakaki et al., 2020; Schaffer et al., 2021). We argue that public opinion is a third key factor whose role should be better incorporated into modeling efforts (Peng, Iyer, Binsted et al., 2021), importantly taking into account the differentiated impact of public opinion in democratic and non-democratic settings.

We propose a simple operationalization of these three concepts based on a selection of indicators and explore their variation across countries to identify context-specific challenges and enablers of climate policy ambition. Table 1 summarizes the selected indicators for each of the three concepts (see Table S1 in the Supplementary Material for details on the indicators and their sources). Different arguments can be made to motivate the selection of the key political determinants of climate policy ambition and the indicators that should be employed to measure them. Our selection is based on a review of the relevant literature and made for descriptive purposes. As our objective is to highlight how these factors can be incorporated in IAMs, we have striven to develop a simple framework that allows us to assess variation in political environments across and within IAM modeling regions (see a map of the most common regional aggregation of global IAMs in Figure 1 and the classification of countries in the five regions in Table S3 in the Supplementary Material).

The remainder of this article is organized as follows. Sections 2 to 4 focus on the conceptualization and operationalization of emissions lock-in, capacity, and public opinion, providing descriptive evidence on the variation of these factors across countries and regions. Section 5 summarizes evidence of the variation of these three factors across the five IAM modeling regions. Section 6 reflects on how these insights from political science can be incorporated into IAMs, and Section 7 concludes, highlighting the main insights from the article and calling for more empirical work that can lead to improvements in the assumptions adopted by IAMs. The link to access the article's replication package is made available in the Supplementary Material.

2. Emissions Lock-In

A key aspect shaping countries' likelihood of implementing ambitious climate policies is their current emission levels. In this context, Unruh (2000) has coined the term "carbon lock-in" to describe how technological systems and institutional factors have coevolved to lock industrial economies into fossil-dependent pathways. Vested interests (economic, social, or political actors who benefit from the current system and have strong incentives to oppose reforms that would alter the status quo) and the dependence on emitting sectors and technologies have been shown to have a fundamental impact on energy and climate policy decisions (Cherp et al., 2018; E. Moe, 2016). Most of the existing literature on the role of carbon lock-in and vested interests focuses on the challenges to reduce carbon dioxide emissions from fossil sources (Erickson et al., 2015; Lamb & Minx,

Table 1. Summary of the concepts and indicators that we propose to use to assess cross-country and cross-regional variation of political drivers of climate policy ambition.

Concept	Guiding question	Indicators
Emissions lock-in	What type of *resistance* to reducing emissions can be expected in a country, both on the *production* side (interest-based opposition) and on the *consumption* side (resistance to shifting consumption patterns)?	Carbon lock-in: • CO_2 emissions (consumption) • Fossil rents (production) Methane lock-in: • Per capita methane emissions in the agriculture, forestry, and other land use (AFOLU) sector (consumption) • Share of agriculture in GDP (production)
Capacity	Does a country have the *capabilities* to implement ambitious climate policies and develop and scale-up new low-carbon technologies?	Governance capabilities: • Government effectiveness • Rule of law Economic capabilities: • GDP per capita • Ease of doing business Technological capabilities: • R&D as % of GDP • STEM graduates as % of total graduates
Public Support	How likely is it that in a country there will be sufficient *public support* to implement ambitious climate policies?	Environmental attitudes Postmaterialist values

Note: Details on the indicators and their sources are provided in Table S1 of the Supplementary Material.

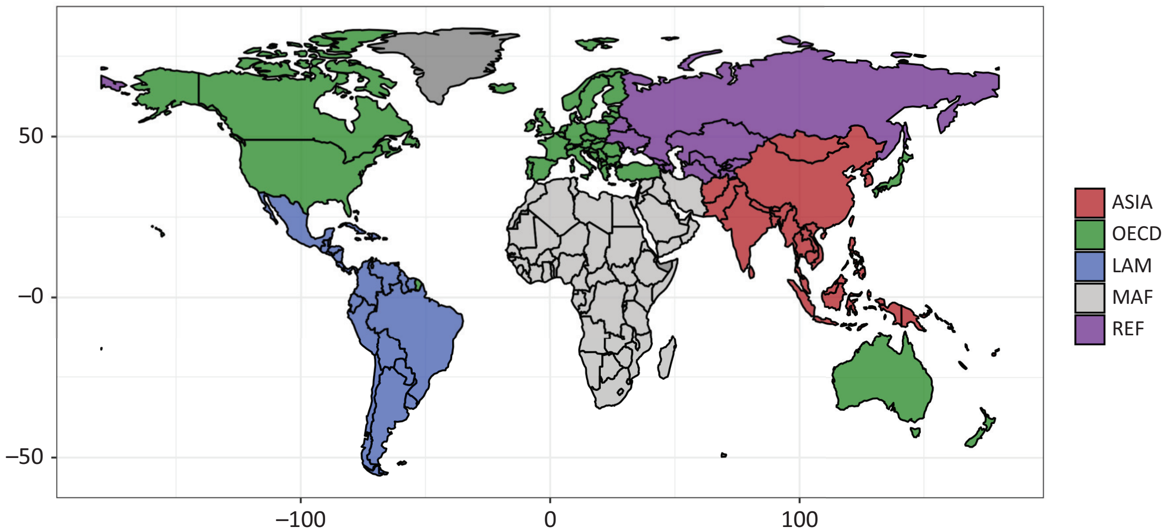

Figure 1. The most common regional aggregation of global IAMs, employed in the *5th IPCC Assessment Report*. Notes: The five regions are OECD, REF (reforming economies, or former Soviet Union countries), LAM (Latin and Central America), MAF (Middle East and Africa), and ASIA (Asian countries, excluding the Middle East, Japan, Korea, and former Soviet Union countries).

2020). However, emissions of other GHGs significantly contribute to global warming, with methane accounting for about 40% of the contribution of GHGs to short-term global warming (Cain et al., 2022; Höglund-Isaksson et al., 2020; IPCC, 2014; Saunois et al., 2020; Shindell et al., 2017). Mitigation will therefore require important changes also in the agricultural sector (Fesenfeld et al., 2018), raising different challenges and potential opposition from different interest groups, in particular in countries whose economies are more dependent on agriculture. Moreover, lock-in dynamics are present both on the production and on the consumption side. It is therefore important to incorporate both the power of producers in incumbent sectors and the dependence on emitting sources on the consumption side, linked for instance to the resistance to shifting consumption patterns.

To provide a comprehensive picture, we propose to measure emissions lock-in by employing four indicators, covering both the production and the consumption side not only in the energy and industry sectors, which are responsible for most carbon emissions, but also in the agricultural sector, which is responsible for most methane emissions. To proxy the carbon lock-in in the energy and industry sectors, we use (a) the share of fossil fuels in electricity generation (for the consumption side) and (b) fossil rent as a share of GDP (for the production side); to proxy the methane lock-in in the agricultural sector, we use (c) per capita methane emissions in the AFOLU sector (for the consumption side) and (d) the share of agriculture in GDP (for the production side).

Figure 2 visualizes the geographical variation in emissions lock-in across countries. There is significant variation in the level and type of emissions lock-in across regions, with very high carbon lock-in in the MAF, ASIA, REF, and OECD regions, and high methane lock-in in the LAM and MAF regions, and in a few OECD countries.

3. Capacity

A second key element shaping climate policy ambition is capacity, which refers to the ability of the state to implement goals and policies (Cingolani, 2013). It refers to capabilities, including material resources and organizational competencies, that the state possesses and can employ to reach policy goals. The political science literature shows that capacity exerts considerable influence on a broad set of policy outcomes such as economic development, civil conflict, democratic consolidation, and international security (Hanson & Sigman, 2021). Capacity has also been shown to be a key driver of climate and energy policy (Aklin & Urpelainen, 2013; Eskander & Fankhauser, 2020; Jewell et al., 2019; Levi et al., 2020). Different capabilities are relevant to different functions of the state. Building on a broad low-carbon transition literature, we argue that three categories of capabilities are relevant for climate policy implementation: (a) governance capabilities, (b) economic capabilities, and (c) technological capabilities.

3.1. Governance Capabilities

Governance capacity, defined as the ability to make and enforce policy decisions, is the first key element shaping the ability of a country to reach policy goals. Countries with high governance capacity have been shown to be more likely to phase out coal (Jewell et al., 2019), have higher deployment rates of renewable energy (Aklin & Urpelainen, 2013), have higher levels of carbon prices

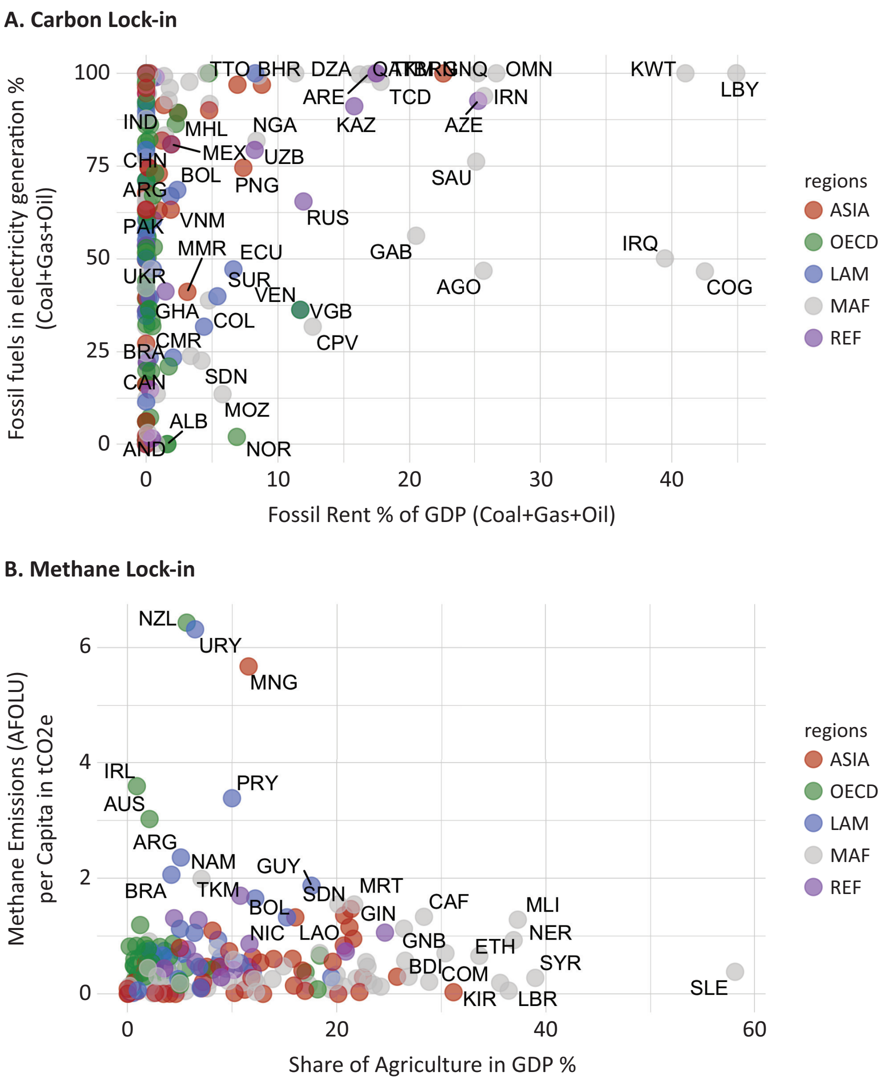

Figure 2. Geographical variation in emissions lock-in. Notes: Panel A includes a scatterplot of countries with the share of fossil fuels in electricity generation on the y-axis and fossil rent as a share of GDP on the x-axis; panel B focuses on methane lock-in in the agricultural sector, with per capita methane emissions in the AFOLU sector on the y-axis and the share of agriculture in GDP on the x-axis; values are from 2019; Table S1 in the Supplementary Material provides details on all the data sources.

(Levi et al., 2020), be better at implementing climate laws (Eskander & Fankhauser, 2020), and have better air quality (Danish et al., 2019; Halkos, 2013).

The most widely used measures of governance capacity are the World Bank Worldwide Governance Indicators (Kraay et al., 2010). We propose to employ two indicators, measuring (a) government effectiveness, defined as the ability of the government to provide public services and to formulate and implement public policies, and (b) the rule of law, defined as the extent to which agents have confidence in and abide by the rules of society. Figure 3 visualizes the geographical variation in governance capabilities across countries belonging to different IAM regions. There is significant cross- and within-regional variation in governance capabilities. OECD countries generally score highest on both indicators, followed by countries in the ASIA region. Governance capacity can be a key enabler of mitigation in these regions; in other regions, capacity building can contribute to increasing the likelihood of more ambitious climate action.

3.2. Economic Capabilities

Economic capacity can also be a key enabler of climate mitigation action. A systematic and robust relationship has been identified between GDP per capita and the deployment of new technologies—or the phasing-out of old ones (Aguirre & Ibikunle, 2014; Brutschin, Cherp, et al., 2021; Halkos, 2013; Jewell et al., 2019). Achieving ambitious climate mitigation goals will also require major domestic and foreign investments in low-carbon technologies. Investment environments can be key enablers of the diffusion of low-carbon technologies, in particular in countries that are not frontrunners. For example, a

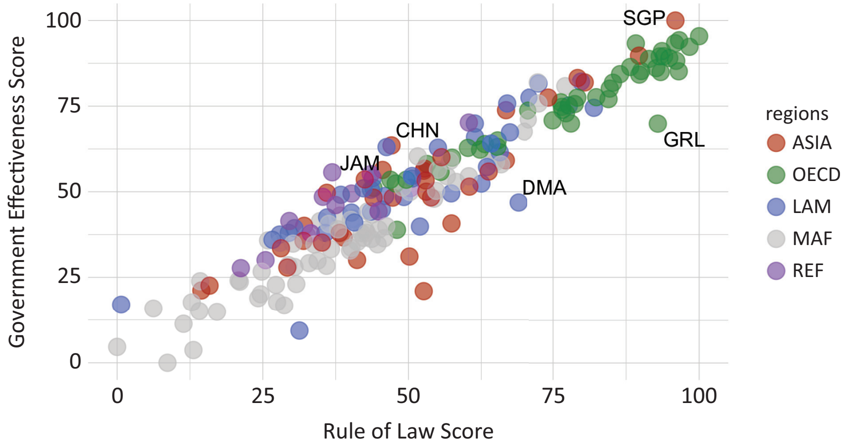

Figure 3. Geographical variation in governance capabilities. Notes: Scatterplot of countries with the World Bank Government Effectiveness and Rule of Law indicators on the y- and x-axis, respectively; the indicators are rescaled to a range from 0 to 100; values are from 2019; Table S1 in the Supplementary Material provides details on the data source.

major increase in global trade flows of solar photovoltaic technologies has been observed over recent years, with a key role played by China. We measure economic capabilities by employing two indicators: (a) GDP per capita, as a proxy of the overall domestic economic structure, and (b) the measure of "ease of doing business" developed by the World Bank, as a proxy of countries' investment environment.

Figure 4 shows the geographical variation in economic capabilities across countries. Predictably, OECD countries are well-positioned in terms of GDP per capita and market environment. On the whole, the Middle East and African countries scale low on both proxies of economic capacity, suggesting that achieving mitigation in this region might require substantial financial support from other countries. Some low-income African countries have an open investment environment, which might facilitate the diffusion of low-carbon technologies.

3.3. Technological Capabilities

Reaching ambitious climate goals will also require significant efforts in terms of technological innovation and diffusion. Technological capacity will be crucial in particular for the mitigation of emissions in the energy sector and the industrial sector. Historically, new energy technologies were often developed in OECD countries and subsequently diffused to other regions (Brutschin, Cherp, et al., 2021; Cherp et al., in press), and countries that were able to support new technologies through R&D were able to achieve higher shares of renewable energy (Aklin & Urpelainen, 2013). Substantial technological resources have been shown to be necessary, especially for the scaling up of complex and "lumpy" technologies, such as nuclear energy technologies (Brutschin & Jewell, 2018; Wilson et al., 2020). However, technological innovation and diffusion can be also key enablers of demand-side

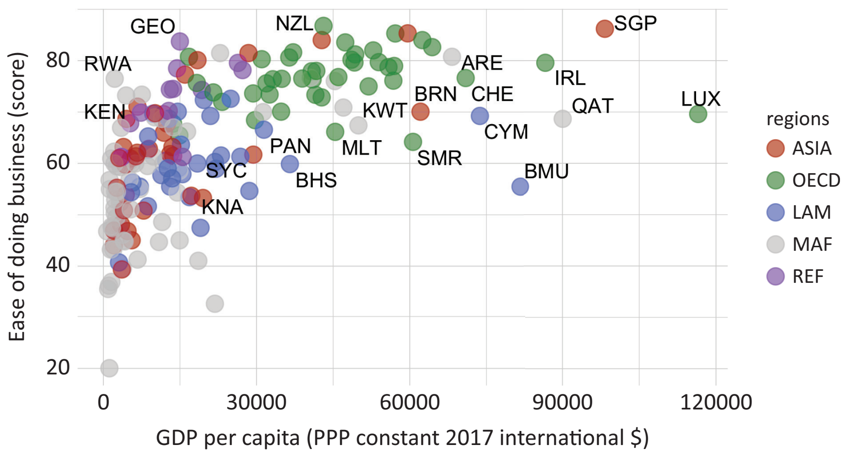

Figure 4. Geographical variation in economic capabilities. Notes: Scatterplot of countries with the World Bank Ease of Doing Business index on the y-axis and GDP per capita on the x-axis; values are from 2019; Table S1 in the Supplementary Material provides details on the data sources.

mitigation in the building and transportation sectors, facilitating the scaling up of energy efficiency technologies and low-carbon infrastructure construction.

Technological capabilities can therefore be key enablers of more ambitious climate policies. We employ two indicators to measure technological capabilities: (a) R&D investments as a share of GDP, and (b) the share of graduates in science and engineering over total graduates. Combining these two indicators allows us to identify countries and regions that are not traditionally considered global leaders in technological innovation but have a high level of human capital that can facilitate the diffusion of new low-carbon technologies. Figure 5 shows the geographical variation in technological capabilities across countries. There is substantial variation within regions. On average, not only OECD but also Asian and former Soviet countries possess high levels of technological capacity, which, in the presence of political decisions to undertake ambitious mitigation strategies, could significantly facilitate the scaling up of low-carbon technologies.

4. Public Support

Public opinion has been shown to have a significant impact on policy decisions (Adams et al., 2004; Burstein, 2003; Caughey & Warshaw, 2018; Wlezien & Soroka, 2012), also in the climate policy domain (Bakaki et al., 2020; Bromley-Trujillo & Poe, 2020; Schaffer et al., 2021; Vandeweerdt et al., 2016). Public support and opposition to different energy technologies can be important determinants of the development and diffusion of different low-carbon technologies (Boudet, 2019; Devine-Wright, 2006). Supportive public opinion can enable the implementation of ambitious climate policies, in particular in democratic countries.

A broad interdisciplinary literature has investigated the drivers of climate change belief, attention, concern, and public support for climate policies. Inglehart's post-materialist theory argues that the achievement of physical and economic security produces a shift from concerns for material security to post-materialist values, including belonging, self-expression, quality of life, and an increased concern for environmental protection (Inglehart, 1981). Indeed, different studies have documented the impact of the country's economic performance and of personal economic conditions on environmental attitudes (Duijndam & van Beukering, 2021; Scruggs & Benegal, 2012).

Unfortunately, we have no access to survey data measuring climate-specific attitudes in a broad set of countries with good coverage of all continents. We are aware that Gallup collected climate opinion data across 143 countries from 2007 to 2010 and that a second wave was collected in the past few years, but we do not have access to those datasets. The freely available dataset with the broadest geographical coverage containing information on environmental attitudes across a broad set of countries is the Integrated Values Survey (IVS), which combines the European Values Study and the World Values Survey (European Values Study & World Values Survey, 2021). We employ IVS data on environmental attitudes and post-materialist values to map cross-country and cross-regional variation in attitudes that can enable ambitious climate action. Future studies could employ climate-specific public opinion data to assess such variation more accurately.

Figure 6 displays the geographical variation in environmental attitudes—measured as the preference between environmental protection and economic growth—and post-materialist values across countries (details of survey questions are provided in Table S2 of the Supplementary Material). It is evident that OECD countries are the ones where attitudes supportive of climate policies are most prevalent, providing further evidence that it is the region where most climate mitigation

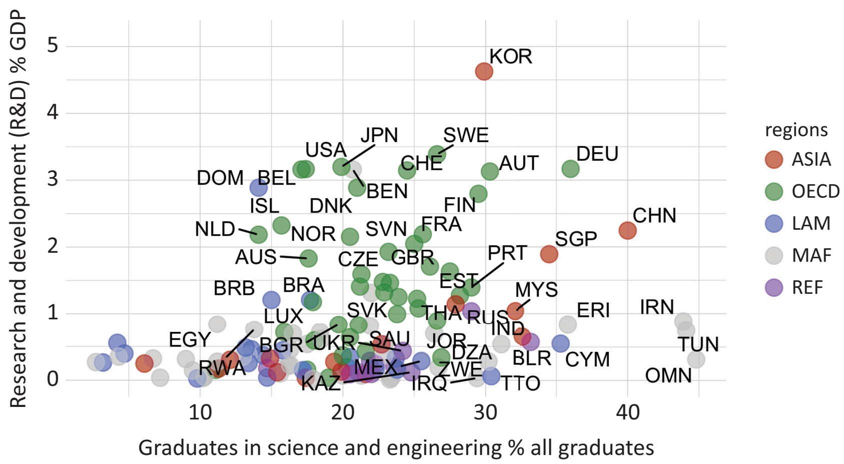

Figure 5. Geographical variation in technological capabilities. Notes: Scatterplot of countries with R&D investment as a percentage of GDP on the y-axis and the percentage of graduates in science and engineering over total graduates on the x-axis; values are from 2019; Table S1 in the Supplementary Material provides details on the data sources.

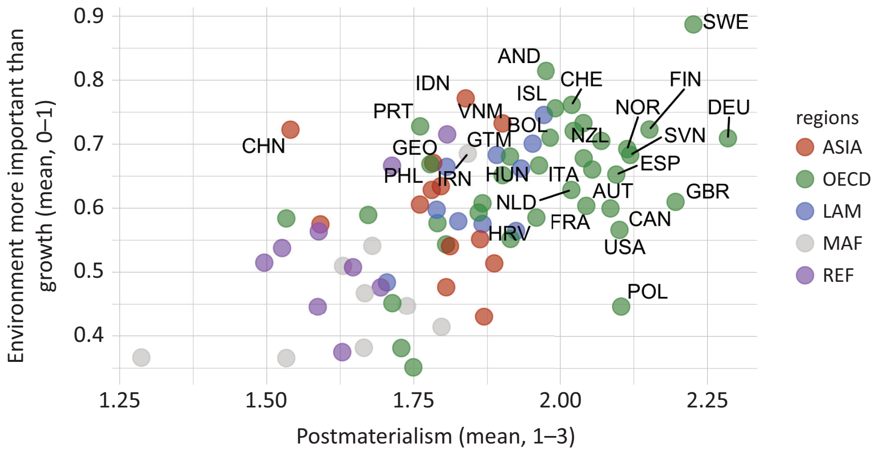

Figure 6. Geographical variation in public opinion across countries. Notes: Scatterplot of countries, with the average values of Inglehart's post-materialism index on the x-axis (country-level averages ranging from 1 to 3) and the average of a measure of preferences between environmental protection and economic growth on the y-axis (country-level averages ranging from 0 to 1); data from the last IVS wave (2017–2020); details on the measures are provided in Table S1 and S2 in the Supplementary Material.

efforts could be concentrated. Public opinion in countries of the LAM and ASIA regions could be relatively supportive of climate action, but there is considerable variation within regions. The MAF and REF regions are those whose population is potentially the least supportive of climate action.

5. An Overview of Emissions Lock-in, Capacity, and Public Support Across Integrated Assessment Modeling Regions

The purpose of this article is to give an overview of how political factors might pose challenges or act as enablers of climate policy ambition and suggest how they can be better incorporated in modeling exercises. The importance of these factors will vary across different countries and specific policy output and outcomes. To make a broad assessment of the regional heterogeneity across key enablers and constraints, we develop aggregate regional indices and report some descriptive statistics. To build these indices, we employ the following aggregation procedure: (a) we standardize each country-level indicator from 0 to 100, (b) we aggregate relevant indicators to build country-level indices for each dimension by computing their mean, and (c) we compute the population-weighted regional average of the country-level aggregate indicators.

Figure 7 illustrates aggregated regional indices for carbon lock-in, methane lock-in, governance, economic and technological capabilities, and public support. Looking at these statistics, we can see that in the OECD region, despite a high carbon lock-in, a broad set of political

Regions	Carbon lock-in	Agricultural lock-in	Governance capabilities	Economic capabilities	Technological capabilities	Public support
OECD	43.2	6	82.2	61.3	47	62.3
ASIA	44.3	13.6	51.8	39.8	47.8	49
LAM	27.5	13.5	45	38.3	26.4	53.3
MAF	35	17.6	36.6	30.9	24.4	29.5
REF	44.7	10.9	43.4	46	34.3	29.3

Figure 7. Regionally population-weighted aggregated standardized indices for key dimensions, with yellow signaling possible challenges and green signaling possible enablers. Notes: These indices are based on standardization of each of the indicators described in the article on a 0 to 100 scale, a mean-based aggregation of the indicators relevant to each dimension to build dimension-specific country-level indices, and a population-weighted regional mean-based aggregation; these values are reported for illustrative purposes and do not have mathematical meaning; the colors are assigned based on the median values of the distribution of the standardized indices in the country level data.

factors might act as enablers of climate policy ambition. In the ASIA region, lock-in is still high, but governance and technological capabilities might act as enablers of more ambitious climate policy. The LAM region faces relatively low carbon lock-in but a high lock-in of its agricultural sector and might face some challenges linked to governance, economic, and technological capabilities. In the MAF region, capacity and public support are not high, but carbon lock-in is low, and the transition might face fewer challenges, especially if there is a direct shift to a low-carbon development pathway. The REF region has high carbon lock-in and very low public support for climate mitigation. However, in the presence of political decisions aimed at ambitious mitigation, it might have technological and economic capabilities that could act as key enablers of the low-carbon transition.

6. A Framework to Incorporate Insights from Political Science in Integrated Assessment Models

There is now a general agreement in the climate mitigation literature that the social sciences should play a bigger role in shaping the development of new climate mitigation scenarios (Anderson & Jewell, 2019; Beckage et al., 2020; De Cian et al., 2020; Peng, Iyer, Bosetti, et al., 2021). Disregarding key insights from political science might lead to overestimating or underestimating mitigation potential in different countries or regions. Including such insights can help develop a more accurate understanding of the risks and enablers of ambitious mitigation pathways (Brutschin, Pianta, et al., 2021). There are some existing efforts to model social and political dynamics in the context of climate mitigation, such as studies of the linkages between human behavior and climate models (Beckage et al., 2018; Moore et al., 2022) and the international futures model (Hughes, 2016). So far, those efforts have not been applied to larger-scale process-based IAMs (such as MESSAGE, REMIND, WITCH, or IMAGE), which have a very detailed representation of different types of technologies. We present a simple framework to include insights from political science in IAMs based on the imposition of empirically motivated constraints on some of the key parameters in IAMs. A key limitation of our framework is that it does not incorporate feedback dynamics among the key drivers and the main outcomes of interest. Such an approach could in the future be extended to include a more direct coupling to a social system model. However, the incorporation of such feedback dynamics would exponentially increase the complexity of the model and require even stronger assumptions on the relationships between all drivers and outcomes.

The proposed approach, summarized in Figure 8, follows the logic of imposing exogenous constraints on

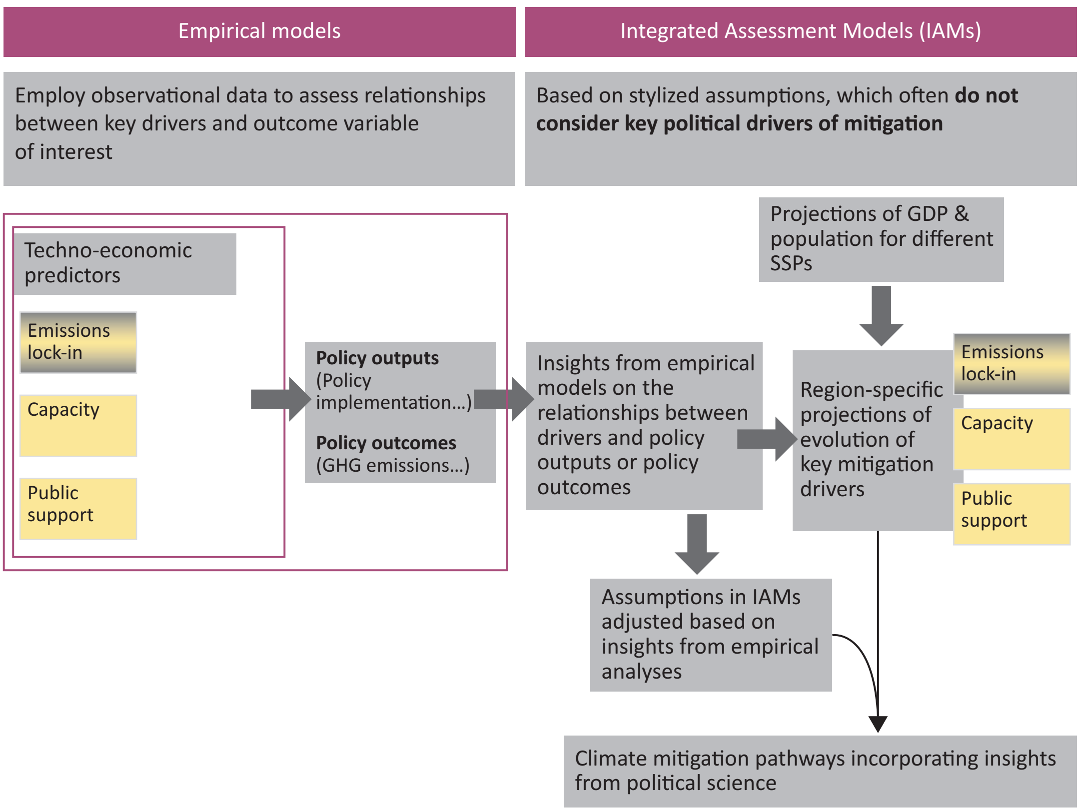

Figure 8. Overview of the framework to incorporate insights from empirical analyses on the political drivers of climate mitigation into IAMs. Notes: This approach is based on past literature and frameworks presented in Andrijevic et al. (2020), Cherp et al. (2018), and Lamb and Minx (2020); emissions lock-in is marked with a different color to signal that this variable might be proxied directly from the model outputs.

existing model parameters based on insights from empirical research. Examples of existing applications using a similar approach include the qualitative narratives of the shared socio-economic pathways (SSPs; Riahi et al., 2017), an exercise to impose constraints on the level of investments depending on institutional quality (Iyer et al., 2015), or, in the context of the US, assuming state-level variation in carbon prices that is reflective of state-level variation in public support for climate policy (Peng, Iyer, Binsted et al., 2021).

The proposed framework aims at improving some of the key assumptions adopted in IAMs, rather than proposing a forecast-based model or assuming any strong causal links between key drivers and the main outputs of interest. The linkage between empirical models and IAMs is based on the following key elements: (a) Both empirical models and IAM include some of the key variables/parameters that measure either policy outputs (such as carbon prices) or policy outcomes (such as GHG emissions); (b) it is possible to employ empirical analyses to identify correlations between the key drivers that we identified in our overview and policy output/outcomes; and (c) it is possible to develop country-level and regional-level projections that incorporate the geographical variation in such drivers. As many global IAMs divide the world into macro-regions that include many countries, careful reflection should be devoted to how much insights from empirical work, which is often done at the country level, can be extended to the regional level.

Some first attempts to explore how IAMs react to regionally differentiated socio-economic constraints might start with relatively simple set-ups where regional emissions or carbon prices (depending on the type of IAM) are constrained based on historically observed correlations with the political drivers of mitigation that we identify in this article. A more complex approach could focus on specific sectors or technologies. For example, the so-called technology learning curves could be calibrated based on their historical relationships with political variables. By varying key input assumptions of IAMs, we could explore more systematically in which regions the major bottlenecks are and what type of enablers might contribute most to reaching more ambitious climate targets in different regions and contexts. Further empirical research is essential to translate these insights into IAMs, as the effect of different political factors might vary substantially across countries, regions, and specific climate policy actions.

7. Conclusion

This article brings together insights from political science and socio-technical transitions research to highlight three key political factors that can fundamentally shape climate policy ambition: emissions lock-in, state capacity, and public opinion. We propose an operationalization of these factors based on a selection of indicators to assess their variation across countries and regions and suggest how they can be incorporated into climate modeling efforts by the IAM community. This can contribute to improving the incorporation of political dynamics in climate scenarios, which have a considerable impact on global and national climate policy discussions and decisions but have so far taken into account social and political dynamics only to a very limited extent. We argue that the incorporation of such insights in future modelling efforts is crucial, given that political factors are likely to be much more powerful drivers of future climate mitigation action compared to techno-economic constraints.

We explore the variation in emissions lock-in, state capacity, and public opinion across countries and regions, documenting significant cross-regional and within-regional heterogeneity. We highlight how OECD countries have the highest potential for mitigation, which contrasts with most IAM scenarios, which often shift mitigation efforts to other regions due to cost-effectiveness considerations. Some countries, including the Russian Federation, are well equipped to develop and adopt new technologies but have low governance capacity and public support for climate action. To identify levers of climate policy ambition in these contexts, it is essential to understand under what conditions the institutional landscape and public opinion could change or how soon technological diffusion will create economic incentives to mitigate. Latin American countries face a different set of challenges, related to the prominence of an agricultural sector with high methane emissions and to limited state capacity. Importantly, there is often considerable variation in emissions lock-in, capacity, and public support within regions. A substantial cross-country heterogeneity makes it difficult to provide a comprehensive assessment of the region including the Middle East and African countries. This within-region heterogeneity is also reflected for instance in important differences between European countries and the US, highlighting the importance of a more disaggregated regional aggregation in IAMs. We do not argue that all political factors we focus on in this article are key drivers of climate policy ambition in all contexts, but we stress how assessing their distribution can contribute to shedding light on potential challenges and enablers of mitigation action across contexts.

A limited number of studies have attempted to include political dynamics in IAMs, but a systematic approach to incorporate political factors is so far missing. We describe a framework to build new scenarios that incorporate political drivers of climate mitigation. Building on empirical analyses of existing relationships between key political factors and climate policy outputs and outcomes, we can develop assumptions on the relationships between input and output variables for new IAM scenarios that are more transparently grounded in empirical data. However, more research on the size of the effects of lock-in dynamics, capacity, and public opinion on different policy outputs and outcomes will be essential to inform future research endeavors in this direction.

Further investigating the interplay between these factors will permit an assessment of where major mitigation bottlenecks or virtuous cycles might arise.

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Conflict of Interests

The authors declare no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

References

Adams, J., Clark, M., Ezrow, L., & Glasgow, G. (2004). Understanding change and stability in party ideologies: Do parties respond to public opinion or to past election results? *British Journal of Political Science*, *34*(4), 589–610. https://doi.org/10.1017/S0007123404000201

Aguirre, M., & Ibikunle, G. (2014). Determinants of renewable energy growth: A global sample analysis. *Energy Policy*, *69*, 374–384. https://doi.org/10.1016/j.enpol.2014.02.036

Aklin, M., & Mildenberger, M. (2020). Prisoners of the wrong dilemma: Why distributive conflict, not collective action, characterizes the politics of climate change. *Global Environmental Politics*, *20*(4), 4–27. https://doi.org/10.1162/glep_a_00578

Aklin, M., & Urpelainen, J. (2013). Political competition, path dependence, and the strategy of sustainable energy transitions. *American Journal of Political Science*, *57*(3), 643–658.

Anderson, K., & Jewell, J. (2019). Debating the bedrock of climate-change mitigation scenarios. *Nature*, *573*(7774), 348–349. https://doi.org/10.1038/d41586-019-02744-9

Andrijevic, M., Crespo Cuaresma, J., Muttarak, R., & Schleussner, C.-F. (2020). Governance in socioeconomic pathways and its role for future adaptive capacity. *Nature Sustainability*, *3*(1), 35–41. https://doi.org/10.1038/s41893-019-0405-0

Bailey, I., & Compston, H. (2012). *Feeling the heat*. Springer.

Bakaki, Z., Böhmelt, T., & Ward, H. (2020). The triangular relationship between public concern for environmental issues, policy output, and media attention. *Environmental Politics*, *29*(7), 1157–1177. https://doi.org/10.1080/09644016.2019.1655188

Beckage, B., Gross, L. J., Lacasse, K., Carr, E., Metcalf, S. S., Winter, J. M., Howe, P. D., Fefferman, N., Franck, T., Zia, A., Kinzig, A., & Hoffman, F. M. (2018). Linking models of human behaviour and climate alters projected climate change. *Nature Climate Change*, *8*(1), 79–84. https://doi.org/10.1038/s41558-017-0031-7

Beckage, B., Lacasse, K., Winter, J. M., Gross, L. J., Fefferman, N., Hoffman, F. M., Metcalf, S. S., Franck, T., Carr, E., Zia, A., & Kinzig, A. (2020). The earth has humans, so why don't our climate models? *Climatic Change*, *163*(1), 181–188. https://doi.org/10.1007/s10584-020-02897-x

Bosetti, V. (2021). Integrated assessment models for climate change. *Oxford Research Encyclopedia of Economics and Finance*. Advance online publication. https://doi.org/10.1093/acrefore/9780190625979.013.572

Boudet, H. S. (2019). Public perceptions of and responses to new energy technologies. *Nature Energy*, *4*(6), 446–455. https://doi.org/10.1038/s41560-019-0399-x

Bromley-Trujillo, R., & Poe, J. (2020). The importance of salience: Public opinion and state policy action on climate change. *Journal of Public Policy*, *40*(2), 280–304. https://doi.org/10.1017/S0143814X18000375

Brutschin, E., Cherp, A., & Jewell, J. (2021). Failing the formative phase: The global diffusion of nuclear power is limited by national markets. *Energy Research & Social Science*, *80*, Article 102221. https://doi.org/10.1016/j.erss.2021.102221

Brutschin, E., & Jewell, J. (2018). International political economy of nuclear energy. In A. Goldthau, M. F. Keating, & C. Kuzemko (Eds.), *Handbook of the international political economy of energy and natural resources* (pp. 322–341). Edward Elgar. https://ideas.repec.org/h/elg/eechap/15812_23.html

Brutschin, E., Pianta, S., Tavoni, M., Riahi, K., Bosetti, V., Marangoni, G., & van Ruijven, B. J. (2021). A multidimensional feasibility evaluation of low-carbon scenarios. *Environmental Research Letters*, *16*(6), Article 064069. https://doi.org/10.1088/1748-9326/abf0ce

Burstein, P. (2003). The impact of public opinion on public policy: A review and an agenda. *Political Research Quarterly*, *56*(1), 29–40. https://doi.org/10.1177/106591290305600103

Cain, M., Jenkins, S., Allen, M. R., Lynch, J., Frame, D. J., Macey, A. H., & Peters, G. P. (2022). Methane and the Paris Agreement temperature goals. *Philosophical Transactions of the Royal Society A: Mathematical,* *Physical and Engineering Sciences*, *380*(2215), Article 20200456. https://doi.org/10.1098/rsta.2020.0456

Caughey, D., & Warshaw, C. (2018). Policy preferences and policy change: Dynamic responsiveness in the American states, 1936–2014. *American Political Science Review*, *112*(2), 249–266. https://doi.org/10.1017/S0003055417000533

Cherp, A., Vinichenko, V., Jewell, J., Brutschin, E., & Sovacool, B. (2018). Integrating techno-economic, socio-technical and political perspectives on national energy transitions: A meta-theoretical framework. *Energy Research & Social Science*, *37*, 175–190. https://doi.org/10.1016/j.erss.2017.09.015

Cherp, A., Vinichenko, V., Tosun, J., Gordon, J. A., & Jewell, J. (2021). National growth dynamics of wind and solar power compared to the growth required for global climate targets. *Nature Energy*, *6*(7), 742–754.

Cingolani, L. (2013). *The state of state capacity: A review of concepts, evidence and measures*. Maastricht Economic and Social Research Institute on Innovation and Technology.

Danish, Baloch, M. A., & Wang, B. (2019). Analyzing the role of governance in CO2 emissions mitigation: The BRICS experience. *Structural Change and Economic Dynamics*, *51*, 119–125. https://doi.org/10.1016/j.strueco.2019.08.007

Dasgupta, S., & De Cian, E. (2018). The influence of institutions, governance, and public opinion on the environment: Synthesized findings from applied econometrics studies. *Energy Research & Social Science*, *43*, 77–95. https://doi.org/10.1016/j.erss.2018.05.023

De Cian, E., Dasgupta, S., Hof, A. F., van Sluisveld, M. A. E., Köhler, J., Pfluger, B., & van Vuuren, D. P. (2020). Actors, decision-making, and institutions in quantitative system modelling. *Technological Forecasting and Social Change*, *151*, Article 119480. https://doi.org/10.1016/j.techfore.2018.10.004

Devine-Wright, P. (2006). Energy citizenship: Psychological aspects of evolution in sustainable energy technologies. In J. Murphy (Ed.), *Governing technology for sustainability* (pp. 74–97). Routledge.

Duijndam, S., & van Beukering, P. (2021). Understanding public concern about climate change in Europe, 2008–2017: The influence of economic factors and right-wing populism. *Climate Policy*, *21*(3), 353–367. https://doi.org/10.1080/14693062.2020.1831431

Erickson, P., Kartha, S., Lazarus, M., & Tempest, K. (2015). Assessing carbon lock-in. *Environmental Research Letters*, *10*(8), Article 084023. https://doi.org/10.1088/1748-9326/10/8/084023

Eskander, S. M. S. U., & Fankhauser, S. (2020). Reduction in greenhouse gas emissions from national climate legislation. *Nature Climate Change*, *10*(8), 750–756. https://doi.org/10.1038/s41558-020-0831-z

European Values Study, & World Values Survey. (2021). *European Values Study and World Values Survey: Joint EVS/WVS 2017–2021 dataset* (Dataset version 2.0.0) [Data set]. GESIS. https://doi.org/10.4232/1.13899

Fesenfeld, L. P., Schmidt, T. S., & Schrode, A. (2018). Climate policy for short- and long-lived pollutants. *Nature Climate Change*, *8*(11), 933–936. https://doi.org/10.1038/s41558-018-0328-1

Geels, F. W., Sovacool, B. K., Schwanen, T., & Sorrell, S. (2017). Sociotechnical transitions for deep decarbonization. *Science*, *357*(6357), 1242–1244. https://doi.org/10.1126/science.aao3760

Green, J. F., & Hale, T. N. (2017). Reversing the marginalization of global environmental politics in international relations: An opportunity for the discipline. *PS: Political Science & Politics*, *50*(2), 473–479. https://doi.org/10.1017/S1049096516003024

Halkos, G. E. (2013). Exploring the economy–environment relationship in the case of sulphur emissions. *Journal of Environmental Planning and Management*, *56*(2), 159–177. https://doi.org/10.1080/09640568.2012.657756

Hanson, J. K., & Sigman, R. (2021). Leviathan's latent dimensions: Measuring state capacity for comparative political research. *The Journal of Politics*, *83*(4), 1495–1510. https://doi.org/10.1086/715066

Höglund-Isaksson, L., Gómez-Sanabria, A., Klimont, Z., Rafaj, P., & Schöpp, W. (2020). Technical potentials and costs for reducing global anthropogenic methane emissions in the 2050 timeframe: Results from the GAINS model. *Environmental Research Communications*, *2*(2), Article 025004. https://doi.org/10.1088/2515-7620/ab7457

Hughes, B. B. (2016). International futures (IFs) and integrated, long-term forecasting of global transformations. *Futures*, *81*, 98–118. https://doi.org/10.1016/j.futures.2015.07.007

Inglehart, R. (1981). Post-materialism in an environment of insecurity. *American Political Science Review*, *75*(4), 880–900. https://doi.org/10.2307/1962290

Intergovernmental Panel on Climate Change. (2014). *Climate change 2014: Synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf

Intergovernmental Panel on Climate Change. (2018). *Global warming of 1.5 °C: An IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. https://www.ipcc.ch/sr15

Intergovernmental Panel on Climate Change. (2021). *Climate change 2021: The physical science basis.* https://www.ipcc.ch/report/sixth-assessment-report-working-group-i

Iyer, G. C., Clarke, L. E., Edmonds, J. A., Flannery, B. P., Hultman, N. E., McJeon, H. C., & Victor, D. G. (2015). Improved representation of investment decisions in assessments of CO 2 mitigation. *Nature Climate Change*, *5*(5), 436–440. https://doi.org/10.1038/nclimate2553

Javeline, D. (2014). The most important topic political scientists are not studying: Adapting to climate change. *Perspectives on Politics*, *12*(2), 420–434. https://doi.org/10.1017/S1537592714000784

Jewell, J., & Cherp, A. (2020). On the political feasibility of climate change mitigation pathways: Is it too late to keep warming below 1.5 °C? *Wiley Interdisciplinary Reviews: Climate Change*, *11*(1), Article e621. https://doi.org/10.1002/wcc.621

Jewell, J., Vinichenko, V., Nacke, L., & Cherp, A. (2019). Prospects for powering past coal. *Nature Climate Change*, *9*(8), 592–597. https://doi.org/10.1038/s41558-019-0509-6

Keohane, R. O. (2015). The global politics of climate change: Challenge for political science. *PS: Political Science & Politics*, *48*(1), 19–26. https://doi.org/10.1017/S1049096514001541

Kraay, A., Kaufmann, D., & Mastruzzi, M. (2010). *The worldwide governance indicators: Methodology and analytical issues*. World Bank Group. https://doi.org/10.1596/1813-9450-5430

Lamb, W. F., & Minx, J. C. (2020). The political economy of national climate policy: Architectures of constraint and a typology of countries. *Energy Research & Social Science*, *64*, Article 101429. https://doi.org/10.1016/j.erss.2020.101429

Levi, S., Flachsland, C., & Jakob, M. (2020). Political economy determinants of carbon pricing. *Global Environmental Politics*, *20*(2), 128–156. https://doi.org/10.1162/glep_a_00549

Meckling, J., & Nahm, J. (2021). Strategic state capacity: How states counter opposition to climate policy. *Comparative Political Studies*, *55*(3), 493–523. https://doi.org/10.1177/00104140211024308

Mildenberger, M. (2020). *Carbon captured: How business and labor control climate politics*. The MIT Press.

Moe, E. (2016). *Renewable energy transformation or fossil fuel backlash: Vested interests in the political economy*. Springer.

Moe, T. M. (2015). Vested interests and political institutions. *Political Science Quarterly*, *130*(2), 277–318. https://doi.org/10.1002/polq.12321

Moore, F. C., Lacasse, K., Mach, K. J., Shin, Y. A., Gross, L. J., & Beckage, B. (2022). Determinants of emissions pathways in the coupled climate–social system. *Nature*, *603*, 103–111. https://doi.org/10.1038/s41586-022-04423-8

O'Neill, B. C., Carter, T. R., Ebi, K., Harrison, P. A., Kemp-Benedict, E., Kok, K., Kriegler, E., Preston, B. L., Riahi, K., Sillmann, J., van Ruijven, B. J., van Vuuren, D., Carlisle, D., Conde, C., Fuglestvedt, J., Green, C., Hasegawa, T., Leininger, J., Monteith, S., & Pichs-Madruga, R. (2020). Achievements and needs for the climate change scenario framework. *Nature Climate Change*, *10*(12), 1074–1084. https://doi.org/10.1038/s41558-020-00952-0

Peng, W., Iyer, G., Binsted, M., Marlon, J., Clarke, L., Edmonds, J. A., & Victor, D. G. (2021). The surprisingly inexpensive cost of state-driven emission control strategies. *Nature Climate Change*, *11*(9), 738–745. https://doi.org/10.1038/s41558-021-01128-0

Peng, W., Iyer, G., Bosetti, V., Chaturvedi, V., Edmonds, J., Fawcett, A. A., Hallegatte, S., Victor, D. G., van Vuuren, D., & Weyant, J. (2021). Climate policy models need to get real about people—Here's how. *Nature*, *594*(7862), 174–176. https://doi.org/10.1038/d41586-021-01500-2

Riahi, K., van Vuuren, D. P., Kriegler, E., Edmonds, J., O'Neill, B. C., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., Lutz, W., Popp, A., Cuaresma, J. C., KC, S., Leimbach, M., Jiang, L., Kram, T., Rao, S., Emmerling, J., . . . Tavoni, M. (2017). The shared socioeconomic pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, *42*, 153–168. https://doi.org/10.1016/j.gloenvcha.2016.05.009

Roelfsema, M., van Soest, H. L., den Elzen, M., de Coninck, H., Kuramochi, T., Harmsen, M., Dafnomilis, I., Höhne, N., & van Vuuren, D. P. (2022). Developing scenarios in the context of the Paris Agreement and application in the integrated assessment model IMAGE: A framework for bridging the policy-modelling divide. *Environmental Science & Policy*, *135*, 104–116. https://doi.org/10.1016/j.envsci.2022.05.001

Rogelj, J., Geden, O., Cowie, A., & Reisinger, A. (2021). Net-zero emissions targets are vague: Three ways to fix. *Nature*, *591*(7850), 365–368. https://doi.org/10.1038/d41586-021-00662-3

Saunois, M., Stavert, A. R., Poulter, B., Bousquet, P., Canadell, J. G., Jackson, R. B., Raymond, P. A., Dlugokencky, E. J., Houweling, S., Patra, P. K., Ciais, P., Arora, V. K., Bastviken, D., Bergamaschi, P., Blake, D. R., Brailsford, G., Bruhwiler, L., Carlson, K. M., Carrol, M., . . . Zhuang, Q. (2020). The global methane budget 2000–2017. *Earth System Science Data*, *12*(3), 1561–1623. https://doi.org/10.5194/essd-12-1561-2020

Schaffer, L. M., Oehl, B., & Bernauer, T. (2021). Are policymakers responsive to public demand in climate politics? *Journal of Public Policy*, *42*(1), 136–164. https://doi.org/10.1017/s0143814x21000088

Scruggs, L., & Benegal, S. (2012). Declining public concern about climate change: Can we blame the great recession? *Global Environmental Change*, *22*(2), 505–515. https://doi.org/10.1016/j.gloenvcha.2012.01.002

Seto, K. C., Davis, S. J., Mitchell, R. B., Stokes, E. C., Unruh, G., & Ürge-Vorsatz, D. (2016). Carbon lock-in: Types, causes, and policy implications. *Annual Review of Environment and Resources*, *41*(1), 425–452. https://doi.org/10.1146/annurev-environ-110615-085934

Shen, S. V. (2021). Integrating political science into climate modeling: An example of internalizing the costs of climate-induced violence in the optimal management of the climate. *Sustainability*, *13*(19), Article 10587.

Shindell, D., Borgford-Parnell, N., Brauer, M., Haines, A., Kuylenstierna, J. C. I., Leonard, S. A., Ramanathan, V., Ravishankara, A., Amann, M., & Srivastava, L. (2017). A climate policy pathway for near- and long-term benefits. *Science*, *356*(6337), 493–494. https://doi.org/10.1126/science.aak9521

Tørstad, V., Sælen, H., & Bøyum, L. S. (2020). The domestic politics of international climate commitments: Which factors explain cross-country variation in NDC ambition? *Environmental Research Letters*, *15*(2), Article 024021. https://doi.org/10.1088/1748-9326/ab63e0

Trutnevyte, E., Hirt, L. F., Bauer, N., Cherp, A., Hawkes, A., Edelenbosch, O. Y., Pedde, S., & van Vuuren, D. P. (2019). Societal transformations in models for energy and climate policy: The ambitious next step. *One Earth*, *1*(4), 423–433. https://doi.org/10.1016/j.oneear.2019.12.002

Turnheim, B., & Nykvist, B. (2019). Opening up the feasibility of sustainability transitions pathways (STPs): Representations, potentials, and conditions. *Research Policy*, *48*(3), 775–788. https://doi.org/10.1016/j.respol.2018.12.002

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy Policy*, *28*(12), 817–830. https://doi.org/10.1016/S0301-*4215*(00)00070-7

van Beek, L., Hajer, M., Pelzer, P., van Vuuren, D., & Cassen, C. (2020). Anticipating futures through models: The rise of integrated assessment modelling in the climate science-policy interface since 1970. *Global Environmental Change*, *65*, Article 102191. https://doi.org/10.1016/j.gloenvcha.2020.102191

VanDeveer, S. D., Steinberg, P. F., Sowers, J. L., & Weinthal, E. (2022). Comparative environmental politics: Contributions from an emerging field. In P. G. Harris (Ed.), *Routledge handbook of global environmental politics* (pp. 161–174). Routledge.

Vandeweerdt, C., Kerremans, B., & Cohn, A. (2016). Climate voting in the US Congress: The power of public concern. *Environmental Politics*, *25*(2), 268–288. https://doi.org/10.1080/09644016.2016.1116651

van Sluisveld, M. A. E., Harmsen, J. H. M., Bauer, N., McCollum, D. L., Riahi, K., Tavoni, M., van Vuuren, D. P., Wilson, C., & van der Zwaan, B. (2015). Comparing future patterns of energy system change in 2°C scenarios with historically observed rates of change. *Global Environmental Change*, *35*, 436–449. https://doi.org/10.1016/j.gloenvcha.2015.09.019

Victor, D. (2015). Climate change: Embed the social sciences in climate policy. *Nature*, *520*(7545), 27–29. https://doi.org/10.1038/520027a

Vinichenko, V., Cherp, A., & Jewell, J. (2021). Historical precedents and feasibility of rapid coal and gas decline required for the 1.5 C target. *One Earth*, *4*(10), 1477–1490.

Wilson, C., & Grubler, A. (2011). Lessons from the history of technological change for clean energy scenarios and policies. *Natural Resources Forum*, *35*(3), 165–184. https://doi.org/10.1111/j.1477-8947.2011.01386.x

Wilson, C., Grubler, A., Bento, N., Healey, S., Stercke, S. D., & Zimm, C. (2020). Granular technologies to accelerate decarbonization. *Science*, *368*(6486), 36–39. https://doi.org/10.1126/science.aaz8060

Wlezien, C., & Soroka, S. N. (2012). Political institutions and the opinion–policy link. *West European Politics*, *35*(6), 1407–1432. https://doi.org/10.1080/01402382.2012.713752

Żebrowski, P., Dieckmann, U., Brännström, Å., Franklin, O., & Rovenskaya, E. (2022). Sharing the burdens of climate mitigation and adaptation: Incorporating fairness perspectives into policy optimization models. *Sustainability*, *14*(7), Article 3737. https://doi.org/10.3390/su14073737

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Article

Exploring Enablers for an Ambitious Coal Phaseout

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Abstract
To reach the mitigation goals of the Paris Agreement, many countries will have to phase out their coal power plants prematurely, i.e., before the end of their normal lifetimes, which will lead quite possibly to significant stranded assets. This could present a major challenge, particularly for many of the rapidly developing countries whose electricity demand is growing and which are currently expanding their coal fleets. Recent research shows that countries with aging power plants and decreasing coal consumption are more inclined to phase out coal, but little is known about where, why, and how coal power plants are being prematurely retired. In the context of the hybrid Paris Agreement, attention is increasingly shifting to domestic mitigation capacities and, alongside this—given the vested interests involved in different sectors—to state capacity to implement the transformations required to achieve deep decarbonization. In this article, we aim to study those capacities in the context of coal phaseout. We use a recent and comprehensive global dataset on coal power plants and employ a mixed-methods research design to (a) identify general emerging patterns with respect to premature coal fleet retirement, and (b) derive stylized types of political strategies to prematurely retire coal power plants. We find state capacity to be a robust predictor of general and premature coal retirement, and we identify three main strategies that countries have used to date to prematurely retire coal: (a) *rein-in* using top-down regulatory enforcement of environmental, climate, or other regulations that affect the operating licenses of coal plants; (b) *buy-out* or provision of compensation to companies and regions to appease vested interests; and (c) *crowd out* where accelerating market and price dynamics in the power sector crowd out coal. We propose that future research should explore more systematically the kinds of strategy that might be most promising in the regions and countries needing to rapidly phase out coal, taking into account their political structures, and also the implications that such strategies might have for global mitigation efforts.

Keywords
climate mitigation; coal phaseout; premature coal retirement; strategic state capacity

Issue
This article is part of the issue "Exploring Climate Policy Ambition" edited by Elina Brutschin (International Institute for Applied Systems Analysis) and Marina Andrijevic (International Institute for Applied Systems Analysis).

1. Introduction

Around one-quarter of global greenhouse gas (GHG) emissions can be attributed to coal plants in the power sector (Cui et al., 2019). There is clear agreement in climate science that to increase the probability of reaching the goals of the Paris Agreement, the use of unabated coal in the power sector needs to decline rapidly (Cui et al., 2019; Spencer et al., 2018; Tong et al., 2019). All pathways likely to limit warming to 2°C or below show a near elimination of coal by 2050 (Intergovernmental Panel on Climate Change, 2022). This implies that many rapidly developing countries, where the majority of coal capacity has been added in the last two decades (Tong et al., 2019), would need to prematurely retire their coal fleet, that is, close their coal power plants before its usual operating lifetime of 40–60 years is complete. This places the burden of stranded assets disproportionately on those rapidly developing regions (Edwards et al., 2022). Overall, coal phaseout raises concerns related to equity in international climate politics (Jakob et al., 2020) and also to "societal feasibility" (Spencer et al., 2018), given that fast rates of coal decline have rarely been observed historically (Vinichenko et al., 2021).

There is a growing amount of research focusing on coal phaseout (Blondeel et al., 2020; Diluiso et al., 2021; Jewell et al., 2019; Steckel & Jakob, 2021) that highlights the importance of "vested interests" and "carbon lock-in'' to explain why the phasing out of coal is so challenging. Membership of the prominent "Powering Past Coal Alliance" (PPCA; a coalition of national and subnational governments, businesses, and organizations working to advance the transition from unabated coal power generation to clean energy) is mainly confined to countries with a relatively old coal fleet or a low share of coal in electricity generation (i.e., where the influence of vested interests is on the decrease; Jewell et al., 2019). In this article, we focus on the newly developed notion of "strategic state capacity" which is defined as "the ability of the state to mobilize or demobilize interest groups in pursuit of policy goals" (Meckling & Nahm, 2021, p. 493). To date, studies on the political economy of coal phaseout have focused on material interests (e.g., age of coal fleet, share in power production, etc.), institutional settings (climate governance structures, policies), and regime types (Blondeel et al., 2020; Jakob & Steckel, 2022; Rentier et al., 2019), and less on actual political strategies and capacities to implement them against vested interests.

The key objective of the study is to explore whether and how countries with higher levels of state capacity enable a more ambitious coal phaseout. We contribute to the growing body of research by using a mixed-methods research design to answer the following research questions: (a) Is there any systematic evidence to show that countries with higher levels of state capacity are better equipped to phase out coal? and (b) What strategies do countries use to prematurely retire power plants? To answer these questions, in Section 2 we briefly discuss the state of the coal sector, highlighting that almost three-quarters of the current coal fleet is less than 20 years old. In Section 3, we explore how past literature has looked at the patterns of coal phaseout and we focus on explaining some of the key mechanisms that link state capacity to the ability to overcome vested interests. We discuss the methods and results of our quantitative analysis in Section 3.1, and of our qualitative analysis in Section 3.2. In general, we find state capacity to be a robust predictor of the overall share of retired coal capacity as well as of the prematurely retired share, and the operationalization of state capacity that we use adds more explanatory detail than relying on a log of GDP per capita, which is a widely used proxy for state capacity. With China and India both being on a path of growing state capacity, increasing capacity to phase coal out prematurely can be expected in those countries. State capacity alone, however, will not be enough to overcome vested interests. Decision makers would need to implement political phaseout strategies to overcome, mediate, or align vested interest within their countries. Distributive effects must also be taken into account at the global level where conflicts related to historic emissions and equity will shape overall global mitigation efforts. In our qualitative analysis, we identify three broader strategies currently deployed across a wide range of countries: (a) *rein-in* with a top-down regulatory enforcement of environmental, climate, or other regulations that affect the operating licenses of coal plants; (b) *buy-out*, namely, paying compensation to companies and regions to appease vested interests; and (c) *crowd out* where accelerating market and price dynamics in the power sector crowd out coal in the power sector. In our conclusion we call for more detailed research into those strategies, and the contexts in which they emerge—research that could become relevant in the future.

2. Current State of the Coal Sector

All pathways likely to limit warming to 2°C or below show a near elimination of coal without Carbon Capture and Storage (CCS) by 2050 (Intergovernmental Panel on Climate Change, 2022). To demonstrate the scale of the global challenge of phasing out coal, we summarize historical data and the most up-to-date data from the coal sector by using coal power plant data from the Global Power Plant Tracker Database (Global Energy Monitor, 2022). To make it easier to compare recent data with the outputs from scenarios, we aggregate country-level data in Figure 1 into four Integrated Assessment Model (IAM) regions (Europe, North America, India+, and China+), which cover the largest share of the current installed coal capacity. We provide the full list for regional categorization in the Supplementary Material, Table S1. Figure 1 highlights two main trends that we wish to emphasize: (a) There was a major build-up of new coal fleet after 2006, and (b) the coal scale-up in the China+ region has developed at an unprecedented rate, reaching over 1000 GW by 2021, which roughly corresponds to 50% of the current total global coal capacity installed.

As decisions about closing or refurbishing existing coal infrastructure are strongly influenced by the national political and economic context, we further provide the most recent coal sector snapshot at the country level in Figure 2. In Figure 2 (A) we can see that there are four countries that have successfully managed to phase out coal: Austria, Belgium, Portugal, and Sweden. As all these countries are relatively small or had a relatively small coal capacity in global terms (for example, Sweden had only two coal power plants to retire), the total amount of phaseout out is small in the overall global equation of coal capacity. A more promising impact on global mitigation efforts could be achieved if countries that currently have a relatively high share of coal capacity and an older fleet (a mean operational age of over 40 years), such as, for example, Russia and the US (indicated in blue), would retire their existing coal fleets. Retiring coal power plants in countries where the coal fleet is on average older than 20 years would account for about 500 GW or one-quarter of the current global coal capacity. The scale of the challenge represented by coal phaseout is shown particularly clearly in

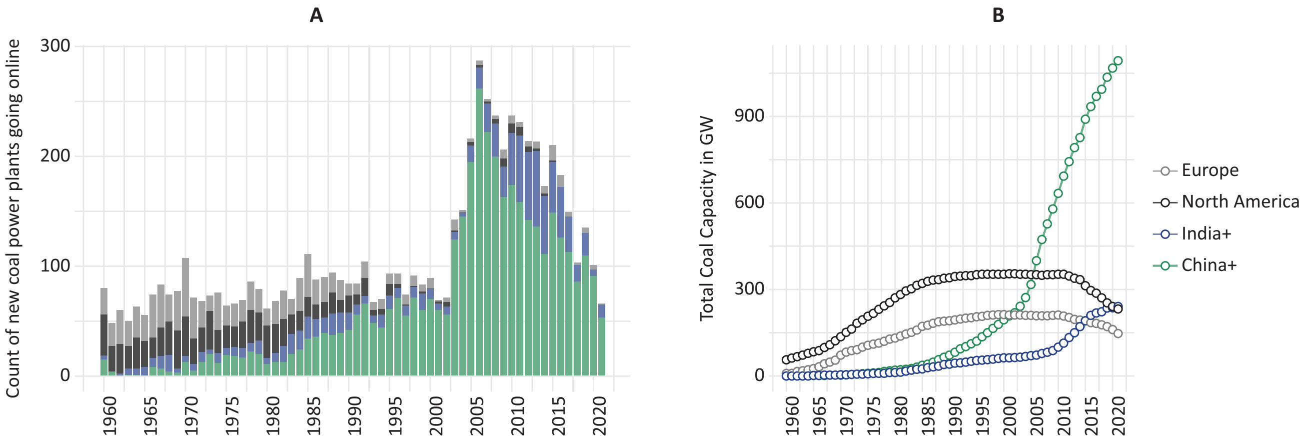

Figure 1. Figures A and B are based on data from the Global Power Plant Tracker Database (Global Energy Monitor, 2022) and aggregated into key IAM regions. China+ includes China (including Hong Kong), Cambodia, Korea (DPR), Laos (PDR), Mongolia, Vietnam; India+ includes India, Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan, Sri Lanka. For the full list of regional categorization see the Supplementary Material, Table S1. Figure A shows the number of new coal power plants going online in a given year for a given region. Figure B is based on calculations that include all operating power plants and exclude retired ones, and shows the total installed coal capacity in a given year and a given region in GW.

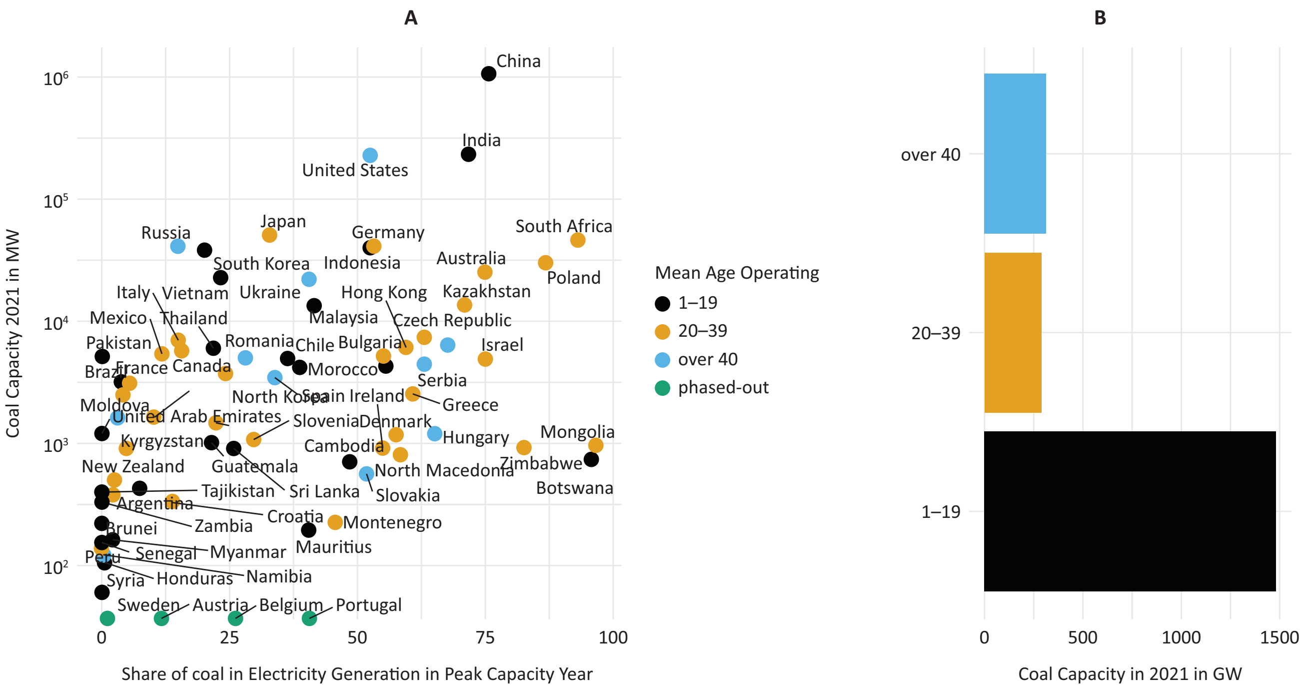

Figure 2. Figures A and B are based on data from the Global Power Plant Tracker Database (Global Energy Monitor, 2022) and from the World Bank Indicator on the share of coal in electricity generation. In Figure A, the x-axis shows the share of coal in electricity generation (in %) in the year in which peak installed coal capacity was achieved; for countries where coal capacity is growing, the latest available data are used. This should indicate the level of domestic challenge that a country might face with coal phaseout. The y-axis indicates the total installed coal capacity as of 2021 in MW using logarithmic scale to highlight the importance of a country in the global context (i.e., to indicate the absolute coal capacity compared to other countries). The "Mean Age Operating" is calculated based on the mean age of all currently operating power plants and weighted by their capacity. Figure B shows the sum of coal capacity in GW for all countries that fall within a given "Mean Age Operating" category in 2021.

Figure 2 (B), which highlights that around 1500 GW or three-quarters of the current global coal capacity is less than 20 years old.

3. Prospects of Coal Phaseout and the Role of State Capacity

To reach the mitigation goals of the Paris Agreement, an essential and key strategy is to stop emitting GHGs into the atmosphere and thus to phase out coal. In Section 2 we highlighted the scale of the challenge that a coal phaseout presents for certain regions and especially for certain countries. Based on this, it is not surprising that the division along developed- and developing-country lines was reflected in the most recent climate negotiations at COP26. While developed countries with quite old coal fleets, led by the UK, sought to include the call for a coal phaseout in the cover decision of United Nations Framework Convention on Climate Change's (UNFCCC) COP26, emerging economies—established users with growing coal capacities—tried to weaken the declaration by referring to arguments of equity and historical emissions. In the end, the UNFCCC document summarizing agreements from COP26 included the objective to accelerate efforts towards "the phasedown of unabated coal power" (UNFCCC, 2021, p. 3) rather than phaseout, as stated in the initial draft.

There is a general agreement in the current scientific literature that it is the "coal lock-in," or the "degree to which a society is locked-in on investments, resources, assets and activities related to coal" (Rentier et al., 2019, p. 621) that makes coal phaseout particularly difficult. The member countries of the PPCA whose objective is to phase out coal have in common a weak coal industry or being a climate leader (Blondeel et al., 2020, p. 9); they also have a lower share of coal in electricity generation, older coal power plants, and no majorly increasing energy demand (Jewell et al., 2019). Studying the UK coal phaseout from a historical perspective, Turnheim and Geels (2012) conclude that, normally, for a technological regime to be destabilized and an old technology to be replaced, multiple processes need to be aligned such as, for example, political support, economic viability of alternatives, and declining public support. Against this backdrop and given the current global coal landscape (Figure 2), the prospects for a global coal phaseout in alignment with Paris Agreement goals would seem rather bleak.

Nonetheless, we do observe overall increasing ambition in climate mitigation (Ou et al., 2021), and there are countries that have phased out coal or have pledged to phase out coal before 2030. The Netherlands, which is a member of the PPCA, has committed to retiring three large coal-powered plants by 2029 (total capacity: 2.4 GW) that went online in 2015 (i.e., after only 14 years of operation). China recently pledged not to build new coal power plants oversees (Ni et al., 2021). The UK, one of the initiators of the PPCA, managed to commit to phasing out coal despite initial major societal and industry opposition. There are thus many examples where vested interests in the coal sector could be overcome.

Meckling and Nahm (2021) argue that "strategic state capacity" or the ability of countries to mobilize or demobilize interests could be a useful notion with a view to understanding why certain countries manage to implement climate policies that are more ambitious. Depending on the type of political system (polity) when dealing with different interest groups, a country's government might consider: (a) recruiting allies, (b) aligning interests, (c) limiting access, or (d) quieting interests. Using Germany's coal phaseout agreement as one of the case studies, Meckling and Nahm (2021) identify that Germany was able to conciliate interests through compensation, by offering a package worth €40 billion to affected regions. The main insight of their study is that some "governments are able to pursue state goals against interest group opposition and not in others, even when bureaucratic capacity does not vary" (Meckling & Nahm, 2021, p. 22).

Building on work by Meckling and Nahm (2021), we focus on the role of (strategic) state capacity in the context of coal phaseout by proposing a mixed-methods research design where we explore: (a) whether there is a systematic link between levels of state capacity and progress in terms of the phasing out of coal using quantitative methods, and (b) what other types of strategy beyond compensation are used by countries to phase out coal and how these could be linked to the level of state capacity using qualitative methods. Overall, there have been many single or comparative case studies of coal phaseout (Diluiso et al., 2021; Markard et al., 2021; Oei et al., 2020; Rentier et al., 2019) but only a few studies including cases that would shed more light on generalizable patterns (Blondeel et al., 2020; Jewell et al., 2019; Steckel & Jakob, 2021; Vinichenko et al., 2021). This is not surprising, given that there are not very many cases where coal phaseout has been observed and, additionally, it is not very clear how countries in the different stages of coal phaseout (Nacke et al., 2022) should be compared. The concept of state capacity is also difficult to operationalize (Savoia & Sen, 2015) and many past analyses of technologies to date have used GDP per capita as a proxy for state capacity (Brutschin et al., 2021; Jewell et al., 2019). We address the methodological issues pertaining to quantitative analysis and to the results in Section 3.1 and we discuss the approach to, and results of, the qualitative analysis in Section 3.2.

3.1. Quantitative Analysis of Coal Phaseout

To assess whether there is a systematic link between the phasing out of coal and state capacity, we propose to focus on cross-country variation in the degree to which coal has been phased out to date. In our model specifications we use a linear regression model with robust standard errors to account for heteroskedasticity in residual distribution. We focus on the role of state capacity and include a range of additional control variables that might be linked to the observed cross-country variation. In what follows, we describe in greater detail the measurement of our dependent variable (the degree to which coal has been phased out), how we propose to measure state capacity, and the other additional variables that we include to assess the robustness of the link between state capacity and the ability to phase out coal. It is essential to note that this type of analysis does not allow any claims to be made about the causal link between state capacity and coal phaseout. There are many other confounding variables that could be highly correlated with state capacity and coal phaseout. We can, however, in the qualitative part of our analysis (Section 3.2) further explore the plausibility of linking state capacity to progress in coal phaseout.

Past analyses have looked at membership of the PPCA as a possible indicator of a country's commitment to phasing out coal (Blondeel et al., 2020; Jewell et al., 2019). This measure could, however, miss some interesting cases such as China and the US, which are not members of the PPCA, but are prematurely retiring parts of their coal fleet (as we also briefly discuss in Section 3.2). In our analysis, we aggregate power plant data from the Global Power Plant Tracker Database (Global Energy Monitor, 2022) where, for most power plants, it is reported when a power plant went online, its total capacity, and the year it was retired. This detailed information enables different combinations of data to be aggregated for a given country. Ideally, we wish to identify countries where we can observe the trend of a declining coal fleet stock and incorporate information about the share of fleet that has been prematurely retired. As an initial measure we thus propose to use the share of prematurely retired coal capacity (coal power plants that are bigger than 100 MW and less than 30 years old) of the total capacity in the peak year, to which we later refer as "*premature*." Yet countries might retire many power plants prematurely without substantially decreasing their overall coal stock or, in other words, without a real trend toward coal phaseout. We thus use *two additional measures* to also account for those trends: (a) share of retired coal capacity in total capacity in the peak year (based on the year in which a country reached peak capacity; i.e., after which capacity did not substantially increase) which we refer to as "*retired total*," and (b) share of peak capacity as a share of the current capacity which we refer to as "*peak versus current*" (calculated to indicate the retired share in the current capacity). As shown in Table S2 of the Supplementary Material, we report, for each country, the year coded as the peak year and the values for all three measures; apart from a few exceptions, there is a general overlap across the three measures. The Netherlands is a particularly interesting example, given that, compared to peak capacity, a substantial share of the country's coal capacity has already been retired (over 60%, and around 30% even prematurely); but because of recent new build-ups, the current share of coal capacity is still at around 70% of peak capacity. Thus, what we observed in the Netherlands was a recent upgrade of its coal fleet. The Netherlands is still committed to a complete coal phaseout by 2029.

As our focus is on state capacity, our research requires a quantifiable definition of state capacity that ideally goes beyond the general measures of bureaucratic quality. Broadly, state capacity refers to the general ability of a state to implement goals and policies (Cingolani, 2013). There are many different ways to operationalize state capacity (Hanson & Sigman, 2021; Savoia & Sen, 2015) that focus on different functions of a state. Recently, Hanson and Sigman (2021) developed a new operationalization of state capacity that covers three of its key domains: extractive, coercive, and administrative. This new variable is based on 21 indicators *(Administrative efficiency*, *Bureaucratic quality*, *Census frequency*, *Efficiency of revenue mobilization*, *Fiscal capacity*, *Information capacity*, *Law and order*, *(log) Military personnel per 1,000 in population*, *(log) Military expenditures per capita*, *Monopoly on use of force*, *(log) Police officers per 1,000 in population*, *Quality of budgetary and financial management*, *Quality of public administration*, *Rigorous and impartial public administration*, *State antiquity index*, *State authority over territory*, *Statistical capacity*, *Taxes on income as % of taxes*, *Taxes on international trade as % of taxes*, *Total tax revenue as % of GDP*, *Weberiannes*) and covers the period from 1960 to 2015. This measure goes beyond a narrow measurement of administrative or bureaucratic capacity, like, for example, the World Bank Governance indicators, which focus on government effectiveness, rule of law, corruption, voice and accountability, political stability, and regulatory quality. Depending on the year, this state capacity measure from Hanson and Sigman (2021) ranges from −2.31 to 2.96, with the highest levels of state capacity being estimated for Denmark. For our regression analysis we use the state capacity value for the year in which a given country reached peak capacity, while for countries in which coal capacity is still increasing we use the value from the latest year available.

The selection of additional control variables for our key model specifications is not only guided by general frameworks highlighting the key drivers of national climate policies (Lamb & Minx, 2020), but also based on other past findings pertaining to coal phaseout (see Table 1 for an overview of all variables, definitions, sources, and some basic descriptive statistics). For all control variables we pick the values at the peak coal capacity year; for countries which have not yet reached peak in their coal capacity, we take the most recent available data. As mentioned earlier, a widely used proxy for state capacity is a log of GDP per capita, which we obtained from the World Bank World Development Indicators and which is reported in constant international US$2017. Carbon lock-in and vested interests are often proxied by measuring the share of coal (or other

Table 1. Overview of the variables included in the quantitative analysis.

Variable	Exact measurement	Source	Mean/SD	Min–Max	N
The share of prematurely retired coal capacity in the total capacity in the peak year	Taking the total prematurely retired coal capacity (coal power plants that are bigger than 100 MW and younger than 30 years) and dividing it by the total installed coal capacity in the year in which country reached peak capacity	Own calculations based on Global Energy Monitor (2022)	2.35/6.46	0–33.63	81
Share of retired coal capacity	Taking the total retired coal capacity and dividing it by the total installed coal capacity in the year in which the country reached peak capacity (maximum capacity over the observed time span)	Own calculations based on Global Energy Monitor (2022)	19/29.25	0–100	81
Share of peak capacity as a share of the current capacity	One minus the ratio between capacity in the peak year and capacity in 2021	Own calculations based on Global Energy Monitor (2022)	84/28.73	0–100	81
Log GDPpc	GDP per capita PPP constant international US$2017	World Bank World Development Indicators (WDI). Variable: GB.XPD.RSDV.GD.ZS	9.72/0.89	7.34–11.34	72
State capacity	extractive, coercive, and administrative capacity based on 21 indicators	Hanson and Sigman (2021)	0.96/0.83	−0.78–2.87	69
Coal reserves	R/P ratio of total proved reserves	BP (2021)	1.17/3.8	0–23	81
Share of coal in electricity generation	Electricity production from coal sources (% of total)	World Bank World Development Indicators (WDI). Variable: eg.elc.coal.zs	34.22/28.74	0–96.6	72
Federal Government	Dummy variable coded 1 if there are independent sub-federal units (states, provinces, regions, etc.) that impose substantive constraints on national fiscal policy	Henisz (2017)		0–1	78
Liberalization Index	Ranges from 0 to 8 from non-liberalized to completely liberalized power sector	Erdogdu (2011) and Urpelainen and Yang (2019)	5.92/2.14	0–8	76
Climate Emergency	Share of population in a given country that answered yes to the question "Do you think climate change is a global emergency?''	Flynn et al. (2021)	67.07/8.26	50–81	28

fossil fuels) in electricity generation (Lamb & Minx, 2020). We thus include a similar variable which is reported in World Bank Development Indicators. Apart from that we also include a measure of coal reserves (reserves to production ratio) from the British Petroleum Statistical Review (BP, 2021). To additionally control for whether it is more challenging to phase out coal in a more federalized or a more centralized state, we included a binary measure from the Political Constraint Dataset, which is coded 1 if there are independent sub-federal units (states, provinces, regions, etc.) that impose substantive constraints on national fiscal policy (Henisz, 2017). As it might be easier to switch to new cheaper technologies and overcome vested interests in more liberalized markets (Brutschin et al., 2021), we also include a liberalization index that ranges from 0 to 8 from a non-liberalized to completely liberalized power sector and was collected for developed and developing countries by Erdogdu (2011) and Urpelainen and Yang (2019). Finally, there is a growing interest in understanding how public opinion might affect the levels of climate policy ambition. Unfortunately, there are only a few datasets that provide this variable. Nonetheless, as an additional sensitivity, we include data from the recent Peoples' Climate Vote Survey (Flynn et al., 2021), which reports the share of population in a given country that answered yes to the question "Do you think climate change is a global emergency?" As there are only 28 countries for which data is available from the published report, the overall number of observations included in the models including the "climate emergency" variable is fairly low.

We report the main results in Figure 3 using regression coefficient plots, which display the regression coefficient as a dot and ranges of 90% confidence intervals (we also report full regression tables for each specification in the Supplementary Material). If the confidence interval does not contain the zero value (marked by the red line), the results are statistically significant at the 10% statistical significance level. This visualization makes it easier to compare results, especially when there is more than one dependent variable. The main difference between the results presented in Figure 3 (A) and Figure 3 (B) is that Figure 3 (B) includes a "climate emergency" variable, with a substantially reduced sample size. By including a "climate emergency" variable, the direction of effect for most of the variables holds, yet many are no longer statistically significant because of the small sample size and thus possibly the lack of adequate variation.

Overall, we see that the effect of state capacity, our main variable of interest, is robust across many different specifications (we also report some alternative specifications, including different control variables, in the Supplementary Material). While we cannot state with certainty that state capacity per se causes some states to be more successful than others at phasing out coal, we do, however, find that countries with higher state capacity are both generally and systematically associated with a higher degree of coal phaseout. Apart from that, there are two other key interesting findings pertaining to the connection between liberalization of the power sector and whether a country has a federal government structure. As expected, countries with a more liberalized power sector seem to have a higher degree of coal phaseout than those without. Finally, for the dependent variable that measures the share of prematurely retired coal capacity, we also observe that countries with independent federal units have generally lower shares of prematurely retired coal capacity.

The main goal of this part of our analysis was to assess whether there is a systematic link between state capacity and the degree of coal phaseout. It is, however, also essential to understand which specific strategies

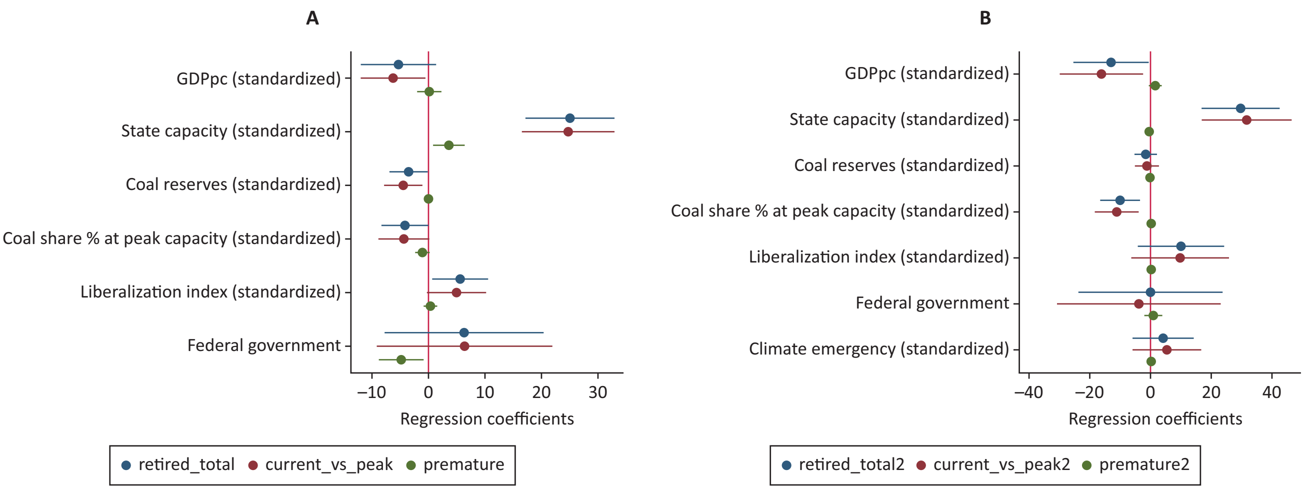

Figure 3. A and B show the results from the main analysis using the three measurements of the degree of coal phase out discussed in the text ("premature," "current versus peak," and "retired total") and standardized independent variables. Figure B show the sensitivities that include the "climate emergency" variable, which substantially reduced the sample size. Note: If the confidence interval does not contain the zero value (marked by the red line), the results are statistically significant at the 10% statistical significance level.

certain states use to overcome vested interests. We explore this part in the following Section 3.2.

3.2. Key Strategies to Prematurely Retire Coal

As the Paris Agreement is a hybrid agreement, in which soft modes of coordination between signatories dominate rather than top-down regulatory mandates (Aykut et al., 2022), it is essential to gain a better understanding of domestic mitigation capacity. Identifying existing strategies to counter vested interests is particularly important in the context of future climate policymaking, as societal transformations toward deep decarbonization are associated with distributive effects across sectors, interest groups, regions, etc. (Mildenberger, 2020; Victor et al., 2019). As well as enabling the quantitative analysis of enablers of premature coal phaseout, the global data from the Global Power Plant Tracker allows the political strategies of state actors that facilitate coal phaseout and counter vested interests to be qualitatively identified. The data allow “actions on the ground” with regard to coal phaseout practices to be explored in different countries and help identify commonalities and differences between different political strategies and approaches. Although Meckling and Nahm’s (2021) notion of strategic state capacity focuses on “advanced industrialized economies” and is based on case studies from France, Germany, the US, and California, we argue that their proposed concept is a good starting point for exploring the development of research designs that allow mitigation capacities to be qualitatively explored, especially in countries and sectors with well-established and strong vested interests.

As in the previous quantitative analysis which, in part, focused on prematurely retired coal power plants, we identified coal-fired power plants and units larger than 100 MW and less than 30 years old. In a first step, we applied these selection criteria to the Global Energy Monitor database and identified 46 cases of prematurely closed coal plants. Figure 4 provides an overview of this selection by plant size in MW and plant age. It shows that China stands out by retiring many small and young units, while several EU countries have retired units between 20 and 30 years old; Germany is an outlier because it has retired some very young and large units. In this section, we attempt to shed more light on these developments and identify patterns of policy coal phaseout strategies based on an exploratory qualitative analysis of the Global Energy Monitor Wiki that provides background information on coal plant closures.

This article cannot provide detailed case studies but aims for an initial exploratory analysis to establish a conceptual differentiation of coal phaseout strategies. Such an approach allows only limited generalization: More in-depth studies and comparative work on premature phaseout decisions are needed in the future. To elicit the major political strategies involved in premature coal phaseout, we applied an exploratory and inductive coding strategy informed by both conceptual considerations from the literature on strategic state capacity and desk research of available information on premature coal phaseouts. We started the analysis by gathering the main reasons and justifications for the premature closure of all 46 units or plants (> 100 MW, < 30 years, based on the Global Energy Monitor Wiki; see the Supplementary Material for more details). Where the Wiki did not provide sufficient details, we extended the desk research to media reporting, announcements by companies, and policy documents. In a next step, we identified key patterns in commonalities and differences in strategies to phase out coal across the findings and—informed by Meckling and Nahm’s terminology on strategic state

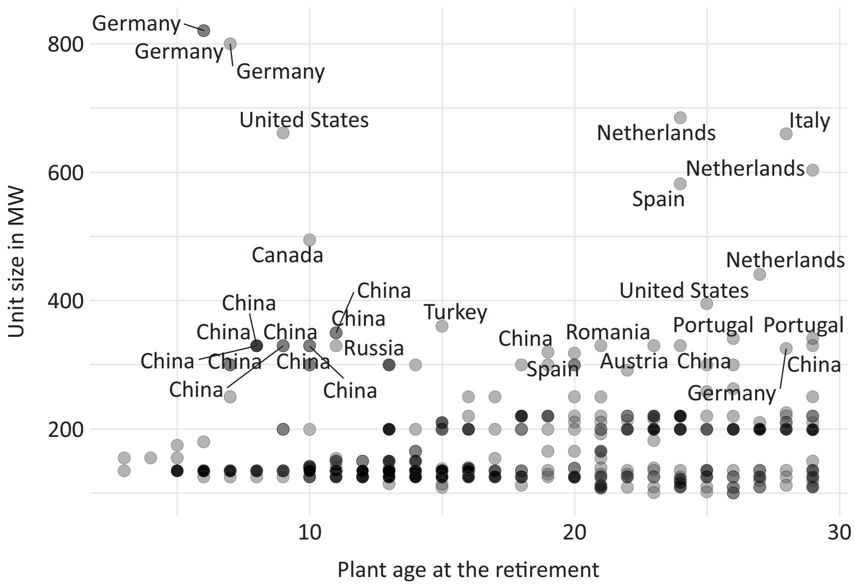

Figure 4. Cases of premature coal power plant retirements based on the data from the Global Energy Monitor (2022). Here we highlight cases where plants larger than 100 MW were retired.

capacity (2021)—developed a conceptual differentiation of strategies we found. After identifying three different illustrative strategies, we did a second round of coding to associate every premature closure with one of the general patterns (see Figure 5, which summarizes all the steps in the process).

Based on our review of 46 prematurely retired units (for a full overview see Supplementary Material, Table S4) we find the following three illustrative political strategies: (a) *rein-in* through top-down regulatory enforcement of environmental, climate, or other regulations that affect the operating license of coal plants; (b) *buy-out* by providing compensation to companies and regions to appease vested interests; and (c) *crowd-out* by accelerating and underpinning existing market and price dynamics in the power sector that crowd out coal. These strategies represent a continuum ranging from top-down direct state intervention to implicit governance of premature phaseout (see Figure 6 for a conceptual overview). The three illustrative patterns do, of course, overlap and should not be thought of as mutually exclusive. Furthermore, it is important to highlight that the strategies are being implemented in complex political and economic environments and that their success depends on many context-specific factors. This exploratory analysis helps to provide a first overview of political strategies and point to relevant questions for future research.

Rein-in is a key strategy for early decommissioning of coal-fired power plants or units. In general, we have observed two distinct sets of regulatory enforcement. First, cases in which operating permits are revoked in the form of administrative decisions by agencies or other government entities due to violations of pollution or other environmental regulations. An example of this is the Weiquiao plant in China where, after a pollution scandal, four units of 1,320 MW were retired after just eight years in operation (Global Energy Monitor, 2021). Another example from China is the Chentangzhuang power station, a seven-year-old coal plant with 600 MW that had to switch to gas because the Tianjin Municipal Government was trying to expand the urban area and improve living conditions (Baidu, 2021). We also found examples of regulatory enforcement of premature coal phaseout in European countries, for example, in the Netherlands, where the government decided to close the Maasvlakte power station (age: 29 years; 603 MW). Although the decision was later revoked by the Dutch consumer and market authority, the company closed the power plant in 2017 due to the issue of new energy efficiency standards with which it was unable to comply (Beall, 2014).

A second pattern we have observed is governments being actively engaged in *buying-out* to appease the interests of companies owning and operating the plants as well as political constituents linked to coal mining. One of the most prominent compensation schemes is being implemented in Germany. Companies received an average compensation per MW of €66.259 (Bundesnetzagentur, 2022). In a newly established auction framework, companies can apply for their plants to be decommissioned. In the first round, two of the youngest coal plants were among the successful bidders (Moorburg, age: 6; 820 MW; and Westfalen, age: 7; 800 MW). German climate and energy politics has long been seen as a frontrunner in deploying renewables while continuing to burn coal; "targeted compensation politics" (Meckling & Nahm, 2021) have now managed to overcome well established vested interests. Compensation has also been paid in the Netherlands for the Hembweg coal plant (age: 25; 685 MW). Following a court ruling (the "Urgenda target"), the Dutch government paid €52.5 million to Vattenfall in exchange for early retirement of the plant (European Commission, 2020; Karagiannopoulos, 2019).

Finally, we identified strategies aiming to instigate and accelerate market dynamics that are increasingly crowding coal out of the power market. Due to the plummeting prices of renewables, many coal plants

Figure 5. Overview of inductive coding strategy and desk research for qualitative analysis of sample of closed coal power plants.

Figure 6. Strategies for premature coal power plant retirement.

are struggling to remain profitable, and companies are deciding to ditch or switch their existing coal infrastructure (Diluiso et al., 2021). Among these early retirements, many plants are being switched over to gas production, and some are being used to burn biomass. In some cases, these developments are being accelerated and supported by government decisions. For example, the Spanish operator of the Litoral de Almer plant (age: 24; 582 MW) made the case that the plant was no longer competitive because of the high cost of CO_2 rights (Edwardes-Evans & Baratti, 2019). The closure was accompanied by Just Transition agreements to "cushion the social consequences of this measure" which the state is involved in (Endesa, 2021). Another example of accelerating market dynamics is the Keephills power station in Canada (age: 10; 495 MW). The owner, TransAlta, decided to switch the plant to gas due to its limited economic viability in the oversupplied Alberta power market and the low power price environment. This decision was taken in the context of regulations to phase out traditional coal-fired electricity by 2030, eliminating all emissions from the power sector by 2035 and an annually increasing federal carbon tax (Climate Action Tracker, 2021).

All of the examples mentioned here would qualify for a detailed case study to analyze the political strategies and economic dynamics in more detail. This cannot be done in this article. Nevertheless, the exploratory analysis of the coal-fired power plants that were closed prematurely shows that different strategies exist to promote the coal phaseout. More detailed research on each of these three illustrative strategies could, in the future, show the extent to which they are context-specific and which aspects are transferable to other countries; this would help further improve the knowledge about the enabling conditions for an early coal phaseout.

4. Conclusion

The phasing out of coal is one of the politically and economically challenging elements in the envisaged societal transformation toward deep decarbonization. The premature retirement of existing coal power plants, as a key element of achieving net zero emissions targets by mid-century, will face substantial obstacles and will be problematic for policymakers—even more so in the context of surging gas prices. The research carried out for this article, based on a mixed-methods approach, contributes to a better understanding of the enabling conditions and political strategies behind premature coal phaseout.

Our analysis makes a number of innovative contributions to the ongoing debates. We show that a general measure of state capacity that goes beyond GDP per capita is a robust predictor for both total and prematurely retired share of coal capacity across a wide variation of political systems and levels of development. Given that China and India both have a relatively high score in terms of state capacity and that recent developments in those countries are following an upward trend, the hope that they will develop and implement goals of downsizing or phasing out coal is a tangible one. The importance of state capacity additionally implies that this is a key contextual factor that needs to be taken into account when strategies from success stories are considered for replication elsewhere.

Our other key contribution pertains to the application of the concept of "strategic state capacity" (Meckling & Nahm, 2021), namely, to strategies concerned with how vested interests can be overcome, with the political challenge of phasing out coal plants prematurely. The inductive approach taken in this research to finding patterns among existing cases of prematurely retired coal power plants shows how important it is to explain not only *why* countries retire power plants but also *how*. The continuum of political strategies from top-down state intervention to implicit and more indirect forms of governing coal phaseouts indicates the variety and context-sensitivity of successful political strategies. Future research should explore questions about which political strategy fits which context, what factors for success can be identified, and what forms of international cooperation help facilitate premature coal phaseout. The very different starting positions with regard to coal phaseout among many developed economies and growing economies such as China and India point to the importance of equity debates. It is to be expected that coal phaseout could, from the political point of view, turn into a highly contested symbol for discussions about historic emissions and current mitigation obligations. These political circumstances will affect the political strategies deployed to phase out coal, and new strategies could emerge. Equity, however, is relevant not only in the context of international climate negotiations and global mitigation efforts under the UNFCCC, but also at the national level. We observe that some countries use elaborate schemes under the heading of "just transition" to pay off companies, political constituencies, and workers, while in other countries, market mechanisms are more prevalent and the state does not become involved. To build further support for climate mitigation across a wide range of actors, it will be crucial to understand which strategies create the least costs for the public and the economy, while being politically robust and effective in achieving premature coal phaseout.

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Conflict of Interests

The authors declare no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

References

Aykut, S., Schenuit, F., Klenke, J., & d'Amico, E. (2022). It's a performance, not an orchestra. Rethinking soft coordination in global climate. *Global Environmental Politics*, *22*(4), 1–24. https://doi.org/10.1162/glep_a_00675

Baidu. (2021). 天津陈塘热电有限公司 [Tianjin Chentang Thermal Power Co., Ltd.]. https://baike.baidu.com/item/天津陈塘热电有限公司

Beall, A. (2014, July 23). Dutch government confirms 2.4GW of coal plants to close by 2017. *Independent Commodity Intelligence Services*. https://www.icis.com/explore/resources/news/2014/07/22/9803678/dutch-government-confirms-2-4gw-of-coal-plants-to-close-by-2017

Blondeel, M., Van de Graaf, T., & Haesebrouck, T. (2020). Moving beyond coal: Exploring and explaining the Powering Past Coal Alliance. *Energy Research & Social Science*, *59*, Article 101304. https://doi.org/10.1016/j.erss.2019.101304

BP. (2021). *Statistical review of world energy*. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Brutschin, E., Cherp, A., & Jewell, J. (2021). Failing the formative phase: The global diffusion of nuclear power is limited by national markets. *Energy Research & Social Science*, *80*, Article 102221. https://doi.org/10.1016/j.erss.2021.102221

Bundesnetzagentur. (2022). *Geplant, beschlossen, umgesetzt* [Planned, decided, implemented]. https://www.bundesnetzagentur.de/DE/Allgemeines/DieBundesnetzagentur/Insight/Texte/Energiewende/Blog2_Energiewende_Kohleausstieg.html

Cingolani, L. (2013). *The state of state capacity: A review of concepts, evidence and measures* (MERIT Working Papers No. 2013–053). United Nations University—Maastricht Economic and Social Research Institute on Innovation and Technology. https://ideas.repec.org/p/unm/unumer/2013053.html

Climate Action Tracker. (2021). *Canada*. https://climateactiontracker.org/countries/canada/policies-action

Cui, R. Y., Hultman, N., Edwards, M. R., He, L., Sen, A., Surana, K., McJeon, H., Iyer, G., Patel, P., Yu, S., Nace, T., & Shearer, C. (2019). Quantifying operational lifetimes for coal power plants under the Paris goals. *Nature Communications*, *10*, Article 4759. https://doi.org/10.1038/s41467-019-12618-3

Diluiso, F., Walk, P., Manych, N., Cerutti, N., Chipiga, V., Workman, A., Ayas, C., Cui, R. Y., Cui, D., Song, K., Banisch, L. A., Moretti, N., Callaghan, M. W., Clarke, L., Creutzig, F., Hilaire, J., Jotzo, F., Kalkuhl, M., Lamb, W. F., . . . Minx, J. C. (2021). Coal transitions—Part 1: A systematic map and review of case study learnings from regional, national, and local coal phase-out experiences. *Environmental Research Letters*, *16*(11), Article 113003. https://doi.org/10.1088/1748-9326/ac1b58

Edwards, M., Cui, R. Y., Bindl, M., Hultman, N., Mathur, K., McJeon, H., Iyer, G., Song, J., & Zhao, A. (2022). Quantifying the regional stranded asset risks from new coal plants under 1.5°C. *Environmental Research Letters*, *17*(2), Article 024029. https://doi.org/10.1088/1748-9326/ac4ec2

Endesa. (2021). *Endesa sets up the assessment table for the international Future-e Litoral project tender*. https://www.endesa.com/en/press/press-room/news/energy-transition/endesa-sets-up-assessment-table-international-future-litoral-project

Edwardes-Evans, H., & Baratti, G. (2019). *Endesa to close entire Iberian coal fleet*. S&P Global Commodity Insights. https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/coal/093019-endesa-to-close-entire-iberian-coal-fleet

Erdogdu, E. (2011). What happened to efficiency in electricity industries after reforms? *Energy Policy*, *39*(10), 6551–6560. https://doi.org/10.1016/j.enpol.2011.07.059

European Commission. (2020, May 12). *State aid: Commission approves compensation for early closure of coal fired power plant in the Netherlands* [Press Release]. https://ec.europa.eu/commission/presscorner/detail/en/ip_20_863

Flynn, C., Yamasumi, E., Fisher, S., Snow, D., Grant, Z., Kirby, M., Browning, P., Rommerskirchen, M., & Russel, I. (2021). *The peoples' climate vote*. United Nations Development Programme. https://www.undp.org/publications/peoples-climate-vote

Global Energy Monitor. (2021). *Weiqiao Aluminum power station*. Global Energy Monitor Wiki. https://gem.wiki/Weiqiao_Aluminum_power_station

Global Energy Monitor. (2022). *Global coal plant tracker* [Data set]. https://globalenergymonitor.org/projects/global-coal-plant-tracker/download-data

Hanson, J. K., & Sigman, R. (2021). Leviathan's latent dimensions: Measuring state capacity for comparative political research. *The Journal of Politics*, *83*(4), 1495–1510. https://doi.org/10.1086/715066

Henisz, W. J. (2017). *The Political Constraint Index (POLCON) dataset (2017 release)* [Data set]. University of Pennsylvania. https://mgmt.wharton.upenn.edu/profile/1327

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Mitigation of climate change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Jakob, M., & Steckel, J. C. (Eds.). (2022). *The political economy of coal: Obstacles to clean energy transitions*. Routledge.

Jakob, M., Steckel, J. C., Jotzo, F., Sovacool, B. K., Cornelsen, L., Chandra, R., Edenhofer, O., Holden, C., Löschel, A., Nace, T., Robins, N., Suedekum, J., & Urpelainen, J. (2020). The future of coal in a carbon-constrained climate. *Nature Climate Change*, *10*(8), 704–707. https://doi.org/10.1038/s41558-020-0866-1

Jewell, J., Vinichenko, V., Nacke, L., & Cherp, A. (2019). Prospects for powering past coal. *Nature Climate Change*, *9*(8), 592–597. https://doi.org/10.1038/s41558-019-0509-6

Karagiannopoulos, L. (2019, March 8). Dutch government tells Vattenfall to shut 650 MW coal plant by end-2019. *Reuters*. https://www.reuters.com/article/us-netherlands-coal-vattenfall/dutch-government-tells-vattenfall-to-shut-650-mw-coal-plant-by-end-2019-idUSKCN1QP1ZI

Lamb, W. F., & Minx, J. C. (2020). The political economy of national climate policy: Architectures of constraint and a typology of countries. *Energy Research & Social Science*, *64*, Article 101429. https://doi.org/10.1016/j.erss.2020.101429

Markard, J., Rinscheid, A., & Widdel, L. (2021). Analyzing transitions through the lens of discourse networks: Coal phase-out in Germany. *Environmental Innovation and Societal Transitions*, *40*, 315–331. https://doi.org/10.1016/j.eist.2021.08.001

Meckling, J., & Nahm, J. (2021). Strategic state capacity: How states counter opposition to climate policy. *Comparative Political Studies*, *55*(3), 493–523. https://doi.org/10.1177/00104140211024308

Mildenberger, M. (2020). *Carbon captured: How business and labor control climate politics*. MIT Press.

Nacke, L., Cherp, A., & Jewell, J. (2022). Phases of fossil fuel decline: Diagnostic framework for policy sequencing and feasible transition pathways in resource dependent regions. *Oxford Open Energy*, *1*, Article oiac002. https://doi.org/10.1093/ooenergy/oiac002

Ni, V., & Sullivan, H. (2021, September 22). 'Big line in the sand': China promises no new coal-fired power projects abroad. *The Guardian*. https://www.theguardian.com/world/2021/sep/22/china-climate-no-new-coal-fired-power-projects-abroad-xi-jinping

Oei, P.-Y., Brauers, H., & Herpich, P. (2020). Lessons from Germany's hard coal mining phase-out: Policies and transition from 1950 to 2018. *Climate Policy*, *20*(8), 963–979. https://doi.org/10.1080/14693062.2019.1688636

Ou, Y., Iyer, G., Clarke, L., Edmonds, J., Fawcett, A. A., Hultman, N., McFarland, J. R., Binsted, M., Cui, R., Fyson, C., Geiges, A., Gonzales-Zuñiga, S., Gidden, M. J., Höhne, N., Jeffery, L., Kuramochi, T., Lewis, J., Meinshausen, M., Nicholls, Z., . . . McJeon, H. (2021). Can updated climate pledges limit warming well below 2°C? *Science*, *374*(6568), 693–695. https://doi.org/10.1126/science.abl8976

Rentier, G., Lelieveldt, H., & Kramer, G. J. (2019). Varieties of coal-fired power phase-out across Europe. *Energy Policy*, *132*, 620–632. https://doi.org/10.1016/j.enpol.2019.05.042

Savoia, A., & Sen, K. (2015). Measurement, evolution, determinants, and consequences of state capacity: A review of recent research. *Journal of Economic Surveys*, *29*(3), 441–458. https://doi.org/10.1111/joes.12065

Spencer, T., Colombier, M., Sartor, O., Garg, A., Tiwari, V., Burton, J., Caetano, T., Green, F., Teng, F., & Wiseman, J. (2018). The 1.5°C target and coal sector transition: At the limits of societal feasibility. *Climate Policy*, *18*(3), 335–351. https://doi.org/10.1080/14693062.2017.1386540

Steckel, J. C., & Jakob, M. (2021). The political economy of coal: Lessons learnt from 15 country case studies. *World Development Perspectives*, *24*, Article 100368. https://doi.org/10.1016/j.wdp.2021.100368

Tong, D., Zhang, Q., Zheng, Y., Caldeira, K., Shearer, C., Hong, C., Qin, Y., & Davis, S. J. (2019). Committed emissions from existing energy infrastructure jeopardize 1.5 °C climate target. *Nature*, *572*(7769), 373–377. https://doi.org/10.1038/s41586-019-1364-3

Turnheim, B., & Geels, F. W. (2012). Regime destabilisation as the flipside of energy transitions: Lessons from the history of the British coal industry (1913–1997). *Energy Policy*, *50*, 35–49. https://doi.org/10.1016/j.enpol.2012.04.060

United Nations Framework Convention on Climate Change. (2021). *Decision 1/CP.26*. https://unfccc.int/sites/default/files/resource/Overarching_decision_1-CP-26_0.pdf

Urpelainen, J., & Yang, J. (2019). Global patterns of power sector reform, 1982–2013. *Energy Strategy Reviews*, *23*, 152–162. https://doi.org/10.1016/j.esr.2018.12.001

Victor, D. G., Geels, F. W., & Sharpe, S. (2019). *Accelerating the low carbon transition: The case for stronger, more targeted and coordinated international action*. The Brookings Institution. https://www.brookings.edu/wp-content/uploads/2019/12/Coordinatedactionreport.pdf

Vinichenko, V., Cherp, A., & Jewell, J. (2021). *Historically unprecedented coal and gas decline in Asia, OECD, Russia and Middle East in 1.5°C scenarios*. Manuscript submitted for publication.

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Article

Closing the Implementation Gap: Obstacles in Reaching Net-Zero Pledges in the EU and Germany

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Abstract
The European Union and Germany have recently committed themselves to greenhouse-gas neutrality by 2050 and 2045, respectively. This substantially reduces their *gaps in ambition* to the Paris climate goals. However, the current climate policy mix is not sufficient to reach these targets: There is a major *implementation gap*. Based on economic, legal, and political science perspectives, this article identifies key obstacles in legislating stringent climate policy instruments and making them effective. Using a simple framework, we map the stage of the process in which the obstacles are at work. Moreover, we discuss the potential effectiveness of a select list of prominent drivers of climate-related regulation in overcoming said obstacles and conclude by pointing towards conditions for closing the implementation gap. In doing so, we focus on the current legislative processes of the "Fit-for-55" package by the European Commission and the 2021 Federal Climate Change Act in Germany. Our analysis builds on the extant literature, and we suggest avenues for further research.

Keywords
ambition gap; climate policy; European Union; Germany; implementation gap

Issue
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1. Introduction

The world is currently heading towards well above 2°C warming by 2100 (Intergovernmental Panel on Climate Change [IPCC], in press-a; Sognnaes et al., 2021), which indicates the failure of the Paris Agreement. The reason for this can be broken down into two deficiencies of climate-related regulation: the *ambition gap* and the *implementation gap*. The ambition gap is defined in relation to the carbon budget implied by the 1.5°-to-well-below-2.0°C corridor set by the Paris Agreement (Friedlingstein et al., 2022). Thus, the gap is essentially an incongruity between the agreed-upon goal and states' emission reduction pledges in the form of nationally determined contributions (NDCs). The adoption of net-zero emission targets by several countries has sparked hopes that the ambition gap is shrinking (Meinshausen et al., 2022).

Much less attention has been devoted to the implementation gap which is the subject of this article. Echoing the new emphasis on the implementation gap in the IPCC's Working Group III summary for policymakers (IPCC, in press-b), which defines this gap as the difference between implemented policies and NDCs, we argue that the bottom-up elements of the Paris Agreement require shifting the attention to this gap and zooming in on the conditions for closing it. In what follows, implementation refers to what is required to move from a jurisdiction's respective abatement target to the target being met. Hence, it includes the policy-formulation stage as far as it concerns climate policy instruments aiming to bring emissions in line with the climate targets adopted but not the process of adopting the targets. We define the implementation gap as the difference between a jurisdiction's targeted reduction path and the actual and projected reductions achieved with the current set of climate policy instruments (policy outcome). We subdivide the implementation gap into two components: First, the stringency of policy outputs might not be in line with the targets, and second, policy outputs fail to fully translate into the intended policy outcomes. The implementation gap thus captures insufficient stringency as well as limitations arising from counterproductive interactions and imperfect enforcement of concrete sets of policy instruments put in place to achieve a jurisdiction's abatement targets. Recent quantitative assessments indicate that the magnitude of the implementation gap is substantial (IPCC, in press-b; Liu & Raftery, 2021; REN21, 2021).

The EU and Germany have seen major increases in mitigation ambition since 2020. The new European Commission (EC) has pledged greenhouse-gas (GHG) neutrality by 2050, a 55% reduction in GHG emissions by 2030, and has announced the European Green Deal as its key transformation narrative and policy framework. In July 2021, the EC presented a set of legal initiatives to overhaul the entire set of climate policy instruments making them "Fit for 55," i.e., the 55% reduction target (Schlacke et al., 2022). In light of the new EU targets, a historic ruling by its constitutional court, and the upcoming federal elections, Germany raised its ambition in 2021 to GHG neutrality by 2045.

One might be tempted to conclude that committing to these targets will induce the required mitigation efforts. The fundamental transformation of production processes, infrastructure, and lifestyles requires stringent climate-policy instruments. Several concerns motivate the focus on the obstacles to closing the implementation gap. First, only part of the implementation gap is due to recent increases in ambition. Current policies are also insufficient to meet the previous, less ambitious targets (Edenhofer et al., 2021). Second, the recent rise in energy prices spurred severe opposition both to the "Fit for 55" proposal (van Gaal, 2021) as well as key existing policies such as the EU Emission Trading System (ETS; Morawiecki, 2022). Third, governance mechanisms might be insufficient (Knodt et al., 2021). Fourth, current emission trajectories and government assessments confirm the relevance of the implementation gap. Emissions in Germany have risen substantially from 2021 to 2022, including a 17% increase in emissions from coal-fired power plants with sector targets in housing and transport being missed (Federal Environment Agency & German Federal Ministry for Economic Affairs and Climate Action, 2022). In January 2022, the German government stated that "the speed of climate action must nearly triple" (Federal Ministry for Economic Affairs and Climate Action, 2022, p. 1) to achieve the adopted targets.

After presenting a conceptual framework that decomposes the implementation gap into two main components and helps structure our analysis in Section 2, we zoom in on the implementation gap in the EU and Germany and explore key obstacles to closing it in Section 3. In Section 4, we assess how effective a select list of prominent drivers of climate-related regulation is in overcoming these obstacles. Along the way, we suggest avenues for further research.

2. Conceptual Framework

The process of moving from a formalized abatement target to actually cutting emissions in line with said target involves several steps and many intertwining threads. Each thread typically involves at least one policymaking process where a climate policy instrument is (re-)designed and legislated. The new or revised instrument then impacts current and future emissions by directly and indirectly creating incentives for consumers and producers to change behaviors and technologies. The impact on emissions qualitatively and quantitatively depends on the design of the instrument, its interactions with other instruments, enforcement, and the economic, political, and cultural context.

We contribute by identifying different obstacles that interfere with this process and locating them within this two-step model of the climate-target implementation process (Section 3). First, we focus on obstacles that hamper the policy-formulation process, from target-setting to specific policy *output*. The policy-formulation process is represented by the left-hand side in Figure 1. Examples of such obstacles are the salience of distributional conflicts, ill-defined, scattered, or overlapping competencies, and capacity constraints in the face of holistic reforms (Section 3.1). Second, we investigate what reduces the effectiveness of existing climate policy instruments (Knill et al., 2012) focusing on the processes from policy output to policy *outcome* (Cairney et al., 2019), e.g., counter-productive interactions with other instruments and lack of enforcement (Section 3.2). Policy effectiveness occupies the right-hand side of Figure 1. Finally, we probe the ability of a select list of potential drivers to overcome these obstacles. With the conceptual framework, we aim at providing a helpful way to both organize existing empirical evidence as well as identify areas for future research to better understand the challenges faced when closing the implementation gap. Using the EU and Germany as examples, we explore the ongoing and crucial phase of moving from ambitious new climate targets to actually decarbonizing our societies.

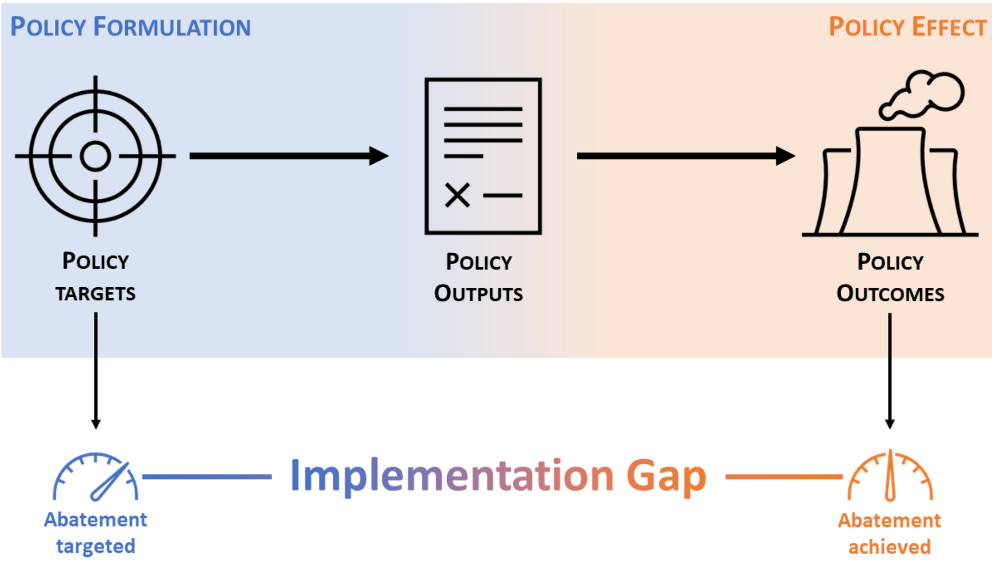

Figure 1. Conceptual illustration of the implementation gap.

3. What Impedes Implementation of Climate Targets?

The obstacles in implementing climate targets are rooted in the diversity of sources of GHG emissions. The production or consumption of most goods and services currently involve GHG emissions either directly or indirectly. The new net-zero paradigm highlights that all processes need to completely decarbonize, compensate the residuals with carbon dioxide removal, or stop happening. Given the multitude of sources and processes emitting GHG, from burning fossil fuels in power plants, passenger cars, production processes in the heavy and chemical industries, agriculture, and many more, it is a widely held tenet that no single regulatory instrument will suffice. Their scope is limited by jurisdictions, technologies, sectors, and the response patterns of actors. In contrast to defining an overarching climate target that encompasses all emitters irrespective of their type and location, implementation needs to tackle the complexity and diversity on the ground. In this section, we investigate obstacles to closing the implementation gap effectively at different stages of the process.

3.1. Obstacles to the Policy-Formulation Process

The first set of obstacles interferes with the implementation of climate targets primarily, but not necessarily exclusively, during the policy-formulation process, i.e., the (re-)designing and legislating of climate policy instruments.

3.1.1. Coordination of Interventions

The heterogeneity of sources, sectors, and sites currently emitting GHGs implies that no single legislative body in the EU or Germany bears exclusive responsibility for implementing climate targets and that for each legislative body or government, several policy fields and departments are involved, respectively. Hence, both external and internal coordination is required for closing the implementation gap.

At the EU level, the European Climate Law (Regulation of 30 June 2021, 2021) sets overall reduction targets for GHG emissions. They are allocated to three clusters of sectors each with its own regulatory framework. These frameworks are the ETS, covering energy and industry; the Effort Sharing Regulation (ESR; Regulation of 30 May 2018, 2018), spanning transport, buildings, non-ETS industry, and waste; and the Land Use, Land Use Change, and Forestry Regulation (LULUCF). There is some flexibility between these frameworks, as removal credits from LULUCF and, for nine member states, ETS allowances can be used to some extent for compliance under the ESR. Internally, the regulatory frameworks follow different principles of how reduction efforts are spread between member states and individual emitters. While the ETS relies on the market to coordinate the allocation of reduction efforts, the ESR sets reduction goals for each member state and delegates implementation to national governments. In the past, the two regulatory approaches coexisted at the EU level without much interference as they covered different sectors. However, the Fit-for-55 package proposes a second ETS for ESR sectors while maintaining the national targets of the ESR. How the two regulatory approaches would interact depends on the details of their final design and is a question for further research.

The different regulatory approaches at the EU level also imply that the vertical coordination between the EU and member states differs for the ETS and ESR sectors. For ETS sectors, the carbon market directly involves individual emitting installations. Member states are therefore tasked with administering the ETS and should otherwise focus on addressing obstacles that interfere with the efficiency of the carbon market or alleviating undesirable distributional consequences. In practice, however, the market-based approach of the ETS is supplemented by additional interventions targeting emissions at the member-state level as we illustrate in the case of Germany.

On a national level, Germany sets overall reduction targets in its Federal Climate Change Act (FCCA) and defines annual carbon budgets for six sectors. For ESR sectors, such as housing and transport, national sector targets are the first step towards implementation. For ETS sectors, e.g., energy and industry, their role is less obvious. The explanatory memorandum to the FCCA states that, in ETS sectors, targets ensure the contribution of non-ETS installations that are part of these sectors (Deutscher Bundestag, 2019, p. 19). This is in line with the total GHG emissions of ETS installations being determined at the EU level by the number of emission allowances issued. However, the German Coal Phaseout Act legislated in 2020 was justified by arguing that the ETS cannot guarantee that FCCA targets for the energy sector are met (Deutscher Bundestag, 2020, pp. 4–5, 178). Hence, a cornerstone of German climate policy is motivated by a perceived conflict between a key EU climate policy instrument and national abatement targets. We elaborate on the interactions created between these overlapping climate policies in Section 3.2.1.

3.1.2. Salience of Burdens and Conflicts

The choice, design, stringency, and mix of climate policy instruments determine who is going to bear the burden of the transition. From an economic perspective, target setting focuses on balancing the total costs with total benefits. The policy-formulation process focuses on spreading the costs across different groups. Costs refer both to monetary and non-monetary burdens. The latter include right infringements, changes in lifestyles or consumption patterns, the displeasure of facing a wind turbine or transmission line in one's backyard, and trade-offs with other policy areas such as nature protection and the efforts to reduce unemployment and poverty. Interest groups will do their best in fending off burdens by lobbying for different or weaker interventions (Cory et al., 2021; Meng & Rode, 2019). Solving distributional conflicts at the policy-formulation stage might hence be the core challenge of climate policy (Aklin & Mildenberger, 2020).

The recent surge in energy prices, mainly driven by increases in gas and coal prices, has intensified the debate over how much (extra) burden companies and consumers should bear. Germany introduced a carbon price for fuels used outside the ETS in 2021. Its level and trajectory have been found to be insufficient even for Germany's old climate targets set in 2014 (Edenhofer et al., 2021). Nevertheless, the coalition agreement of the new government explicitly refrains from raising prices for social reasons in light of rising energy bills (Koalitionsvertrag, 2021, p. 63), and in response to the war against Ukraine, measures have been adopted to shield consumers and companies from increasing energy prices. The latter reduces the incentives to reduce fuel use and hence emissions. At the EU level, high energy and emission allowance prices have sparked heated debates over both price management in the ETS (Khan, 2021; Morawiecki, 2022) as well as the Fit-for-55 package more generally (van Gaal, 2021). There is an emerging debate on whether redistributing the revenues raised by carbon pricing increases support for this instrument (Mildenberger et al., 2022; Sommer et al., 2022).

The more ambitious the climate targets, the faster and more fundamental the change processes that are required to achieve them. Deep change intensifies the distributional challenge faced when organizing majorities for climate policies: Assets get stranded and business models and careers become obsolete while new ones emerge. Institutions determine the actors and interests represented in decision-making and thus play a crucial role in moderating conflicts, creating new narratives, providing credible commitments, and transferring resources between stakeholders (Meckling & Nahm, 2022). However, research on the role of institutions in climate policymaking is still in its infancy (Dubash et al., 2021) and further conceptual and empirical work is needed.

3.1.3. Passing Along Responsibility: Multilevel Climate Politics in the EU

Given that the implementation of climate targets involves policymakers at multiple levels such as the EU, national, state, and local bodies (Rayner & Jordan, 2016), and that implementation induces distributional conflicts, there are clear incentives to pass along unpopular decisions. At the same time, policymakers try to retain or gain power over resources deemed crucial for their respective constituencies. We illustrate this struggle regarding the location of political responsibilities.

For the EU, legal competencies vary substantially across different climate and energy-relevant policy fields. (Re-)interpreting competencies in and of itself is quite often part of the policy-formulation process (Rayner et al., in press). The Climate and Energy Package 2030 adopted in 2018, for example, advanced the integration of climate and energy policies (Skjærseth, 2021). This was met by fears of infringements on national sovereignty. With net-zero being established as a new "organizing principle" of climate policymaking (Schenuit et al., 2021), member states' concerns about sovereignty have been extended, e.g., to forest or agricultural policy.

The set of policies the EU can choose from is not only influenced by actual competencies. There is a long history of politically motivated "red lines" that inhibited the use of certain policy instruments. One prominent example is the failed carbon tax, a victim of the general aversion in some member states to allowing the

EU to levy taxes (Convery, 2009). Despite shared environmental competencies as laid out in Articles 192 and 194 of the Treaty on the Functioning of the European Union (TFEU), intergovernmentalism still plays a key role in EU climate policymaking (Dupont & Oberthür, 2016). Most prominently, heads of states and governments manage to keep control over the overall climate targets. They successfully requested an EU-wide, instead of member-state specific, 2050 net-zero target, and the European Council communicated the minus 55% target for 2030 to the United Nations Framework Convention on Climate Change (UNFCCC) before official trilogue negotiations with the European Parliament had been finalized. Until now, the so-called Visegrád Group (i.e., Poland, Hungary, Slovakia, and the Czech Republic) has been quite successful in shaping EU legislation (Ćetković & Buzogány, 2019); however, without "harder" soft governance, the EU risks missing its "55" targets (Knodt et al., 2021) by passing responsibility to close the gap in the policy-formulation process back and forth between national governments and the EU. In light of the Russian invasion of Ukraine, the new importance of energy security also pointed to the sovereignty of member states over their energy mix and related political conflicts that have shaped EU energy policy well before the crisis (Szulecki et al., 2016). How the new security dimension of the EU Green Deal will affect the practice of passing along responsibility and the implementation gap remains to be seen.

Germany, with the highest GHG emissions and a large dependence on Russian gas, is of particular importance in the processes described. But also in this federal state, responsibility is shifted along. The power of legislation in the field of climate protection lies at the national level and is subject to concurrent legislation. With the adoption of the FCCA in 2019, the national government has exercised this competence. The FCCA allows the federal states to legislate themselves (Köck & Kohlrausch, 2021) but does not contain any provisions coordinating the efforts between the national and the state level, raising doubts about the coherence of the various reduction targets (Wickel, 2021). Ten out of 16 states have adopted climate laws that differ in their ambition and content (Wickel, 2022).

The FCCA and some state acts limit themselves to setting a framework and reduction targets, planning instruments, and guiding internal affairs of the administration. Hence, they constitute a stepping-stone of the policy-formulation process, but to close the implementation gap further legislative and administrative decisions are required. Legislative authority for the relevant sectors is divided between national- and state-level: Important legislative powers in energy, emission control, and transport rest with the national government; for the building sector, they are divided between the national and state levels (Fuo et al., 2022); for local infrastructures, they rest with the states. Moreover, state laws in general and national laws in most cases are executed by the states. Local affairs are governed by the municipalities, in particular decisions concerning land use. In the absence of binding guidelines and targets, successful coordination is much less likely and incentives to pass along responsibility prevail. Research on how to achieve better coordination and joint responsibility of all policymakers involved is desirable.

3.1.4. Complexity: Potential Benefits and Risks of "Holistic" Reform

Related challenges for closing the gap in the policy-formulation process are the complexity of legislative procedures, new linkages between policy fields, and the politics inscribed in the envisaged deep decarbonization in the EU (Dupont et al., 2020; Skjærseth, 2021). The Green Deal was accompanied by substantial communication efforts from the EC emphasizing the positive aspects and "holistic character" of the EU's new growth strategy and hiding the manifold substantive trade-offs.

The 16 legislative and strategic proposals of the Fit-for-55 package span many policy domains, each with its own path-dependency, actor constellations, political alliances, and legal competencies (Rayner et al., in press). They include revisions of the three main pillars of EU climate policy (ETS, ESR, LULUCF Regulation). Already these comprised many different actors and varying political alliances—and required complex package deals during their adoption. The new linkages to other policy fields, e.g., those between the LULUCF Regulation and the Common Agriculture Policy, add new interests, positions, and alliances (Schenuit & Geden, in press) and with those, complexity. Although wide-ranging reforms are inevitable in closing the implementation gap and key to effective coordination, risks stemming from a "holistic approach" need to be taken into account.

A key constraint is limited resources. Each legislative initiative requires a substantial amount of attention from members of the European Parliament, national lawmakers, environmental NGOs, journalists, business associations, and other stakeholders. Given that even the EC's resources are stretched to the limit (Guillot, 2021), the impact on effective exclusion of less well-staffed actors is even more pronounced than in less demanding times. This overload leads to transparency and participation problems. In the flood of strategy documents and legislative proposals, it is not only challenging for stakeholders to identify critical points but also hard to make oneself heard. While EU institutions and domestic administrations and policymakers are key actors in enacting policies, it is not only their legislative overburden that could impede implementation. Limitations in stakeholder capacities to deal with complex sets of reform initiatives also create risk. First, important problems and loopholes might remain unnoticed by stakeholders, directly affecting the quality of the policy output. Second, the sidelining of some stakeholders might undermine the legitimacy and acceptability of the policies. In general, initiatives like the EU Green Deal are promising tools to achieve deep decarbonization, which inevitably requires linkages and coordination between policy fields. However, they also incorporate risks, as political liability and accountability can easily be diffused and the burden on lawmakers and stakeholders can become excessive. This can only be avoided by stretching the process over time and by prior capacity building. In turn, this conflicts with the urgency of closing the implementation gap. How to best strike a balance between these conflicting objectives requires further research.

3.1.5. Clash of Ideologies

Political ideology could contribute to the implementation gap by impeding the policy-formulation process both directly and indirectly by making it harder to resolve distributional or coordination conflicts. There is anecdotal evidence around specific policy failures at least partially attributed to ideology (Rosenow & Eyre, 2016). Related evidence backs the hypothesis that ideology matters in policy-formulation processes. First, specific forms of energy production tend to have a clear "political home," as do specific climate policy instruments (Kulin et al., 2021; Mildenberger et al., 2022; Ziegler, 2017). In the climate-cum-energy realm, three ideologically different transition strategies have been identified: state-centred, market-centred, and grassroots-centred (Thonig et al., 2020). Second, ideologies and environmental values have been shown to shape voters' preferences over policy instruments (McCright et al., 2016; Sommer et al., 2022).

It is difficult to assess whether ideology is actually shaping policy-formulation processes to a significant extent, as it is not easy to distinguish it from interest-group politics (Carter & Little, 2021) and the framing of policy instruments (Clarke et al., 2015; Stecula & Merkley, 2019). Furthermore, partisan ideologies are a notoriously moving target (Carter & Little, 2021). The yet limited empirical research in this area suggests that ideology has a rather small role on policy ambition (Thonig et al., 2020), but may indeed have an influence on the policy-formulation process stage (Abban & Hasan, 2021; Gromet et al., 2013). Whether this influence is *causal* remains a question for future research.

3.2. Obstacles to the Impact of Climate-Policy Instruments

The second set of obstacles interferes with closing the implementation gap primarily, but not necessarily exclusively, during the process of turning policy outputs into outcomes, i.e., emissions reductions. The link between policies formulated and emissions abated might be less than perfect because either the instruments do not work as intended or they are not enforced properly.

3.2.1. Counter-Productive Interactions Between Instruments

Emission impacts of overlapping instruments are typically not additive. In particular, the ETS and other climate policies such as coal phaseouts, renewable support, and energy-efficiency measures interact in complex and sometimes counterproductive ways (Willner & Perino, 2022). Both the extent and direction of interaction are determined by details of the overlapping policy and the ETS. In 2019, the Market Stability Reserve (MSR) was introduced into the ETS to "enhance synergy with other climate and energy policies" (Decision of 6 October 2015, 2015, p. 2). The MSR achieves this only for overlapping policies that induce abatement early on. Interventions that allow market participants to anticipate additional abatement several years in advance (e.g., coal phaseouts) can even increase total emissions. It therefore creates an environment that substantially complicates the creation of a coherent and effective climate policy mix. The Fit-for-55 package contains provisions that amplify both the productive and the counterproductive interaction effects (Perino et al., in press). Overall, this makes it less likely that the impact of individual measures can be tracked and that in total they sum up to the ambitious reduction targets. While first quantifications of these interactions exist (Bruninx & Ovaere, 2022), empirical evidence in particular would be welcome.

The German coal phaseout is a prominent example: In a stepwise process, Germany forces coal and lignite plants out of the market by 2038, with emissions from these plants already being subject to the decreasing cap of the ETS. In 2018, the ETS was adjusted in two ways to ensure that overlapping policies have an impact on overall emissions: The MSR now automatically cancels part of the allowances freed up by overlapping policies, and member states were granted the right to cancel allowances unilaterally to support mandated coal phaseouts (Directive of 14 March 2018, 2018, Art. 12(4)). While automatic cancellations render coal phaseouts partially effective, they reduce the effectiveness of unilateral cancellations (Gerlagh & Heijmans, 2019). The German Coal Phaseout Act explicitly refers to both provisions and cancels allowances, taking the impact of the MSR into account. The government recently commissioned two independent reports to learn what that means in practice.

3.2.2. Compliance, Enforcement, and the Limits of Soft Governance

Enforcement of policy outputs is a crucial prerequisite for them to translate into actual emission reductions. Enforcement can be hampered by a lack of competencies or inadequate procedures and efforts. The EU's lack of competencies affects the implementation of the GHG target somewhat and that of the renewable and energy-efficiency targets substantially. The reason is that member states retain the sovereignty to at least broadly determine their own energy mixes, and interfering requires unanimous votes in the Council. Given the current heterogeneity in priorities across member states, this is highly unlikely to occur. As far as emission targets of the ESR and the ETS are concerned, they constitute forms of hard governance that can be enforced, e.g., based on Articles 8 and 9 of the ESR (Peeters & Athanasiadou, 2020). National sovereignty is protected in Article 192(2) of the TFEU only to the extent that measures significantly affecting a member state's choice between different energy sources and the general structure of its energy supply require unanimous votes. For the renewable and efficiency targets, the constraint is more restrictive (TFEU, Art. 194(4)). In the Regulation on the Governance of the Energy Union (Regulation of 11 December 2018, 2018), the EU, therefore, resorts to "soft governance" measures to induce member states to comply with the renewable and efficiency targets. However, there are severe concerns that the tools available will not be sufficient to deliver (Knodt et al., 2021). The proposed strengthening of the renewable and efficiency targets as part of the REPowerEU (European Commission, 2022) in light of the war against Ukraine increases the tension between the EU's ambition and ability to enforce it.

Even in areas where competencies are well defined, policies might not induce the intended emission reductions. Distributional conflicts, complexity, and coordination failures increase the likelihood of ambiguities and loopholes in the legal text (see, e.g., Romppanen, 2020). The incentive to file lawsuits increases in the size of both the stakes involved and loopholes and ambiguities in the law. The salience of conflicts could also result in incentives to invest insufficient effort in monitoring and enforcement. Moreover, the more drastic the measures taken, the more likely are disproportionate infringements on the basic rights of those affected. In Germany, constitutional law requires all state entities to pursue the goals of the FCCA, i.e., compliance with the temperature goals of the Paris Agreement (The Federal Constitutional Court, 2021, 2022). At the same time, the constitution sets limits on mitigation measures, e.g., the fundamental right of property. This constrains how the renovation of the building stock and the phase-out of fossil fuels can be induced. Typically, the proportionality of measures must be ensured through financial compensation, raising the fiscal costs of closing the implementation gap.

4. Which Drivers Help Close the Implementation Gap?

Next, we revisit a select list of drivers of climate-related regulation and assess whether they are effective in closing the implementation gap.

4.1. Climate Protests

The climate protest movement gained massive momentum in 2019. With their focus on protest events organized around major political events such as UNFCCC Conferences of the Parties (COPs) or elections, Fridays for Future helped target adjustment (Siddi, 2021). The movement has not been equally effective in reducing the implementation gap, yet. This is at least partially intended, as the ambition gap has clear priority for the movement and diverging views about details of implementation may likely risk cohesion of the group. There is evidence of such heterogeneity in the movement (Bugden, 2020; Huttunen, 2021; Marquardt, 2020). Furthermore, the Covid-19 pandemic was a severe setback for the protest movement (Haßler et al., 2021), and even the pre-Covid-19 momentum may have been close to maximum capacity (Jarke-Neuert et al., 2021). In sum, it seems that the climate protest movement as it stands is not a major force in closing the implementation gap. However, new strategies could be taken up to more effectively exert pressure to overcome the salience of the burdens (Section 3.1.2) associated with implementation and to hold all levels of government accountable (Section 3.1.3; Pohlmann et al., 2021). Empirical evidence on the movement's impact on specific instruments is still missing.

4.2. Climate Litigation

Another driver pushing towards effective climate-related regulation is climate litigation in favor of decarbonization (Zengerling et al., 2021). For about two decades, there has been a rise in lawsuits against governments, administrations, and companies that seek to enhance creation, design, and enforcement of climate law on various scales (Setzer & Higham, 2021). While some of the recent climate cases, for example, the Urgenda case and the Climate Case Ireland, have targeted the ambition gap, climate litigation also has significant potential to contribute to closing the implementation gap. For example, in April 2021 the German Federal Constitutional Court issued a landmark climate ruling in response to four constitutional complaints which had been brought by individuals and NGOs (The Federal Constitutional Court, 2021, 2022). Complainants had challenged the target and the design of the German 2019 FCCA, especially in regard to its effective implementation. Their winning argument was that the FCCA does not sufficiently specify the emission reduction pathway from 2031 onwards. The decision had two key effects on the implementation gap. As an immediate consequence of the ruling, the German government enacted a revised version of the FCCA which is significantly more precise in its emission reduction pathway beyond 2031. Breaking down the long-term targets into annual sub-targets is a first step in framing tailored climate policies. In addition, and arguably groundbreaking, the court decision established a new fundamental right to climate protection in interpreting the German constitution in an innovative way (Callies, 2021). This new fundamental right paves the way for a new generation of climate litigation in Germany and has great potential to contribute to closing implementation gaps.

It significantly strengthens the constitutional basis for framing legal arguments on the admissibility, as well as on the merits, of climate cases against the national and state governments as well as private companies (Deutsche Umwelthilfe, 2022). Future research should assess how much it contributes to enforcement (Section 3.2.2) and the policy formulation process (Section 3.1).

4.3. Knowledge Production and Scientific Advice

There is wide consensus on the science of climate change (IPCC, in press-a). While targets are always political rather than purely scientific objects (Livingston & Rummukainen, 2020), scientists, by and large, have rallied behind the Paris targets and adjusted their research agendas accordingly (Hänsel et al., 2020; Tollefson, 2021). There is widespread agreement that achieving the 1.5°C target requires reaching net-zero carbon emissions around the middle of this century which, for example, implies phasing out ("unabated") coal power (COP26, 2021). However, whether coal should be replaced by renewables or nuclear or cleaned up with carbon capture and storage is disputed in both science and politics as the recent debate over the EU taxonomy has highlighted. Expert advice on instrument choice and design is also heterogeneous (European Association of Environmental and Resource Economists, 2019; Rosenbloom et al., 2020; van den Bergh & Botzen, 2020). Instruments differ in the distribution of control, economic costs and benefits, and blame and glory between actors and groups within societies, and hence directly contribute to raising the salience of burdens (Section 3.1.2). Stakeholders tend to support instruments that minimize their own burden, and jointly with scientific experts form "instrument constituencies" (Simons & Voß, 2018) advocating for certain modes of governance. At the same time, scientific expertise is crucial in designing instruments that are effective in reducing emissions, i.e., by avoiding counter-productive interactions within the regulatory landscape (Section 3.2.1). The combination of insights from different disciplines and types of expertise into a comprehensive assessment of climate policy mixes and communication of it to policymakers remains a challenge for the scientific community.

4.4. UN Climate Governance

The Paris Agreement has been an important driver in raising climate policy ambitions in the EU—and vice versa (Oberthür & Groen, 2017). However, in terms of implementation, it is much less effective. This is, to a significant extent, by design. The compliance mechanism of the Paris Agreement is only "facilitative" and "non-punitive," and the enforcement branch established under the Kyoto Protocol was not maintained (Paris Agreement, Art. 15; Voigt, 2016). The transparency framework tasked to "promote effective implementation" also explicitly restricts its role to be "facilitative" and "respectful of national sovereignty, and [to] avoid placing undue burden on Parties" (Paris Agreement, Art. 13). In practice, the principle of "naming and shaming" meant to provide incentives for both raising ambitions and implementing NDCs has turned into "claiming and shining" where countries showcase punctual successes and specific critique is rare (Aykut et al., in press).

5. Conclusions

The world is currently heading towards the failure of the Paris Agreement. We have identified the implementation gap as the key reason and argue in favor of shifting attention to this gap and zooming in on the conditions for closing it.

Our contribution in this respect is threefold. First, we offer a conceptual framework that helps researchers and policymakers fix ideas on the implementation gap. Second, we highlight a set of generic obstacles for closing this gap from economic, legal, and political science perspectives and locate them in the "upstream" policy-formulation and the "downstream" policy-effect legs, respectively. We believe this aids in focusing efforts on closing the gap. Third, we discuss the potential effectiveness of a selected list of prominent drivers of climate-related regulation in overcoming the obstacles.

Overall, we arrive at the following assessment: Closing the implementation gap under the voluntary architecture of the Paris Agreement requires voters and interest groups to place continuous pressure on governments at all levels not only to set and stick to abatement pledges but to put effective climate policy instruments in place. Litigation might play an important role in keeping governments on track even if polls or vested interests urge them to take it easy. Furthermore, the quality of the social and institutional fabric of our societies will be crucial in moderating inevitable distributional, ideological, and responsibility conflicts. Better understanding the role of formal and informal institutions as facilitators—or obstacles—in transformation processes and the role of the (social) sciences themselves, are important avenues for future research.

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Conflict of Interests

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References

Abban, A. R., & Hasan, M. Z. (2021). Revisiting the determinants of renewable energy investment: New evidence from political and government ideology. *Energy Policy*, *151*, Article 112184.

Aklin, M., & Mildenberger, M. (2020). Prisoners of the wrong dilemma: Why distributive conflict, not collective action, characterizes the politics of climate change. *Global Environmental Politics*, *20*(4), 4–27.

Aykut, S., Schenuit, F., d'Amico, E., & Klenke, J. (in press). It's a performance, not an orchestra! Rethinking soft coordination in global climate governance. *Global Environmental Politics*.

Bruninx, K., & Ovaere, M. (2022). Covid-19, Green Deal and recovery plan permanently change emissions and prices in EU ETS Phase IV. *Nature Communications*, *13*(1), Article 1165. https://doi.org/10.1038/s41467-022-28398-2

Bugden, D. (2020). Does climate protest work? Partisanship, protest, and sentiment pools. *Socius: Sociological Research for a Dynamic World*, *6*. https://doi.org/10.1177/2378023120925949

Cairney, P., Heikkila, T., & Wood, M. (2019). *Making policy in a complex world*. Cambridge University Press.

Callies, C. (2021). Das "Klimaurteil" des Bundesverfassungsgerichts: „Versubjektivierung" des Art. 20aGG? [The "Climate Ruling" of the Federal Constitutional Court: "Subjectification" of Article 20aGG?]. *Zeitschrift für Umweltrecht*, *6*, 355–357.

Carter, N., & Little, C. (2021). Party competition on climate policy: The roles of interest groups, ideology and challenger parties in the UK and Ireland. *International Political Science Review*, *42*(1), 16–32.

Ćetković, S., & Buzogány, A. (2019). The political economy of EU climate and energy policies in Central and Eastern Europe revisited: Shifting coalitions and prospects for clean energy transitions. *Politics and Governance*, *7*(1), 124–138.

Clarke, C. E., Hart, P. S., Schuldt, J. P., Evensen, D. T., Boudet, H. S., Jacquet, J. B., & Stedman, R. C. (2015). Public opinion on energy development: The interplay of issue framing, top-of-mind associations, and political ideology. *Energy Policy*, *81*, 131–140.

Convery, F. J. (2009). Origins and development of the EU ETS. *Environmental and Resource Economics*, *43*(3), 391–412.

COP26. (2021). *The Glasgow Climate Pact*. https://unfccc.int/documents/310475

Cory, J., Lerner, M., & Osgood, I. (2021). Supply chain linkages and the extended carbon coalition. *American Journal of Political Science*, *65*(1), 69–87.

Decision (EU) 2015/1814 of the European Parliament and of the Council of 6 October 2015 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and amending Directive 2003/87/EC (2015). *Official Journal of the European Union*, L 264.

Deutsche Umwelthilfe. (2022). *Wir klagen für mehr Klimaschutz* [We are suing for more climate protection]. https://www.duh.de/klimaklagen

Deutscher Bundestag. (2019). *Entwurf eines Gesetzes zur Einführung eines Bundes-Klimaschutzgesetzes und zur Änderung weiterer Vorschriften* (Bundestagsdrucksache 19/14337) [Draft law for the introduction of a Federal Climate Change Act and amendment of further rules].

Deutscher Bundestag. (2020). *Entwurf eines Gesetzes zur Reduzierung und zur Beendigung der Kohleverstromung und zur Änderung weiterer Gesetze (Kohleausstiegsgesetz)* (Bundestagsdrucksache 19/17342) [Draft law for the reduction and termination of coal-based power generation and amendment of further rules (Coal Phaseout Act)].

Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814 (2018). *Official Journal of the European Union*, L 76.

Dubash, N. K., Pillai, A. V., Flachsland, C., Harrison, K., Hochstetler, K., Lockwood, M., MacNeil, R., Mildenberger, M., Paterson, M., Teng, F., & Tyler, E. (2021). National climate institutions complement targets and policies. *Science*, *374*(6568), 690–693. https://doi.org/10.1126/science.abm1157

Dupont, C., & Oberthür, S. (2016). While EU institutions and domestic administration and policymakers are key actors in enacting policies, it is not only their legislative overburden that poses a risk. In R. K. W. Wurzel, J. Connelly, & D. Liefferink (Eds.), *The European Union in international climate change politics: Still taking a lead?* (pp. 66–79). Routledge.

Dupont, C., Oberthür, S., & von Homeyer, I. (2020). The Covid-19 crisis: A critical juncture for EU climate policy development? *Journal of European Integration*, *42*(8), 1095–1110.

Edenhofer, O., Franks, M., & Kalkuhl, M. (2021). Pigou in the 21st century: A tribute on the occasion of the 100th anniversary of the publication of *The Economics of Welfare*. *International Tax and Public Finance*, *28*(5), 1090–1121.

European Association of Environmental and Resource Economists. (2019). *Economists' statement on carbon pricing*. https://www.eaere.org/statement

European Commission. (2022). *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions REPowerEU: Joint European Action for more affordable, secure and sustainable energy* (COM/2022/108 final).

Federal Environment Agency, & German Federal Ministry for Economic Affairs and Climate Action. (2022, March 15). *Treibhausgasemissionen stiegen 2021 um 4,5 Prozent* [Greenhouse gas emissions up 4.5 per cent in 2021] [Press release]. https://www.umweltbundesamt.de/presse/pressemitteilungen/treibhausgasemissionen-stiegen-2021-um-45-prozent

Federal Ministry for Economic Affairs and Climate Action. (2022). *Germany's current climate action status*. https://www.bmwi.de/Redaktion/EN/Downloads/E/germany-s-current-climate-action-status.pdf

Friedlingstein, P., Jones, M. W., O'Sullivan, M., Andrew, R. M., Bakker, D. C. E., Hauck, J., Le Quéré, C., Peters, G. P., Peters, W., Pongratz, J., Sitch, S., Canadell, J. G., Ciais, P., Jackson, R. B., Alin, S. R., Anthoni, P., Bates, N. R., Becker, M., Bellouin, N., . . . Zeng, J. (2022). Global carbon budget 2021. *Earth System Science Data*, *14*(4), 1917–2005. https://doi.org/10.5194/essd-14-1917-2022

Fuo, O., Zengerling, C., & Sotto, D. (2022). A comparative legal analysis of urban climate mitigation and adaptation in the building sector in Brazil, Germany, and South Africa. *Climate Law*, *12*(1), 32–97.

Gerlagh, R., & Heijmans, R. J. (2019). Climate-conscious consumers and the buy, bank, burn program. *Nature Climate Change*, *9*(6), 431–433.

Gromet, D. M., Kunreuther, H., & Larrick, R. P. (2013). Political ideology affects energy-efficiency attitudes and choices. *Proceedings of the National Academy of Sciences*, *110*(23), 9314–9319.

Guillot, L. (2021, June 25). Eurocrats burn out under "insane" Green Deal workload. *Politico*. https://www.politico.eu/article/european-commission-green-deal-staff-burnout-workload

Hänsel, M. C., Drupp, M. A., Johansson, D. J. A., Nesje, F., Azar, C., Freeman, M. C., Groom, B., & Sterner, T. (2020). Climate economics support for the UN climate targets. *Nature Climate Change*, *10*, 781–789. https://doi.org/10.1038/s41558-020-0833-x

Haßler, J., Wurst, A.-K., Jungblut, M., & Schlosser, K. (2021). Influence of the pandemic lockdown on Fridays for Future's hashtag activism. *New Media & Society*. Advance online publication. https://doi.org/10.1177%2F14614448211026575

Huttunen, J. (2021). Young rebels who do not want a revolution: The non-participatory preferences of Fridays for Future activists in Finland. *Frontiers in Political Science*, *3*, Article 672362.

Intergovernmental Panel on Climate Change. (in press-a). *Climate change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Intergovernmental Panel on Climate Change. (in press-b). *Climate change 2022: Mitigation of climate change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Jarke-Neuert, J., Perino, G., & Schwickert, H. (2021). *Free-riding for future: Field experimental evidence of strategic substitutability in climate protest*. ArXiv. https://doi.org/10.48550/arXiv.2112.09478

Khan, M. (2021, December 17). EU leaders battle over carbon price as energy costs soar. *Financial Times*. https://www.ft.com/content/eefea72d-0441-4edf-9d56-2e4d835cd4dc

Knill, C., Schulze, K., & Tosun, J. (2012). Regulatory policy outputs and impacts: Exploring a complex relationship. *Regulation & Governance*, *6*(4), 427–444.

Knodt, M., Müller, R., Schlacke, S., & Ringel, M. (2021). (Un)Fit for 55! Ohne eine verschärfte Governance-Verordnung sind die Klimaziele 2030 nicht zu erreichen [(Un)Fit for 55! Without tightened governance regulation, the 2030 climate targets cannot be achieved]. *integration*, *44*(4), 287–300.

Koalitionsvertrag. (2021). *Mehr Fortschritt wagen: Bündnis für Freiheit, Gerechtigkeit und Nachhaltigkeit* [Dare more progress: Alliance for freedom, justice and sustainability]. https://www.bundesregierung.de/breg-de/service/gesetzesvorhaben/koalitionsvertrag-2021-1990800

Köck, W., & Kohlrausch, L. (2021). Klimaschutzgesetzgebung im Bundesstaat—Zur Zukunft der Landesklimaschutzgesetze [Climate protection legislation in the federal state: On the future of state climate protection legislation]. *Zeitschrift für Umweltrecht*, *2021*(11), 610–617.

Kulin, J., Sevä, I. J., & Dunlap, R. E. (2021). Nationalist ideology, rightwing populism, and public views about climate change in Europe. *Environmental Politics*, *30*(7), 1111–1134.

Liu, P. R., & Raftery, A. E. (2021). Country-based rate of emissions reductions should increase by 80% beyond nationally determined contributions to meet the 2°C target. *Communications Earth & Environment*, *2*(1), Article 29.

Livingston, J. E., & Rummukainen, M. (2020). Taking science by surprise: The knowledge politics of the IPCC Special Report on 1.5 degrees. *Environmental Science & Policy*, *112*, 10–16.

Marquardt, J. (2020). Fridays for Future's disruptive potential: An inconvenient youth between moderate and radical ideas. *Frontiers in Communication*, *5*, Article 48.

McCright, A. M., Dunlap, R. E., & Marquart-Pyatt, S. T. (2016). Political ideology and views about climate change in the European Union. *Environmental Politics*, *25*(2), 338–358.

Meckling, J., & Nahm, J. (2022). Strategic state capacity: How states counter opposition to climate policy. *Comparative Political Studies*, *55*(3), 493–523.

Meinshausen, M., Lewis, J., McGlade, C., Gütschow, J., Nicholls, Z., Burdon, R., Cozzi, L., & Hackmann, B. (2022). Realization of Paris Agreement pledges may limit warming just below 2 °C. *Nature*, *604*(7905), 304–309. https://doi.org/10.1038/s41586-022-04553-z

Meng, K. C., & Rode, A. (2019). The social cost of lobbying over climate policy. *Nature Climate Change*, *9*(6), 472–476.

Mildenberger, M., Lachapelle, E., Harrison, K., & Stadelmann-Steffen, I. (2022). Limited impacts of carbon tax rebate programmes on public support for carbon pricing. *Nature Climate Change*, *12*, 141–147.

Morawiecki, M. (2022, January 3). PM Morawiecki: The EU ETS system driven by speculators must be reformed. *EURACTIV*. https://www.euractiv.com/section/emissions-trading-scheme/opinion/pm-morawiecki-the-eu-ets-system-driven-by-speculators-must-be-reformed

Oberthür, S., & Groen, L. (2017). The European Union and the Paris Agreement: Leader, mediator, or bystander? *Wiley Interdisciplinary Reviews: Climate Change*, *8*(1), Article e445.

Peeters, M., & Athanasiadou, N. (2020). The continued effort sharing approach in EU climate law: Binding targets, challenging enforcement? *Review of European, Comparative & International Environmental Law*, *29*, 201–211.

Perino, G., Willner, M., Quemin, S., & Pahle, M. (in press). Policy Brief—The EU ETS Market Stability Reserve: Does it stabilize or destabilize the market? *Review of Environmental Economics and Policy*.

Pohlmann, A., Walz, K., Engels, A., Aykut, S. C., Altstaedt, S., Colell, A., Dietrich, U., Feddersen, H., Friedrich, A., Klenke, J., Krieger, F., Schenuit, F., Datchoua-Tirvaudey, A., Schulz, M., & Zengerling, C. (2021). It's not enough to be right! The climate crisis, power, and the climate movement. *GAIA—Ecological Perspectives for Science and Society*, *30*(4), 231–236. https://doi.org/10.14512/gaia.30.4.5

Rayner, T., & Jordan, A. (2016). Climate change policy in the European Union. In H. von Storch (Ed.), *Oxford research encyclopedia of climate science*. https://doi.org/10.1093/acrefore/9780190228620.013.47

Rayner, T., Szulecki, K., Jordan, A., & Oberthür, S. (Eds.). (in press). *Handbook on European Union climate change policy and politics*. Edward Elgar.

Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013 (2018). *Official Journal of the European Union*, L 156.

Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council (2018). *Official Journal of the European Union*, L 328.

Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') (2021). *Official Journal of the European Union*, L 243.

REN21. (2021). *Renewables 2021: Global status report*. https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf

Romppanen, S. (2020). The LULUCF regulation: The new role of land and forests in the EU climate and policy framework. *Journal of Energy & Natural Resources Law*, *38*, 261–287.

Rosenbloom, D., Markard, J., Geels, F. W., & Fuenfschilling, L. (2020). Opinion: Why carbon pricing is not sufficient to mitigate climate change—And how "sustainability transition policy" can help. *Proceedings of the National Academy of Sciences*, *117*(16), 8664–8668.

Rosenow, J., & Eyre, N. (2016). A postmortem of the Green Deal: Austerity, energy efficiency, and failure in British energy policy. *Energy Research & Social Science*, *21*, 141–144.

Schenuit, F., & Geden, O. (in press). Carbon dioxide removal: Climbing up the EU climate policy agenda. In T. Rayner & K. Szulecki (Eds.), *Handbook on European Union climate change policy and politics*. Edward Elgar.

Schenuit, F., Colvin, R., Fridahl, M., McMullin, B., Reisinger, A., Sanchez, D. L., Smith, S. M., Torvanger, A., Wreford, A., & Geden, O. (2021). Carbon dioxide removal policy in the making: Assessing developments in 9 OECD cases. *Frontiers in Climate*, *3*, Article 638805. https://doi.org/10.3389/fclim.2021.638805

Schlacke, S., Wentzien, H., Thierjung, E. M., & Köster, M. (2022). Implementing the EU Climate Law via the "Fit for 55" package. *Oxford Open Energy*. Advance online publication. https://doi.org/10.1093/ooenergy/oiab002

Setzer, J., & Higham, C. (2021). *Global trends in climate litigation: 2021 snapshot*. Grantham Research Institute on Climate Change and the Environment; Centre for Climate Change Economics and Policy. https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/

2021/07/Global-trends-in-climate-change-litigation_2021-snapshot.pdf

Siddi, M. (2021). Coping with turbulence: EU negotiations on the 2030 and 2050 climate targets. *Politics and Governance*, *9*(3), 327–336.

Simons, A., & Voß, J.-P. (2018). The concept of instrument constituencies: Accounting for dynamics and practices of knowing governance. *Policy and Society*, *37*(1), 14–35.

Skjærseth, J. B. (2021). Towards a European Green Deal: The evolution of EU climate and energy policy mixes. *International Environmental Agreements: Politics, Law and Economics*, *21*(1), 25–41.

Sognnaes, I., Gambhir, A., van de Ven, D.-J., Nikas, A., Anger-Kraavi, A., Bui, H., Campagnolo, L., Delpiazzo, E., Doukas, H., Giarola, S., Grant, N., Hawkes, A., Köberle, A. C., Kolpakov, A., Mittal, S., Moreno, J., Perdana, S., Rogelj, J., Vielle, M., & Peters, G. P. (2021). A multi-model analysis of long-term emissions and warming implications of current mitigation efforts. *Nature Climate Change*, *11*(12), 1055–1062. https://doi.org/10.1038/s41558-021-01206-3

Sommer, S., Mattauch, L., & Pahle, M. (2022). Supporting carbon taxes: The role of fairness. *Ecological Economics*, *195*, Article 107359.

Stecula, D. A., & Merkley, E. (2019). Framing climate change: Economics, ideology, and uncertainty in American news media content from 1988 to 2014. *Frontiers in Communication*, *4*, Article 6. https://doi.org/10.3389/fcomm.2019.00006

Szulecki, K., Fischer, S., Gullberg, A. T., & Sartor, O. (2016). Shaping the "Energy Union": Between national positions and governance innovation in EU energy and climate policy. *Climate Policy*, *16*(5), 548–567.

The Federal Constitutional Court. (2021). *Beschluss des Ersten Senats vom 24. März 2021* (1 BvR 2656/18) [Order of the First Senate of 24 March 2021]. http://www.bverfg.de/e/rs20210324_1bvr265618en.html

The Federal Constitutional Court. (2022). *Beschluss der 1. Kammer des Ersten Senats vom 18. Januar 2022* (1 BvR 1565/21) [Order of the Federal Constitutional Court, 1st Chamber of the First Senate of 18th January 2022] http://www.bverfg.de/e/rk20220118_1bvr156521.html

Thonig, R., Del Río, P., Kiefer, C., Lázaro Touza, L., Escribano, G., Lechón, Y., Späth, L., Wolf, I., & Lilliestam, J. (2020). Does ideology influence the ambition level of climate and renewable energy policy? Insights from four European countries. *Energy Sources, Part B: Economics, Planning, and Policy*, *16*(1), 4–22. https://doi.org/10.1080/15567249.2020.1811806

Tollefson, J. (2021). Top climate scientists are skeptical that nations will rein in global warming. *Nature*, *599*(7883), 22–24.

Treaty on the Functioning of the European Union (Consolidated version), 2012.

van den Bergh, J., & Botzen, W. (2020). Low-carbon transition is improbable without carbon pricing. *Proceedings of the National Academy of Sciences*, *117*(38), 23219–23220.

van Gaal, W. (2021, December 21). Poland threatens to veto EU's Fit for 55. *EUobserver*. https://euobserver.com/climate/153877

Voigt, C. (2016). The compliance and implementation mechanism of the Paris Agreement. *Review of European, Comparative & International Environmental Law*, *25*(2), 161–173.

Wickel, M. (2021). Das Bundes-Klimaschutzgesetz und seine rechtlichen Auswirkungen [The Federal Climate Protection Act and its legal implications]. *Zeitschrift für Umweltrecht*, *2021*(6), 332–339.

Wickel, M. (2022). Klimaschutz—und Energiegesetze der Länder [State climate protection and energy laws]. In M. Ludwigs (Ed.), *Berliner Kommentar zum Energierecht, Band 3: Energieumwelt—und Energieeffizienzrecht, Energieanlagenrecht* [Berlin commentary on energy law, volume 3: Energy environment and energy efficiency law, energy system law] (pp. 512–588). Recht und Wirtschaft.

Willner, M., & Perino, G. (2022). Beyond control: Policy incoherence of the EU emissions trading system. *Politics and Governance*, *10*(1), 256–264.

Zengerling, C., Aykut, S., Wiener, A., & Wickel, M. (2021). Climate litigation. In D. Stammer, A. Engels, J. Marotzke, E. Gresse, C. Hedemann, & J. Petzold (Eds.), *Hamburg climate futures outlook 2021: Assessing the plausibility of deep decarbonization by 2050*. Cluster of Excellence Climate, Climatic Change, and Society.

Ziegler, A. (2017). Political orientation, environmental values, and climate change beliefs and attitudes: An empirical cross-country analysis. *Energy Economics*, *63*, 144–153.

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Article

Climate Policy Ambition: Exploring A Policy Density Perspective

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Abstract
National policy ambition plays a central role in climate change governance under the Paris Agreement and is now a focus of rapidly emerging literature. In this contribution, we argue that policy ambition can be captured by the level of national policy activity, which in accordance with the existing literature should be referred to as "policy density." In this study, we measure climate policy density by drawing on three publicly available databases. All three measurements show an upward trend in the adoption of climate policy. However, our empirical comparison also reveals differences between the measurements with regard to the degree of policy expansion and sectoral coverage, which are due to differences in the type of policies in the databases. For the first time, we compare the patterns of policy density within each database (2000–2019) and reveal that while they are different, they are nonetheless potentially complementary. Since the choice of the database and the resulting measurement of policy density ultimately depend on the questions posed by researchers, we conclude by discussing whether some questions are better answered by some measurements than others.

Keywords
climate policy; policy density; policy instruments; policy outputs

Issue
This article is part of the issue "Exploring Climate Policy Ambition" edited by Elina Brutschin (International Institute for Applied Systems Analysis) and Marina Andrijevic (International Institute for Applied Systems Analysis).

1. Introduction

Two recent developments in climate politics have moved national climate policies and their "ambition" into the limelight. First, the entry into force of the Paris Agreement in 2015 meant that the nationally determined contributions are defined as the main mechanism for discerning a country's level of climate ambition. After 2015, state-level actors in general and national governments in particular have played an even more important role in steering climate governance (Jordan & Huitema, 2014a, 2014b; Tobin, 2017).

Second, because of NGOs and social movements such as Fridays for Future, policymakers are under more political pressure to increase the ambition level of national policies (Jordan et al., 2022; Little, 2020). These actors do not only protest for more ambitious climate action but also resort to other means such as climate change litigation. A particularly prominent case is the lawsuit filed against the oil company Shell by Friends of the Earth Netherlands and six other Dutch NGOs. Likewise, in 2021, Fridays for Future appealed to Germany's Constitutional Court with the goal of exerting pressure on policymakers to take more ambitious climate action. In both cases, the courts ruled in favour of the plaintiffs and asked for more ambitious national action.

While there is agreement that climate policy refers to policy measures (adopted by the legislature or the executive; e.g., Fankhauser et al., 2016) that aim at limiting or reducing greenhouse gas (GHG) emissions (Iacobuta et al., 2018; MacNeil, 2021), somewhat surprisingly, academics and practitioners lack a shared understanding of what "climate policy ambition" means. From a conceptua viewpoint, many policy analysts would equate the "level of ambition" with the "stringency" (Knill et al., 2012) of the policy measures adopted. In the case of climate policy, this means an assessment of how rapidly and/or firmly they are expected to facilitate GHG reductions (Schaffrin et al., 2015; Tobin, 2017).

However, it is widely acknowledged that gathering such data is difficult in practical terms, especially when it covers many countries and extends over long periods of time. So, what alternatives exist to measure climate policy ambition? A proposal put forth by Knill et al. (2012) and adopted in the literature on climate policy (see, e.g., Eskander & Fankhauser, 2020; Le Quéré et al., 2020; Schaffrin et al., 2015) is to equate ambition with "policy density" (that is, the number of policies or policy instruments). In this article, we suggest that measurements based on the notion of policy density can be constructed based on existing databases that include information on policies and/or policy instruments.

In the remainder of this article, we concentrate on three of the most well-known and authoritative extant databases: the Climate Change Laws of the World database (CCLW), produced by the Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Science (Townshend et al., 2011b); the Climate Policy Database (CPD) published by the NewClimate Institute (2022); and the Policies and Measures Database (PMD), provided by the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA). The overall question we aim to explore is: How complementary are the different density measurements that can be derived from the different datasets? In the sections that follow, we first clarify how each database conceives of "policy," then identify the data in each that is most relevant to "density," and extract that data from each database. Then we explore what patterns are revealed for the period 2000–2019. The final section concludes and identifies future research needs.

2. Climate Policy Ambition: A Density Approach

In our understanding, climate policy ambition does not refer to individual policy instruments such as emission reduction regulations but to "bundles" or "portfolios" of policy goals, laws, and policy instruments as the research on policy design has highlighted (see Howlett & Mukherjee, 2014). One way to make sense of these bundles is to relate them to the concepts of policy density and policy stringency as put forth by Knill et al. (2012). Conceptually, policy density captures the policy activity level and internal differentiation of a policy field in terms of the policy instruments it comprises. To operationalize this concept, Knill et al. (2012) rely on the number of policies or instruments.

By contrast, policy stringency captures the degree to which the policy instruments adopted require target groups to change their behaviour. For example, providing subsidies for electric vehicles constrains the individuals' behaviour to a lesser degree than making the purchase of electric vehicles mandatory. The second dimension of policy stringency refers to the scope of a policy. To come back to the previous example, governments could make the purchase of electric vehicles mandatory in all cases or only for a subset such as brand-new ones. In the first case, the policy instrument would be stricter than in the latter. This coding was applied to climate policy by Schaffrin et al. (2015), for example. Another approach to assess climate policies' stringency is to evaluate to what degree they contain durability and flexibility devices, which prevent policies from being dismantled and simultaneously enable adjustments in case of changes in circumstances (Jordan & Moore, 2022).

With both policy density and stringency, information on all relevant policies and policy instruments can then be used to construct aggregate-level measurements of policy ambition. The measurements can be constructed to capture the number of policy instruments at one point in time or an accumulated number. The latter corresponds to a measurement of the total policy stock as it changes over a given period of time.

Policy density and policy stringency are interrelated measurements (Schaffrin et al., 2015). Policy stringency cannot be assessed if no policies or policy instruments are adopted. From this perspective, in comparison to policy density, policy stringency provides a more granular measurement of climate policy ambition. However, a key issue—which has both significant theoretical and empirical implications—is whether such granularity is always absolutely necessary given the relative difficulty of collecting reliable data.

In this article, we concentrate on climate policy density as one way of measuring climate policy ambition. A government's willingness to address climate change is reflected by policy activity. Thus, in our understanding, the higher the policy density (i.e., the greater the number of policy measures in place) the higher the level of climate ambition.

Clearly, policy density is an indicator of climate ambition. Depending on the operationalization approach and the databases used, we could obtain different empirical measures of climate policy ambition, which could lead to different conclusions when used for analytical purposes or deriving policy prescriptions. Therefore, in this article we provide a comparative assessment of the patterns of policy density revealed by different databases.

3. Climate Policy Databases

In this section, we summarise three popular climate policy databases. Furthermore, we compare the empirical data contained within each in order to set the stage for the construction of our policy density measurements.

3.1. The Climate Change Laws of the World Database

The CCLW database comprises national-level climate change acts from 1947 until 2021 for 197 countries plus the European Union. As of 2020, the database included 1,801 laws on climate change mitigation. The collection of climate legislation originates from a collaboration between the Grantham Research Institute on Climate Change and the Environment and GLOBE International with the aim to help legislators transform a set of agreed legislative principles on climate change into nationally appropriate legislation (Townshend et al., 2011a). Different authors have used it to evaluate global progress in adopting climate policies (Averchenkova & Bassi, 2016; Dubash et al., 2013; Iacobuta et al., 2018; Mehryar & Surminski, 2021; N. M. Schmidt & Fleig, 2018; Townshend et al., 2011b, 2013), to understand the political economy of passing climate laws (Eskander & Fankhauser, 2020; Fankhauser et al., 2016) and/or to identify good practice in climate change governance (Averchenkova et al., 2017).

The CCLW database collects climate laws mostly from official sources such as government websites, parliamentary records, and court documents with the aim of being as comprehensive as possible (Grantham Research Institute on Climate Change and the Environment, 2022). The selection of policies is limited to legal documents adopted by decision-making bodies. This coding decision has the advantage that the database comprises climate policy outputs only. From a methodological viewpoint, this entails that the individual data points are homogenous and therefore comparable across countries and over time. Therefore, this dataset lends itself to assessing both policy dynamics and global patterns of climate policy.

A limitation is that it covers only climate laws which are still in force. Although the database was recently modified to provide the history of law—including its amendments–repealed laws are excluded (Eskander & Fankhauser, 2020; Grantham Research Institute on Climate Change and the Environment, 2022). In fact, this particular coding decision has an important consequence for the temporal dynamics of the data provided by the CCLW database since it only captures the expansion of climate policy but not its dismantling, which is, however, a potentially important form of policy change (Burns & Tobin, 2020; Jordan et al., 2013).

3.2. The Climate Policy Database

The CPD comprises data on national climate change mitigation policy and is collected by the NewClimate Institute, supported by PBL Netherlands Environmental Assessment Agency and Wageningen University and Research (NewClimate Institute, 2022). The database was originally compiled to track policy adoption and detect gaps in climate policy (Nascimento et al., 2022). Several authors have used it to analyze patterns of climate policy adoption (Iacobuta et al., 2018) and the impact of mitigation policies on GHG emissions (Fekete et al., 2021; Giarola et al., 2021; Roelfsema et al., 2018, 2020).

The database is composed of data retrieved from a large number of sources, including Climate Watch, the IEA/IRENA Policy Database, and the CCLW (NewClimate Institute, 2022). The latest release was published in 2020 and includes 4,924 mitigation policies for 196 countries covering an observation period from 1927 to 2020 (i.e., nearly three times as many policies compared to the CCLW in the same observation period). The data is most complete for the G20 countries (NewClimate Institute, 2022), which one could see as a limitation, at least at first glance. However, the G20 countries account for the lion's share of global GHG emissions and, therefore, giving priority to this group is plausible.

Although there is still a large share of missing years for repealed policies, the database, by construction, provides information on the year of adoption as well as the year in which a policy measure ended. The latter is particularly important for investment programs and financial instruments that typically run for a fixed period of time. This not only facilitates measuring policy density comprehensively over time but also gauging the extent of policy dismantling (and therefore a reduction in policy density).

One major limitation is that it does not further define what types of policy it includes. Therefore, it is not possible to differentiate between binding laws or non-binding acts without additionally coding manually the information provided by the corresponding short description (Iacobuta et al., 2018).

3.3. The Policies and Measures Database

The PMD brings together a collection of mostly energy-related climate policy measures. It is assembled and maintained by the IEA and the IRENA (IEA, 2022). The database as it exists today is the result of a long-standing collection effort dating back to 1999, drawn from various other databases and information provided by national governments and partner organizations and analyses carried out by the IEA and IRENA. The data included in the database is periodically reviewed by the national governments (IEA, 2022). The database was originally developed to provide policy data for scenario analyses in the *World Energy Outlook*, the IEA's flagship publication (IEA, 2021). Today, it offers an established data source for studies focusing on decarbonization-related policy measures (Le Quéré et al., 2019; Wang & Chen, 2019). It has also been used to address more specific research questions such as the outcomes of renewable energy incentives (Bölük & Kaplan, 2022), the clean energy transition (Müller et al., 2021), and the diffusion of renewable energy policies (Baldwin et al., 2019). The data coverage of the PMD is similar to that of the CPD since it also comprises both binding formal laws and additional policy measures and programs of which some are also of a voluntary character.

The main advantage of the PMD is that it provides the most homogenous set of climate policy measures because of its focus on the energy sector. In addition, it provides detailed information on the type of instruments comprising a given policy, which allows a more fine-grained evaluation of policy instrument mixes.

A limitation compared to the other databases is that the PMD comprises information on mitigation policies only. Furthermore, while the database provides information on the current status of a policy measure (i.e., whether it is still in force or not), it does not list the year in which a policy ended, which also hampers the empirical assessment of policy dismantling.

3.4. The Climate Policy Databases: A Comparison

Table 1 gives an overview of the three databases, which can be used to construct different kinds of policy indicators. We contend that all are suitable for constructing a density-based indicator of climate policy ambition. However, of the three, only the CPD contains information on the year in which a policy measure was dismantled. It is important to have access to an additional database that includes this information because the CCLW and the PMD do not allow for identifying when a given policy was terminated. By checking the correlation between the three climate policy density indicators, we will be able to determine to what extent the operationalization approach of the CCLW and PMD could result in overestimating the level of climate policy ambition.

In addition to the points discussed above, Table 1 reveals that the coverage of sectors varies across the databases as does the coverage of policy instruments; both are of interest when constructing a density-based measurement. The CCLW differentiates between the greatest number of sectors, whereas the CPD offers the most granular coding of climate policy measures. The PMD differs in that it explicitly focuses on the energy sector coverage.

4. A Comparison of Policy Density Derived From the Databases

To construct the density measurements, we cumulate the number of policies countries adopted in a given year over time. Our sample comprises 44 countries that are members of the Organization for Economic Cooperation and Development (OECD) together with Brazil, Russia, India, Indonesia, China, and South Africa. We chose the OECD countries as a comparatively homogeneous group of industrialized countries with large CO_2 emissions and for which there is good data availability. Brazil, Russia, India, Indonesia, China, and South Africa have been added to incorporate countries with rising CO_2 emissions. We compare our policy density measurements for the time period from 2000 to 2019. The first measurement of policy density in 2000 includes the number of policies adopted between 1927 (the first year the databases report a climate policy) and 1999 to incorporate previous policy activity. The measurements constructed based on the CCLW and the PMD are limited to policy expansion as these databases do not provide information on the year policies stopped being in force. The measurement based on the CPD also includes information on policies dismantled during the observation period, i.e., policies repealed in a year t are removed from the density measurement in year $t + 1$.

4.1. General Measurements of Climate Policy Density

Together, the measurements are based on yearly data for the 44 countries, which equals 880 observations and corresponds to the *N* reported in Table 2. The descriptive statistics suggest that major differences exist between the CCLW on the one hand and the CPD and the PMD on the other. In particular, the larger values for the mean and median for the CPD and the PMD measurements indicate that a greater number of climate policies are covered by the latter two databases. This can be explained by the CCLW's focus on formal policymaking and its outputs. Unlike the other two databases, it covers only entire climate laws, not single policy instruments and programmes. The US has the highest density scores in 2019 based on the CPD and the PMD (equalling 366 and 245, respectively), whereas the score is highest for Spain in 2019 based on the CCLW (equalling 33). When comparing the CPD and the PMD, the two times larger median values for the PMD are striking in comparison to nearly equal means, which points towards a strong presence of outliers in the CPD.

Figure 1 illustrates the values of the three policy density measures and shows how they changed between 2000 and 2019. Figure S1 in the Supplementary File offers insights into the mean policy density. Figures S3 to S13 present the density measurements for each country. The median number of policies has increased steadily for all three measurements despite having started with different absolute levels in 2000. The CPD derived measurement shows a sharp increase in 2009, but the measurements constructed by using the CPD and the PMD data are more similar concerning their slope as well as in relation to their distribution over time. The density measurement based on the CCLW data produces a curve that is much flatter than for the previous two.

Despite the similarities between the CPD and the PMD data, the differences may arise from the fact that the CPD-derived measurement incorporates repealed policies. To assess to what extent this explanation may account for the curve of the CPD measurement it appears useful to compare the number of adopted and dismantled policies per year.

As Figure 2 reveals, the number of new policies adopted exceeds the number of repealed policies, and this holds true across the entire observation period. Nevertheless, this finding must be read with caution since the CPD provides the years in which policies were

Table 1. Overview of the three databases.

Database	CCLW	CPD	IEA PMD
Overview	Climate-change related laws collected from official sources, such as government websites, parliamentary records, and court documents	Climate policies compiled from official sources and several other climate policy databases	Mostly energy-related climate policies and measures, compiled from data supplied by member governments, partner organizations, and IEA's own analysis; Governments may review the database periodically
Countries studied	197, including the European Union as a cluster	196	195
Scope	All national-level legislation and executive orders on climate change mitigation, adaptation, damage, and loss or disaster risk management	Climate change policies adopted by the end of 2020 by the G20 economies and non-comprehensive policy data for the rest of the countries. Also provides non-comprehensive data on the subnational level	Government outputs to reduce GHG emissions, improve energy efficiency, and support the development and deployment of renewables and other clean energy technologies, at national, state/provincial, city/municipal, and international levels
Time period	Date of adoption and date of amendment	Date of adoption, date of amendment, and end date of implementation	Year entered into force
Policy objective	Mitigation and adaptation	Mitigation and adaptation	Mitigation
Sectoral coverage	Agriculture; Land Use, Land-Use Change and Forestry (LULUCF); Buildings, Residential and Commercial; Energy; Health; Industry; Public Sector; Transport; Waste; Water; Economy-wide	Agriculture and Forestry; Buildings; Electricity and Heat; Industry; Transport; General (Economy-wide)	Agriculture; Buildings; Electricity and Heat; Industry own use; Manufacturing; Transport; Economy-wide; (based on authors' own aggregation of categories)
Policy instruments	Direct investment; Economic; Governance; Information; Regulation	Barrier removal; Climate strategy; Economy instruments; Information and Education; Policy support; Regulatory instruments; Research and Development Deployment; Target; Voluntary approaches	Climate strategy; Economic instruments; Regulatory instruments; Information and Education; Voluntary instruments; (based on authors' own aggregation of categories)
Data maintenance	Updated in real-time	Updated periodically; yearly static databases provided since 2019	Updated periodically
Host/Owner	Grantham Research Institute on Climate Change and the Environment (2022)	NewClimate Institute (2022)	IEA (2022)

Table 2. Descriptive statistics on policy density measurements.

	N	Mean	Median	*SD*	*CV*	Min	Max
CCLW	880	6.43	5	5.84	0.91	0	33
CPD	880	40.80	15	56.57	1.39	0	366
IEA PMD	880	44.85	33	43.09	0.96	0	245

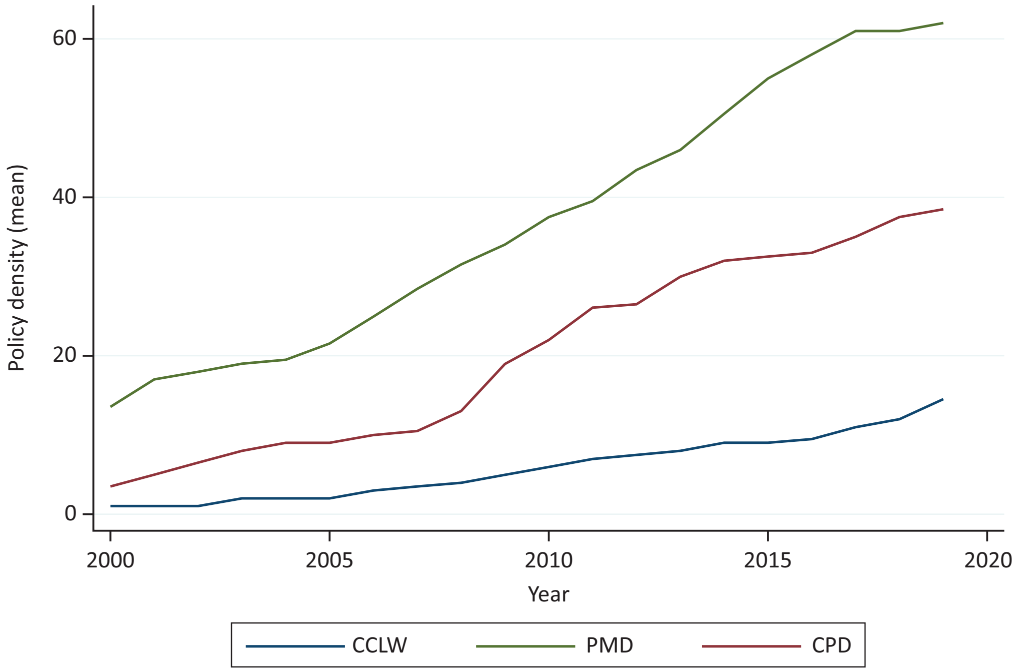

Figure 1. Comparison of median policy density over time.

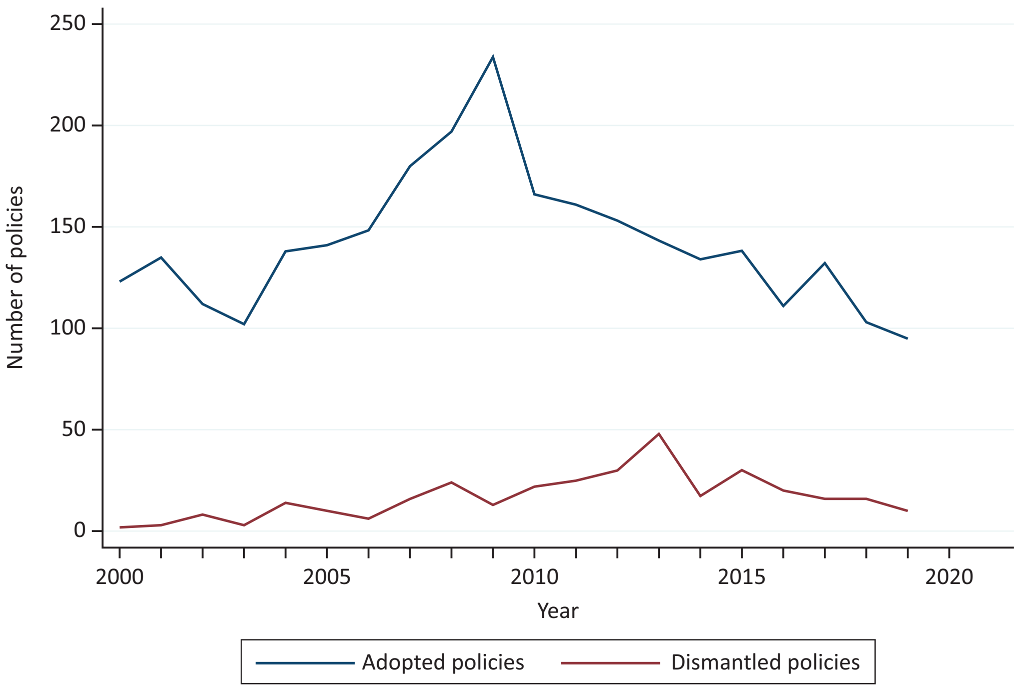

Figure 2. The number of policies adopted and dismantled per annum (2000–2019) based on the CPD.

repealed for only half of the cases, which means that for 530 out of 881 policies, which have been repealed or superseded, the end date is unknown.

When inspecting the same data broken down for individual countries (Figures S14 to S24 in the Supplementary File), we can see that policy dismantling is more frequent in some countries than in others. Australia is one of the countries that stands out as being especially prone to dismantle climate policies, which has already been discussed in the existing literature and explained in terms of changes in the ideological composition of different governments (see, e.g., Crowley, 2013).

Overall, the three policy density measures correlate. Pearson's r is greatest when correlating measurements based on the CPD and the PMD with each other (r = 0.841). The high correlation coefficient indicates that the data used for constructing these two density measurements are quite similar. When correlating the measurement based on the CCLW data with that based on the CPD, we obtain a moderate correlation coefficient ($r = 0.410$), and the same goes for the correlation with the measurement based on the PMD data ($r = 0.486$).

The correlations are lower when we compute them separately for each year (see Table 3). This is worth reporting because of the way the density measurements are constructed, i.e., as cumulative counts, which are likely to be affected by time trends. Therefore, when removing the time trend, the correlation coefficients become much smaller when comparing the CCLW with the other two databases. In fact, the associations are quite weak with coefficients mostly below 0.3 and not statistically significant for many years. However, these measurements become more similar over time with slightly increasing coefficients. On the other hand, density measures based on the CPD and PMD remain highly correlated and statistically significant when comparing them separately for each year.

Another noteworthy observation is that differences between the policy density measures vary between countries, as shown in Figures S3 to S13 in the Supplementary File. To give an example, density measures based on the CPD and PMD in Spain mostly overlap and deviate from the one based on the CCLW. However, when looking at Finland, the density measures based on the CPD and CCLW are very similar and deviate from the density measurement based on the PMD. The question arises whether this is due to inconsistencies within the databases or whether countries actually differ in the types of policies they adopt.

To conclude, our analysis shows major differences in policy density between the CCLW on the one hand, and the CPD and the PMD on the other. Using the former or the latter may either lead to under- or to over-estimating the level of climate policy ambition. Therefore, we suggest that cross-checking measurements could be important to assess the validity of the data.

4.2. Sector-Specific Measurements of Climate Policy Density

In this section, we provide sector-specific measurements of climate policy density. We consider this an important aspect since climate policy has predominantly been associated with energy policy. However, policymakers have begun to think of decarbonisation (and hence climate policy) in much broader terms (Jordan et al., 2022) and to adopt measures that target all sectors, including agriculture and transport.

As highlighted in Table 1, the three databases categorize climate policy sectors in different ways. In the case of the PMD, there is no clear categorization of climate policies. Therefore, we assigned policies to a sectoral categorization used by the IEA to differentiate between different sources of GHG emissions based on the information provided by the database.

Figure 3 gives an overview of the policy density for each sector. For instance, 10% of all mitigation policies included in the CCLW in the year 2000 targeted the agriculture sector (on this more specifically, see N. M. Schmidt, 2020). The largest share of policies in the

Table 3. Correlation between policy density measures.

Year	CCLW and CPD	CCLW and PMD	CPD and PMD
2000	0.153	0.167	0.806***
2001	0.158	0.143	0.809***
2002	0.195	0.203	0.825***
2003	0.160	0.177	0.831***
2004	0.120	0.114	0.846***
2005	0.191	0.123	0.848***
2006	0.161	0.077	0.859***
2007	0.268*	0.189	0.863***
2008	0.300**	0.190	0.875***
2009	0.301**	0.179	0.884***
2010	0.302**	0.239	0.874***
2011	0.315**	0.280*	0.871***
2012	0.285*	0.244	0.864***
2013	0.255*	0.204	0.851***
2014	0.262*	0.218	0.838***
2015	0.316**	0.269*	0.823***
2016	0.341**	0.289*	0.819***
2017	0.327**	0.257*	0.803***
2018	0.357**	0.261*	0.791***
2019	0.333**	0.266*	0.784***
2000–2019	0.401***	0.486***	0.837***

Notes: Reported values are Pearson's r correlation coefficients; level of statistical significance: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

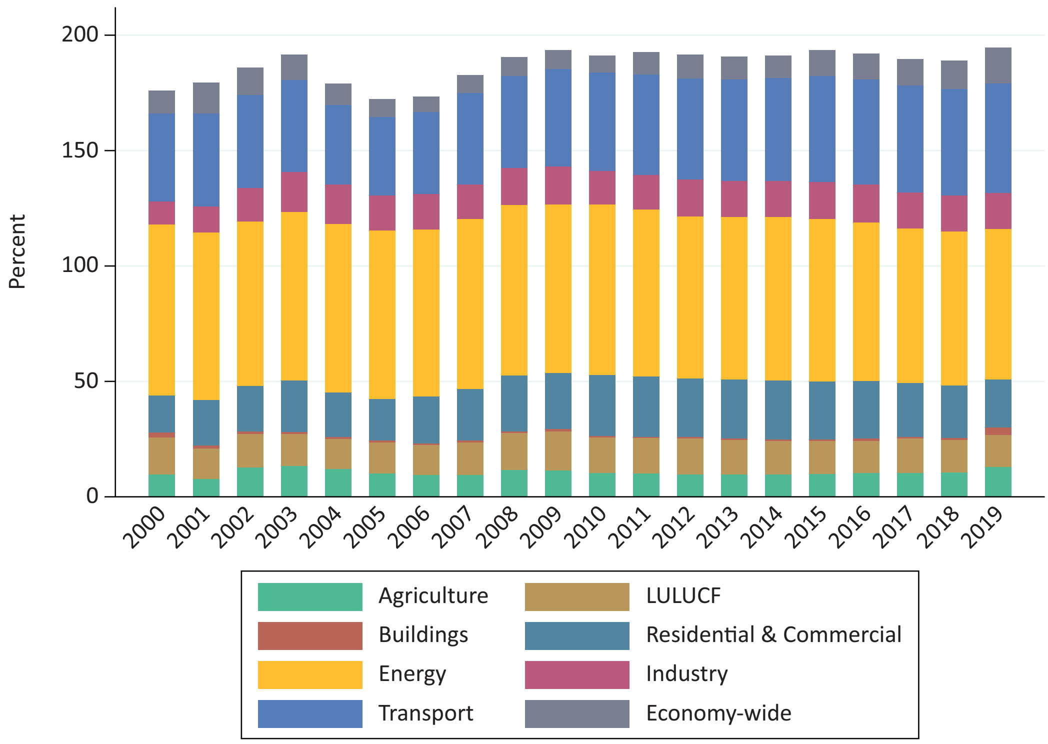

Figure 3. The policy density of different sectors based on the CCLW.

CCLW database targets the energy sector, followed by transport and energy efficiency. A noteworthy observation is that the sum of relative frequencies of policies exceeds 100% when taking together all sectors. This is due to the CCLW's focus on entire climate laws, which are mostly overarching in nature and address multiple policy sectors.

The coverage of policy sectors by the CPD is similar to that of the CCLW database as shown in Figure 4. Most policies address electricity and heat generation,

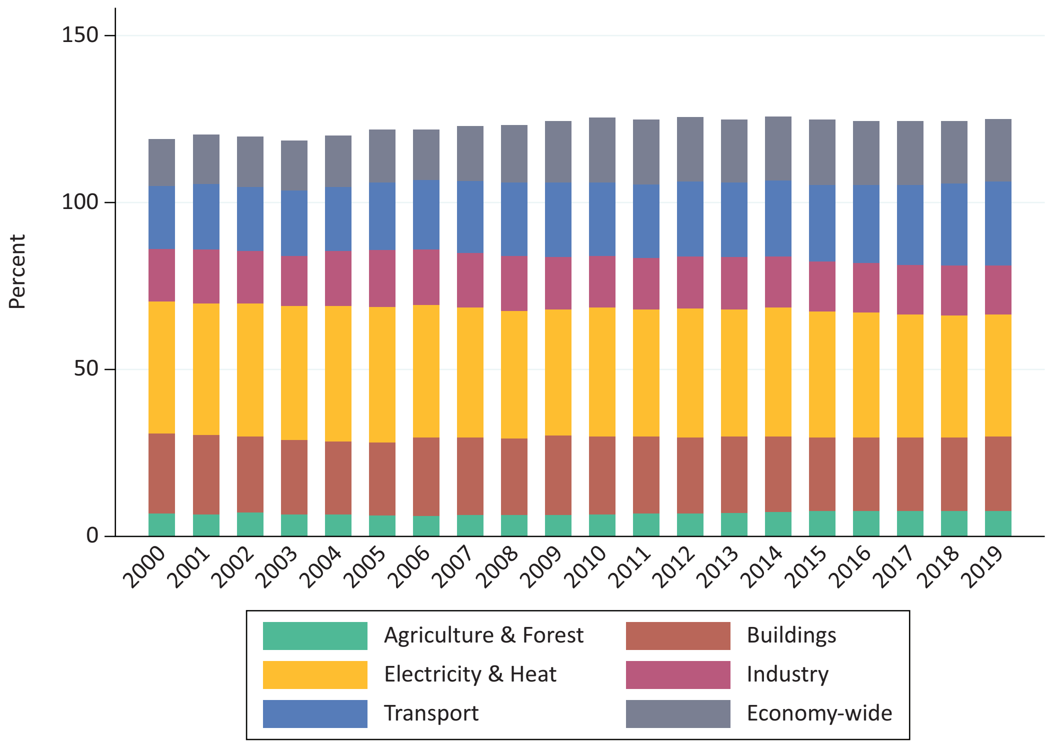

Figure 4. The policy density of different sectors based on the CPD.

followed by energy efficiency, transport, and industry. Only the share of policies addressing agriculture and forest is significantly smaller in comparison to the CCLW database. Noteworthy is the smaller sum of relative frequencies across sectors, pointing to a larger number of policies targeting only one specific sector. This observation is straightforward to explain since the CCLW database codes climate laws whereas the coding units of the CPD are climate policy instruments, which also explain the higher number of absolute counts with the CPD data as compared to the CCLW data.

When examining policy density across different sectors, the PMD's central focus on energy-relevant climate mitigation policies becomes even more apparent. Figure 5 shows that the largest proportion of policies included in this database address energy efficiency, followed by electricity and heat, policies related to energy use in the energy industry, transport, and manufacturing. Policies on agriculture and forestry are mostly missing from the PMD. Of all the databases, the PMD is the narrowest in terms of sector coverage, although it is the most comprehensive with regard to the policy measures included. However, considering that climate policy is still dominated by energy policy, the focus of the PMD is nevertheless appropriate.

Overall, Figures 3 to 5 reveal that the sectoral composition of climate policy density has remained stable in the last two decades. The three measurements complement each other because of the differing categorizations they use for assigning climate policy to sectors. The PMD provides a nuanced picture of energy policy, whereas the other two databases provide insights covering a larger number of sectors.

5. Conclusion

In this explorative study we have presented three extant databases that can be used to construct measurements of climate policy density, which we regard as an important dimension of climate policy ambition. Departing from this overarching argument, we drew on the databases to construct three density-based measurements and compared them. We have shown that all measurements reveal an upward trend with regard to the adoption of climate policy, but that there exist differences in the degree to which the databases aggregated this information. The CCLW database offered the information at the highest level of aggregation and the PMD at the lowest.

From this, we conclude that the empirical information provided by the measurements can be used for different types of research questions perhaps derived from different theories. What we have also shown is that the data included in the datasets are correlated, which suggests that they capture similar concepts. From this, it follows that the three datasets can be used simultaneously in order to check the robustness of analytical findings.

Compared to measuring climate policy ambition by concentrating on the stringency of climate policies, density-based measurements can be more easily constructed from existing databases. However, this does not mean that the conceptualization of climate policy

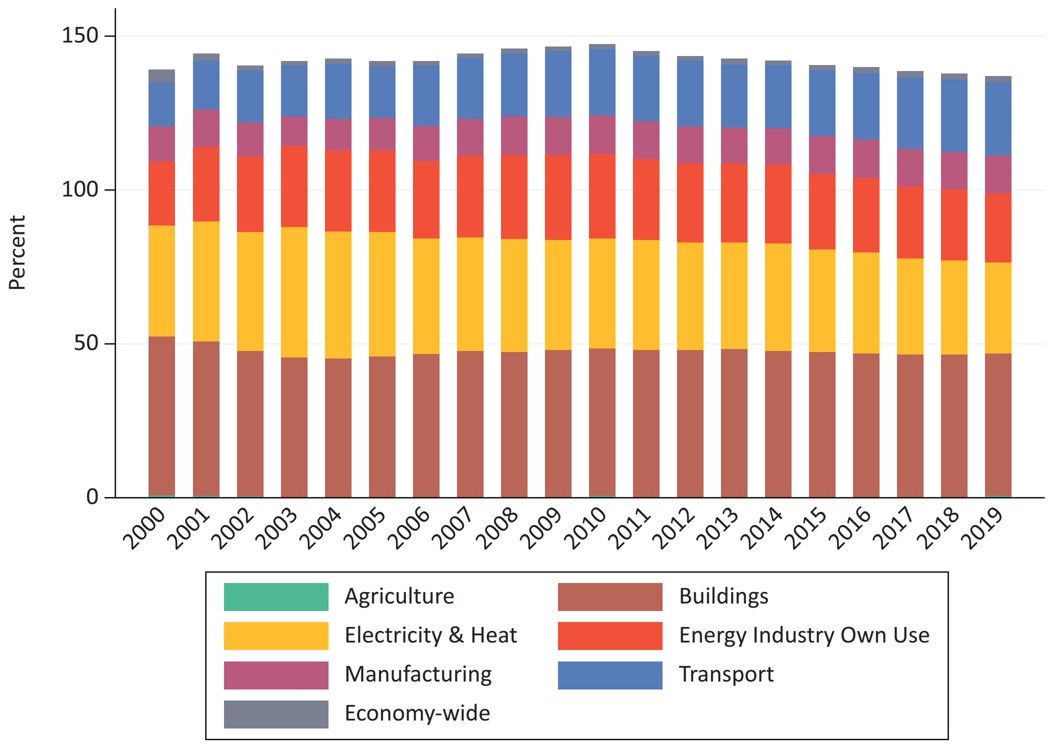

Figure 5. The policy density of different sectors based on the PMD.

ambition as the density of policies or the concrete operationalizations discussed here do not suffer from any limitations or weaknesses. Conceptually, policy density does not capture whether the individual climate policy measures adopted add up to a coherent, consistent, or congruent approach. It is possible that among the set of policies adopted, some involve trade-offs. This is an aspect that deserves enhanced attention when developing the concept of policy density further. In terms of operationalization, one of the main issues with the databases presented here is that we do not have information on how long a given policy measure has been in place. The CPD is the sole exception here, but even it does not provide full information. From this, it follows that there is a need—especially since the ratification of the Paris Agreement—to invest more, both financially but also in terms of collaborative effort, in developing accessible, integrated, and comprehensive databases that capture fully the reality of climate policy ambition.

In a final step, we now allude to some promising new research ideas, discussing each of the databases and their corresponding density measurements in turn.

The measurement based on the CCLW database focuses conceptually on formal policymaking and its outputs. Consequently, it is particularly suitable for assessing how polity and politics matter for climate policy. The most basic question to ask is whether and how the nature and extent of democracy affects climate policy outputs (e.g., Hanusch, 2018), which in the existing literature tends to concentrate on the ratification of international agreements rather than national policy dynamics (for an overview, see Jordan et al., 2022). In this regard, not only the measurement of climate policy but also democratic quality warrants enhanced attention (see Escher & Walter-Rogg, 2018). Along these lines, instead of contrasting the climate policy ambition of democracies versus autocracies, it appears promising to cover all types of political system and assess how far this affects policy outputs or policy outcomes (e.g., GHG emissions). In this context, it should be noted that variations are more pronounced among autocratic systems than democratic ones and that autocraticization processes can affect both autocracies and democracies (see Pelke & Croissant, 2021). And what is more, some social movements such as Extinction Rebellion have even called on policymakers in democracies to adopt some more "authoritarian"-style policies such as those that target frequent flyers.

Researchers wishing to apply theories of policy change (e.g., Weible & Sabatier, 2018) may find the CPD-based measurement particularly suitable. The unique feature of the CPD database is that it provides information on the termination of climate policy measures. Thus, it captures empirical cases where countries dismantled their climate policies, such as Australia in 2013 (Crowley, 2017). Therefore, this measurement offers an apt empirical basis for identifying the drivers of policy expansion and policy dismantling. One straightforward argument here refers to the ideological composition of governments as suggested, for example, by Crowley (2013, 2017) for the specific case of climate policy ambition in Australia, and more generally by Schulze (2021).

Researchers interested in the specificities of policy design (see Howlett & Mukherjee, 2014) such as policy mixes (e.g., T. S. Schmidt & Sewerin, 2019) may find the PMD-based measurement particularly useful. The PMD incorporates single policy measures and programs, which are, compared to comprehensive climate laws, prone to more gradual changes. Therefore, the measurement of policy density based on the PMD allows researchers to grasp incremental changes in climate policy ambition and layering processes, which play an important role in policy design. In this regard, this measurement could be used to assess research questions concerning policy design previously addressed for individual countries (e.g., Koski & Siddiki, 2021) for a larger number of countries and to assess how robust the findings are when the empirical basis is broadened. However, scholars need to bear in mind that the PMD focuses on energy.

Scholars interested in climate policy diffusion—a situation when policy adoption in one country affects adoption in other countries (Biesenbender & Tosun, 2014; Kammerer & Namhata, 2018)—may resort to measurements of policy density based on the PMD or the CPD. Policy diffusion studies typically investigate whether specific policy innovations spread across countries and, thus, cannot directly make use of policy density as a solely quantitative measure of policy activity. However, future studies could incorporate policy density by investigating whether a policy invention, such as the world's first carbon tax, coincides with its spread to other countries, measured by an increased number of this specific policy instrument (carbon taxes). Both the PMD and the CPD provide detailed information on policy instrument types and would enable such an analysis to be undertaken.

Further research may also shed light on policy dismantling as a form of climate policy ambition. Most empirical research and available databases focus on climate policy expansion. Nevertheless, dismantling certain policies, such as fossil fuel subsidies, may also indicate climate policy ambition (Erickson et al., 2020; Skovgaard & van Asselt, 2019). However, dismantling other policies may hinder climate action, as observed in Australia (Crowley, 2017). Capturing these instances comprehensively would make policy density a more valid measure of policy ambition. In a similar vein, to what degree policy density and policy stringency are interrelated measurements of policy ambition should be explored by further empirical research.

Overall, there exist many possibilities for connecting the measurements presented here with theoretical arguments and stimulating new research perspectives. The density measurements could facilitate a more nuanced understanding of changes in climate policy ambition, informing both theoretical debates and policy prescriptions with respect to the dominant barriers and enablers.

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Conflict of Interests

The authors declare no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

References

Averchenkova, A., & Bassi, S. (2016). *Beyond the targets: Assessing the political credibility of pledges for the Paris Agreement*. Grantham Research Institute on Climate Change and the Environment; Centre for Climate Change Economics and Policy. http://eprints.lse.ac.uk/65670

Averchenkova, A., Fankhauser, S., & Nachmany, M. (2017). Introduction. In A. Averchenkova, S. Fankhauser, & M. Nachmany (Eds.), *Trends in climate change legislation* (pp. 1–16). Edward Elgar. https://doi.org/10.4337/9781786435781.00008

Baldwin, E., Carley, S., & Nicholson-Crotty, S. (2019). Why do countries emulate each other's policies? A global study of renewable energy policy diffusion. *World Development*, *120*, 29–45. https://doi.org/10.1016/j.worlddev.2019.03.012

Biesenbender, S., & Tosun, J. (2014). Domestic politics and the diffusion of international policy innovations: How does accommodation happen? *Global Environmental Change*, *29*, 424–433. https://doi.org/10.1016/j.gloenvcha.2014.04.001

Bölük, G., & Kaplan, R. (2022). Effectiveness of renewable energy incentives on sustainability: Evidence from dynamic panel data analysis for the EU countries and Turkey. *Environmental Science and Pollution Research International*, *29*, 26613–26630. https://doi.org/10.1007/s11356-021-17801-y

Burns, C., & Tobin, P. (2020). Crisis, climate change and comitology: Policy dismantling via the backdoor? *JCMS: Journal of Common Market Studies*, *58*(3), 527–544. https://doi.org/10.1111/jcms.12996

Crowley, K. (2013). Pricing carbon: The politics of climate policy in Australia. *Wiley Interdisciplinary Reviews: Climate Change*, *4*(6), 603–613. https://doi.org/10.1002/wcc.239

Crowley, K. (2017). Up and down with climate politics 2013–2016: The repeal of carbon pricing in Australia. *Wiley Interdisciplinary Reviews: Climate Change*, *8*(3), Article e458. https://doi.org/10.1002/wcc.458

Dubash, N. K., Hagemann, M., Höhne, N., & Upadhyaya, P. (2013). Developments in national climate change mitigation legislation and strategy. *Climate Policy*, *13*(6), 649–664. https://doi.org/10.1080/14693062.2013.845409

Erickson, P., van Asselt, H., Koplow, D., Lazarus, M., Newell, P., Oreskes, N., & Supran, G. (2020). Why fossil fuel producer subsidies matter. *Nature*, *578*(7793), E1–E4. https://doi.org/10.1038/s41586-019-1920-x

Escher, R., & Walter-Rogg, M. (2018). Does the conceptualization and measurement of democracy quality matter in comparative climate policy research? *Politics and Governance*, *6*(1), 117–144. https://doi.org/10.17645/pag.v6i1.1187

Eskander, S., & Fankhauser, S. (2020). Reduction in greenhouse gas emissions from national climate legislation. *Nature Climate Change*, *10*, 750–756. https://doi.org/10.1038/s41558-020-0831-z

Fankhauser, S., Gennaioli, C., & Collins, M. (2016). Do international factors influence the passage of climate change legislation? *Climate Policy*, *16*(3), 318–331. https://doi.org/10.1080/14693062.2014.1000814

Fekete, H., Kuramochi, T., Roelfsema, M., den Elzen, M., Forsell, N., Höhne, N., Luna, L., Hans, F., Sterl, S., Olivier, J., van Soest, H. L., Frank, S., & Gusti, M. (2021). A review of successful climate change mitigation policies in major emitting economies and the potential of global replication. *Renewable and Sustainable Energy Reviews*, *137*, Article 110602. https://doi.org/10.1016/j.rser.2020.110602

Giarola, S., Mittal, S., Vielle, M., Perdana, S., Campagnolo, L., Delpiazzo, E., Bui, H., Kraavi, A. A., Kolpakov, A., Sognnaes, I., Peters, G., Hawkes, A., Köberle, A. C., Grant, N., Gambhir, A., Nikas, A., Doukas, H., Moreno, J., & van de Ven, D.-J. (2021). Challenges in the harmonisation of global integrated assessment models: A comprehensive methodology to reduce model response heterogeneity. *The Science of the Total Environment*, *783*, Article 146861. https://doi.org/10.1016/j.scitotenv.2021.146861

Grantham Research Institute on Climate Change and the Environment. (2022). *Methodology—Legislation.* https://climate-laws.org/methodology-legislation

Hanusch, F. (2018). *Democracy and climate change*. Routledge.

Howlett, M., & Mukherjee, I. (2014). Policy design and non-design: Towards a spectrum of policy formulation types. *Politics and Governance*, *2*(2), 57–71. https://doi.org/10.17645/pag.v2i2.149

Iacobuta, G., Dubash, N. K., Upadhyaya, P., Deribe, M., & Höhne, N. (2018). National climate change mitigation legislation, strategy and targets: A global update. *Climate Policy*, *18*(9), 1114–1132. https://doi.org/10.1080/14693062.2018.1489772

International Energy Agency. (2021). *World energy model documentation: October 2021*. https://iea.blob.core.windows.net/assets/932ea201-0972-4231-8d81-356300e9fc43/WEM_Documentation_WEO2021.pdf

International Energy Agency. (2022). *Policies database*. https://www.iea.org/policies/about

Jordan, A., Bauer, M. W., & Green-Pedersen, C. (2013). Policy dismantling. *Journal of European Public Policy*, *20*(5), 795–805. https://doi.org/10.1080/13501763.2013.771092

Jordan, A., & Huitema, D. (2014a). Innovations in climate policy: The politics of invention, diffusion, and evaluation. *Environmental Politics*, *23*(5), 715–734. https://doi.org/10.1080/09644016.2014.923614

Jordan, A., & Huitema, D. (2014b). Policy innovation in a changing climate: Sources, patterns and effects. *Global Environmental Change*, *29*, 387–394. https://doi.org/10.1016/j.gloenvcha.2014.09.005

Jordan, A., Lorenzoni, I., Tosun, J., Enguer i Saus, J., Geese, L., Kenny, J., Saad, E. L., Moore, B., & Schaub, S. (2022). The political challenges of deep decarbonisation: Towards a more integrated agenda. *Climate Action*, *1*(1), Article 6. https://doi.org/10.1007/s44168-022-00004-7

Jordan, A., & Moore, B. (2022). The durability–flexibility dialectic: The evolution of decarbonisation policies in the European Union. *Journal of European Public Policy*. Advance online publication. https://doi.org/10.1080/13501763.2022.2042721

Kammerer, M., & Namhata, C. (2018). What drives the adoption of climate change mitigation policy? A dynamic network approach to policy diffusion. *Policy Sciences*, *51*(4), 477–513. https://doi.org/10.1007/s11077-018-9332-6

Knill, C., Schulze, K., & Tosun, J. (2012). Regulatory policy outputs and impacts: Exploring a complex relationship. *Regulation & Governance*, *6*(4), 427–444. https://doi.org/10.1111/j.1748-5991.2012.01150.x

Koski, C., & Siddiki, S. (2021). Linking policy design, change, and outputs: Policy responsiveness in American state electricity policy. *Policy Studies Journal*. Advance online publication. https://doi.org/10.1111/psj.12442

Le Quéré, C., Jackson, R. B., Jones, M. W., Smith, A. J. P., Abernethy, S., Andrew, R. M., De-Gol, A. J., Willis, D. R., Shan, Y., Canadell, J. G., Friedlingstein, P., Creutzig, F., & Peters, G. P. (2020). Temporary reduction in daily global CO2 emissions during the Covid-19 forced confinement. *Nature Climate Change*, *10*(7), 647–653. https://doi.org/10.1038/s41558-020-0797-x

Le Quéré, C., Korsbakken, J. I., Wilson, C., Tosun, J., Andrew, R., Andres, R. J., Canadell, J. G., Jordan, A., Peters, G. P., & van Vuuren, D. P. (2019). Drivers of declining CO2 emissions in 18 developed economies. *Nature Climate Change*, *9*(3), 213–217. https://doi.org/10.1038/s41558-019-0419-7

Little, C. (2020). The party politics of climate change in Ireland. In D. Robbins, D. Torney, & P. Brereton (Eds.), *Ireland and the climate crisis* (pp. 91–107). Palgrave Macmillan.

MacNeil, R. (2021). Swimming against the current: Australian climate institutions and the politics of polarisation. *Environmental Politics*, *30*(Suppl. 1), 162–183. https://doi.org/10.1080/09644016.2021.1905394

Mehryar, S., & Surminski, S. (2021). National laws for enhancing flood resilience in the context of climate change: Potential and shortcomings. *Climate Policy*, *21*(2), 133–151. https://doi.org/10.1080/14693062.2020.1808439

Müller, F., Neumann, M., Elsner, C., & Claar, S. (2021). Assessing African energy transitions: Renewable energy policies, energy justice, and SDG 7. *Politics and Governance*, *9*(1), 119–130. https://doi.org/10.17645/pag.v9i1.3615

Nascimento, L., Kuramochi, T., Iacobuta, G., den Elzen, M., Fekete, H., Weishaupt, M., van Soest, H. L., Roelfsema, M., de Vivero-Serrano, G., Lui, S., Hans, F., Casas, M. J. de V., & Höhne, N. (2022). Twenty years of climate policy: G20 coverage and gaps. *Climate Policy*, *22*(2), 158–174. https://doi.org/10.1080/14693062.2021.1993776

NewClimate Institute. (2022). *About the database*. Climate Policy Database. https://climatepolicydatabase.org/about

Pelke, L., & Croissant, A. (2021). Conceptualizing and measuring autocratization episodes. *Swiss Political Science Review*, *27*(2), 434–448. https://doi.org/10.1111/spsr.12437

Roelfsema, M., Fekete, H., Höhne, N., den Elzen, M., Forsell, N., Kuramochi, T., de Coninck, H., & van Vuuren, D. P. (2018). Reducing global GHG emissions by replicating successful sector examples: The “good practice policies” scenario. *Climate Policy*, *18*(9), 1103–1113. https://doi.org/10.1080/14693062.2018.1481356

Roelfsema, M., van Soest, H. L., Harmsen, M., van Vuuren, D. P., Bertram, C., den Elzen, M., Höhne, N., Iacobuta, G., Krey, V., Kriegler, E., Luderer, G., Riahi, K., Ueckerdt, F., Després, J., Drouet, L., Emmerling, J., Frank, S., Fricko, O., Gidden, M., . . . Vishwanathan, S. S. (2020). Taking stock of national climate policies to evaluate implementation of the Paris Agreement. *Nature Communications*, *11*(1), Article 2096. https://doi.org/10.1038/s41467-020-15414-6

Schaffrin, A., Sewerin, S., & Seubert, S. (2015). Toward a comparative measure of climate policy output. *Policy Studies Journal*, *43*(2), 257–282. https://doi.org/10.1111/psj.12095

Schmidt, N. M. (2020). Late bloomer? Agricultural policy integration and coordination patterns in climate policies. *Journal of European Public Policy*, *27*(6), 893–911. https://doi.org/10.1080/13501763.2019.1617334

Schmidt, N. M., & Fleig, A. (2018). Global patterns of national climate policies: Analyzing 171 country portfolios on climate policy integration. *Environmental Science & Policy*, *84*, 177–185. https://doi.org/10.1016/j.envsci.2018.03.003

Schmidt, T. S., & Sewerin, S. (2019). Measuring the temporal dynamics of policy mixes—An empirical analysis of renewable energy policy mixes' balance and design features in nine countries. *Research Policy*, *48*(10), Article 103557. https://doi.org/10.1016/j.respol.2018.03.012

Schulze, K. (2021). Policy characteristics, electoral cycles, and the partisan politics of climate change. *Global Environmental Politics*, *21*(2), 44–72. https://doi.org/10.1162/glep_a_00593

Skovgaard, J., & van Asselt, H. (2019). The politics of fossil fuel subsidies and their reform: Implications for climate change mitigation. *Wiley Interdisciplinary Reviews: Climate Change*, *10*(4), Article e581. https://doi.org/10.1002/wcc.581

Tobin, P. (2017). Leaders and laggards: Climate policy ambition in developed states. *Global Environmental Politics*, *17*(4), 28–47. https://doi.org/10.1162/GLEP_a_00433

Townshend, T., Fankhauser, S., Aybar, R., Collins, M., Landesman, T., Nachmany, M., & Pavese, C. (2013). How national legislation can help to solve climate change. *Nature Climate Change*, *3*(5), 430–432. https://doi.org/10.1038/nclimate1894

Townshend, T., Fankhauser, S., Matthews, A., Feger, C., Liu, J., & Narciso, T. (2011a). *GLOBE climate legislation study: Technical Report.* GLOBE International; Grantham Research Institute on Climate. https://core.ac.uk/download/pdf/195495069.pdf

Townshend, T., Fankhauser, S., Matthews, A., Feger, C., Liu, J., & Narciso, T. (2011b). Legislating climate change on a national level. *Environment: Science and Policy for Sustainable Development*, *53*(5), 5–17. https://doi.org/10.1080/00139157.2011.604004

Wang, H., & Chen, W. (2019). Gaps between pre-2020 climate policies with NDC goals and long-term mitigation targets: Analyses on major regions. *Energy Procedia*, *158*, 3664–3669. https://doi.org/10.1016/j.egypro.2019.01.894

Weible, C. M., & Sabatier, P. A. (2018). *Theories of the policy process*. Routledge.

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Article

Gender Heterogeneity and Politics in Decision-Making About Green Public Procurement in the Czech Republic

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Abstract
Green public procurement (GPP) is a widely recognized public policy tool that has attracted considerable scholarly research. However, much of this research has paid little attention to the nature of discretionary decision-making on the part of bureaucrats and local politicians; nor has it recognized that a crucial determinant of the implementation of GPP is the extent to which women hold administrative and political positions. While GPP tends to be discussed as a tool for promoting gender equality, we draw on feminist insights to argue that doing so may be a tool for enhancing the uptake and implementation of GPP. Utilizing the data from a large-N survey among local politicians and upper-echelon bureaucrats in the Czech Republic, we develop a path analysis model exploring the influence of gender on their decision-making. The results give credence to our overall argument that women are more likely to promote GPP. This argument not only breaks new ground by revealing the gendered nature of GPP but also generates straightforward policy implications.

Keywords
decision-making; gender; green public procurement

Issue
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1. Introduction

Public procurement is an important public policy tool suitable for pursuing a wide range of policy goals, including those that are economic, social (Bassarab et al., 2019; Ortega & O'Brien, 2017), and environmental (McCrudden, 2004). According to Sarter (2020), public spending through procurement may be employed to promote regional development, create new jobs, and foster decent employment conditions and equal opportunities. A major form of public procurement is green public procurement (GPP), defined as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (Alhola et al., 2019, p. 97; see also Pacheco-Blanco & Bastante-Ceca, 2016). With the European Union spending more than 14% of its GDP through public procurement (Sönnichsen & Clement, 2020), GPP now presents one of the critical instruments of the Circular Economy Action Plan (European Union, 2020).

Unsurprisingly, GPP has attracted considerable scholarly research (Cheng et al., 2018), much of which foregrounds the issue of supplier selection (e.g., Cheng et al., 2018; Igarashi et al., 2013; Jenssen & de Boer, 2019; Rainville, 2017; Tseng et al., 2019). Further issues explored in this literature pertain to GPP drivers and barriers, collaboration with supply chain partners, green supply chain management practices, GPP performance and impacts, policy, and regulation. Most papers dealing with GPP tend to be technically oriented and lay strong emphasis on the use of mathematical and other optimization models while showing relatively little interest in the nature of decision-making about GPP on the part of politicians and administrators. However, a crucial fact about this decision-making is that despite being highly formalized and regulated by European and national laws (Sarter, 2020), it retains a considerable discretionary component. This fact may not be unique to GPP and may be generally characteristic of public procurement as an area for which some of the most influential public sector positions are responsible (Ali et al., 2018). Nevertheless, there is little doubt that the nature of discretionary decision-making by politicians and administrators may account for the overall level of GPP implementation, especially in countries where this level is considered unsatisfactory.

A good example of such a country is the Czech Republic, which despite its membership in the European Union, exhibits one of the lowest levels of GPP implementation in global comparison (Yu et al., 2020). In the prior literature, the low GPP performance in the Czech Republic has been attributed to specific limiting factors pertaining to education, knowledgeability, and administrative capacity (Plaček, Valentinov et al., 2021). However, what has never been considered in the literature so far is that the low GPP performance in the Czech Republic and elsewhere may be due to the weak engagement of women in GPP positions of responsibility. This conjectural reason behind low GPP performance may be justified by both philosophical and empirical considerations.

On the philosophical level, feminist scholarship, such as feminist ethics of care, has long been aware that women may possess superior sensitivity to multifarious sustainability issues tendentiously neglected by neoliberal mindsets, not least in the new public management context (Nelson, 1995, 2006; Orser et al., 2021). On the empirical level, the evidence provided by the World Economic Forum (2021b) not only shows that female leadership competencies are superior to the respective male competencies on a number of dimensions, but also clearly links female leadership to enhanced pro-environmental outcomes. Furthermore, according to the Global Gender Gap Report, another publication of the World Economic Forum (2021a, p. 5), the current worldwide gender gap remains considerable (and will take over 135 years to be overcome). Putting these philosophical and empirical considerations together, we hypothesize that female engagement constitutes a crucial resource for promoting GPP, particularly in the context of the Czech Republic. We believe that this hypothesis is a much-needed addition to the extant GPP literature that has examined how gender equality can be promoted through GPP, as it has not yet recognized that GPP itself can be promoted through fostering gender equality (e.g., Fazekas et al., 2020; Orser et al., 2021; Sarter & Thomson, 2020).

The practical and political significance of this hypothesis is anchored in its potential to illuminate the possibility of maximizing the contribution of GPP to attaining the goals of sustainability, especially in the context of the Czech Republic as a country whose GPP uptake and performance levels exhibit considerable potential for improvement (Plaček, Valentinov et al., 2021). This context is distinguished by a paradoxical combination of a heavy formalization and bureaucratization of GPP decision-making and its considerable discretionary component, which undermines the accountability impacts of formalization and bureaucratization and remains open-ended regarding its effect on GPP performance. As Finocchiaro Castro and Guccio (2021) argue, this component may result in either higher efficiency or higher corruption. The present article offers an empirical context for exploring how this component will actually play out insofar as it is interrelated with the gender dimension of GPP.

The data comes from a recent large-N survey carried out on local government politicians and administrators in charge of public procurement in the Czech Republic. In methodological terms, our study enriches the extant GPP scholarship by employing path analysis, which does not seem to have been used in this literature so far. But perhaps even more importantly, our study is unique because it offers the opportunity to explore the role of gender in discretionary decision-making on the part of politicians and administrators, a subject little explored not only in the GPP literature but also in the larger literature that deals with public procurement more generally.

2. Literature Review and Conceptualization of Assumptions

Climate change is currently one of the most important and highly researched topics and has attracted enormous scholarly attention (Kovaleva et al., 2021). We can deem gender issues as one of the subfields of climate change research that has been gradually evolving (Kovaleva et al., 2021). These dynamics started in 2008, and by 2019, about 500 papers had been published in journals indexed on the Web of Science (Kovaleva et al., 2021). Most of the research concentrates on gender equality in climate policy and its effects (Lau et al., 2021). According to Lau et al. (2021), the thinking about gender went through several paradigms: (1) gender blind; (2) women in development; (3) women, environment, and development; (4) gender and development; (5) women, culture, and development; and (6) transformation and development. Scholars also point out several sets of assumptions that essentialize women's and men's characteristics and may ultimately lead to counterproductive results, strategies, and policies. These assumptions are the following: "women are caring and connected to the environment, women are a homogenous and vulnerable group, gender equality is a women's issue and gender equality is a numbers game" (Lau et al., 2021, p. 186). Despite the aforementioned trends, we can see a lack of general literature dealing with the participation of women in decision-making and policy processes dealing with climate policy. Ergas and York (2012) focused on the connection between women's political status and the emission of CO_2 per capita. They found that emission of CO_2 is lower in countries where women have higher political status. Frenova (2021) insists that women's organizations—as one of the important nongovernmental players in climate financial decision-making led by the United Nations Framework Convention on Climate Change (UNFCCC)—are still limited and formalistic. Gay Antaki (2020) analyzed the Conference of the Parties (COP) of the UNFCCC in Paris 2015 from the point of view of feminist geography. According to Gay Antaki (2020) terms relating to gender, such as "gender balance," dominate over others, such as "gender equality."

Magnusdottir and Kronsell (2015) showed that in the case of Scandinavia, women and men are equally represented in climate policymaking, and in some cases, women are in the majority. This situation does not automatically result in gender-sensitive climate policymaking. These results contradict the assumption of critical mass theory (Magnusdottir & Kronsell, 2015).

There is also a stream of literature from the branch of corporate finance which connects the issue of boardroom diversity and a firm's carbon emission footprint. Ben-Amar et al. (2017) prove that, based on the sample of publicly listed Canadian firms over the period 2008–2014, the likelihood of voluntary climate change disclosure is increased if there is a higher percentage of women on the board. This result is in line with critical mass theory. Nuber and Velte (2021) confirmed a similar result in the case of the environmental performance of non-financial firms in the European STOXX600 index over the 2009–2018 period. Regarding critical mass theory, the empirical results showed that at least two women directors need to be present. Similar results were obtained in the context of ecological innovation by Nadeem et al. (2020).

The role of gender in administrative and political decision-making processes seems to be a lacuna in the current state of the art of the empirical GPP literature. For example, gender is conspicuous by its absence from the authoritative review by Sönnichsen and Clement (2020), who developed an analytical, conceptual framework of GPP encompassing organizational aspects, individual behavior, and operational tools. In this framework, organizational aspects comprise three subcategories: (a) size, (b) strategy and top-level management, and (c) policies and quality of contracts. The aspects of individual behavior and practices refer to (a) agency and cross-departmental management, and (b) beliefs, awareness, and individual guidance. The operational tools are distinguished along the lines of (a) process and prioritization; (b) carbon emissions, criteria settings, and evaluation; (c) standards, standardization, and legal aspects; and (d) supplier selection (Sönnichsen & Clement, 2020). The authors conclude that:

> The most important factors [within the conceptual structure of GPP] seem to be awareness and knowledge of green public procurement attributes, based on circular policy and strategy implementation. They are essential for the conduct of circular public procurement. The procurer's beliefs and values are highly relevant in a transformation towards circular public procurement—i.e., simply not going for the lowest price, but finding an optimum combination that includes risk, timeliness, and cost for the public institution on a life-cycle basis. (Sönnichsen & Clement, 2020, p. 15)

Obviously, this is an important conclusion foregrounding the significance of GPP's discretionary component, which is, however, not seen in a gender context.

This conclusion is reinforced by a stream of empirical studies, such as those by Liu et al. (2019), who found that the knowledgeability of Chinese public procurement officials about the aims and effects of GPP policies, backed by appropriate training, are positively associated with GPP performance. Similarly, Nikolaou and Loizou (2015) found that the educational backgrounds of respondents influenced their preferences to adopt environmental management practices. Summarizing current theoretical approaches and using questionnaire surveys and structural equation modeling, Yang et al. (2019) likewise prove that subjective norms and perceived behavior control factors significantly influence developers' green procurement behavior. Important as it is, all this work fails to consider GPP's gender dimension, which remains missing in most GPP studies focusing on a single country, sector, or level of government (Cheng et al., 2018; Lindfors & Ammenberg, 2021).

A further line of research envisages a potential gender dimension of GPP but does not consider this dimension to be a relevant GPP determinant. For example, examining the relationship between ability, motivation, opportunity, and sustainable procurement, Grandia and Voncken (2019) have found gender to be an insignificant variable. Drawing on quantitative analysis, Igarashi et al. (2017) found that public procurers are motivated by their beliefs which are independent of their gender and experience. However, the authors did acknowledge the knowledge gap regarding the role of gender in the public procurement literature. More recent studies likewise identify no association between gender and eco-friendly buying behavior, even though some earlier work was open to the idea that eco-friendly buying and gender might be linked, for example, because of women's greater interest in ecological topics (Igarashi et al., 2017).

In conceptual terms, we argue that the prevalent understanding of the role of gender in GPP is framed and indeed subsumed by two theoretical standpoints well elaborated by Orser et al. (2018) and Orser et al. (2021). These are (a) feminist empiricism, which argues that women are disadvantaged; and (b) entrepreneurial feminism, which argues that women can overcome their disadvantage through their own entrepreneurial activity. Both standpoints are anchored in the vision of gender as a social outcome shaped by essentially contingent socialization processes (Orser et al., 2018). As a result of these processes, women may perceive that they do not fit in with masculine occupational role stereotypes and thus feel discouraged from participating in specific fields, such as STEM studies, small business, or specific industries such as defense (Orser et al., 2018). Some scholars argue that similar patterns are characteristic of public procurement insofar as women-owned businesses participating in competitive bidding are systematically having less success (Orser et al., 2021, p. 497). The standpoint of feminist empiricism helps here by pointing out that the limited success of such businesses may be caused by structural barriers and systemic exclusionary dynamics rather than by women's individual features, such as risk aversion or preference for financial caution. The standpoint of entrepreneurial feminism (Orser et al., 2021) concerns how this situation may be redressed. Building on the insight that entrepreneurial ecosystems are dynamic rather than static, entrepreneurial feminism encourages women to launch institutional and entrepreneurial innovations challenging the extant subjugation modalities.

While we agree with these standpoints as far as they go, we argue that they do not exhaust the full potential of feminist thought. The field of GPP may indeed provide a context where women are rightly portrayed as victims of precarious discrimination and exclusion regimes that deserve condemnation and abolition. But what may also be important for GPP, and what is not fully acknowledged by the two standpoints, is the possibility that women may be the carriers of unique capabilities for promoting GPP, especially in settings where the implementation of GPP tends to be weak. This possibility is made plausible by the public administration literature containing a number of arguments and evidence suggesting that women may be particularly capable and moral public administrators. In this line, Lapuente and Suzuki (2021) empirically prove that female managers are more result-oriented than rule-following and thus more effective in promoting societal interests; in addition, they are "more open to new ideas and creativity, and more willing to challenge the status quo" while being more prudent than male managers (Lapuente & Suzuki, 2021, p. 1345). Suzuki and Avellaneda (2018) report a similar experience in the case of local financial management by Japanese city-level governments. The authors find female representation in these governments to be "positively correlated with risk-averse behavior in financial decisions" (Suzuki & Avellaneda, 2018, p. 1741). Other corroborative evidence is presented by Detkova et al. (2021), who found that women occupying public procurement positions in Russia, in contrast to men, have a negative attitude to corruption. The authors even suggest that gender equality measures within the public sector could be one element of the much-needed anti-corruption policies. Bauhr and Charron (2020) go even further and identify a gender difference not only in attitudes toward the severity of corruption but also in perceptions of the forms that corruption takes. According to their data, women and men differ in their perceptions of need and greed, such that women tend to perceive more need-induced corruption, while men tend to perceive it as induced by greed (Bauhr & Charron, 2020). Authors trace this gender difference back to role socialization, social status, and life experience.

A common implication of these empirical studies is that gender equality measures could improve the effectiveness of public administration. We argue that this implication potentially breaks new ground within the current research on GPP in the Czech Republic. Most research on GPP in this country has focused on sustainable procurement and its effects on saving (Džupka et al., 2020) and SME involvement (Nemec et al., 2021). These studies rightly consider GPP as a part of a wider sustainability agenda that pays attention to innovation and social aspects but has failed to emphasize the gender dimension. Thus, we contribute to the scholarly literature on GPP in the Czech Republic with the proposition that gender equality measures would lead to better uptake and implementation of GPP. Whereas the standpoints of feminist empiricism and entrepreneurial feminism seem to boil down to promoting gender equality through GPP, we enrich the literature by suggesting that GPP itself can be promoted by fostering greater gender equality. Our contribution seeks to sensitize the scholarly and public understanding of GPP in the Czech Republic to the role of gender, and to initiate the search for novel theoretical frameworks which enable this sensitivity.

Our empirical strategy rests on condensing the above argument into the four following assumptions.

> Assumption 1: Gender is associated with public procurers' preference for GPP.

Feminist scholarship teaches us that women may exhibit superior sensitivity to multifarious sustainability issues yet be disadvantaged by the systemic imperatives of marginalization and exclusion (Nelson, 1995, 2006; Orser et al., 2021). Public procurement presents a key context where this disadvantage may be materialized. The reason is that the power to make decisions regarding the spending of public money is widely seen as the kind of privilege that, in repressive regimes, would be foreclosed or less accessible to women (cf. Bruns Ali et al., 2018). Specific mechanisms facilitating male privilege and female disadvantage in the public procurement process have become ingrained within a plethora of formal and informal decision-making rules and heuristics and thus engender path dependencies (Ochrana et al., 2019; Plaček, Vaceková et al., 2021) which may also be characteristic of other areas, such as social policy or the legislative process (cf. Plaček et al., 2018). What is crucial is that these mechanisms shape the GPP preferences of politicians and administrators. If so, then it is reasonable to suppose that the increasing proportion of women entering politics or important public procurement positions may be able to break extant rules and thus improve GPP implementation.

> Assumption 2: In awarding public contracts, the public procurer's preference for the price rather than environmental criteria is not associated with gender.

At the core of the public procurement process is the public procurer's choice between alternative suppliers who may compete on economic costs and non-economic environmental criteria. This choice is also present in the GPP context (Plaček, Valentinov et al., 2021; Sönnichsen & Clement, 2020). Recent research on sustainable public procurement shows that public sector officials indeed state preferences for non-economic criteria, even though cost remains crucial (Lerusse & Van de Walle, 2021a). In a recent experimental study, politicians' consideration of criteria other than costs was found to be influenced by political and ideological reasoning (Lerusse & Van de Walle, 2021b). However, the feminist foundation of our argument implies that if public procurers happen to prioritize the lowest price criterion, this preference will not be related to gender.

> Assumption 3: Gender will affect the decision-making of public procurers facing the trade-off between environmental impact and other social sustainability criteria.

Sustainable development can be judged by multiple and partly competing criteria, which may need to be traded off against each other by public procurers. For example, one possible trade-off could be between environmental and social goals, such as fostering local employment or subsidizing local firms. Drawing on feminist scholarship, we assume that women have a superior ability to recognize and differentiate multiple criteria of sustainable procurement (Nelson, 1995, 2006; Orser et al., 2018). As this ability may result in the perceptions of trade-offs among these criteria, it is plausible to assume that navigating these trade-offs will be influenced by gender.

> Assumption 4: In the above-mentioned assumptions, public procurers' decision-making preferences are associated with women's positions in local politics or public procurement administration.

The assumption seeks to uncover position-related differences in women's behavior. Such differences were identified by scholars such as Detkova et al. (2021) and Igarashi et al. (2017), who showed that procurers' behavior varies according to their position. Namely, highly-positioned procurers have different approaches to information and risk. In our study, we distinguish between two positions that women can occupy: local politician and procurement administrator. We expect that, in their quality as local politicians, women bear a higher level of accountability pressures than those that are borne by female public procurement administrators. This difference may result in a greater risk aversion among female local politicians.

3. Data and Methods

We have obtained the data from a large-N survey that took place in the Czech Republic during the summer of 2020. We sent out an electronic questionnaire to the official e-mail addresses of all Czech municipalities, including a cover letter. Our target respondents were persons responsible for GPP implementation, including politicians at the level of mayors or vice-mayors and upper-level bureaucrats at the level of department head. The exact position of respondents depended on the size of the municipalities. From the 6,248 municipalities approached, we obtained 1,117 responses, a response rate of 17.88%. Some results have already been used (Plaček et al., 2021).

The questionnaire included seven questions probing the respondents' attitudes toward GPP. Six questions employed a Likert-type scale offering a range of five answers from "absolutely agree" to "absolutely disagree." One question had the binary form of yes/no, and another was a close-ended question. The questionnaire is enclosed in the Supplementary File. We also asked respondents their full names and e-mails, and we linked this information with education, gender, and position within the organization. With the help of these variables, we tried to explain respondents' answers to the three selected questions that introduced decision-making problems in GPP implementation within the given municipal organization.

Our methodological approach is path analysis, a generalization of multiple regression that allows us to estimate the strength and sign of directional relationships for causal schemes with multiple dependent and independent variables (Li, 1975). The critical difference between path analysis and multiple regression is that multiple regression assumes a simpler (direct) causal relationship with the dependent variable, while the path analysis model identifies a specific causal structure among the independent variables that determine the outcome variables. Importantly, path analysis variables are referred to as exogenous and endogenous rather than independent and dependent. This is because the causes of exogenous variables are determined outside the model; the factors affecting the endogenous variables are respectively found within the model.

We develop a path model exploring whether different individual traits influence and transform GPP decision-making (see Figure 1).

As shown in Figure 1, the exogenous variables, or antecedents (*Female*, *Size*, *Higher Education*), influence the nature of opinions related to GPP, including the consideration of the social usefulness of awarding "green public contracts" (*Socially useful to award "green public contracts"* box in Figure 1); the preference for announcing tenders for cheaper contracts unburdened by environmental requirements (*Announce tender for a cheaper contract* box in Figure 1); and the consideration of the "ecological impact" as the most important criterion of public procurement (*Ecological impact most important criterion* box in Figure 1). In the path analysis methodology, there are two types of effects between any two variables. A direct effect is any direct connection between the variables, and a unidirectional arrow represents these. In our model, the direct effects flow from the set of exogenous variables (*Female*, *Size*, *Higher Education*) to the outcome variables (*Socially useful to award "green public contracts," Announce tender for a cheaper contract*, and *Ecological impact most important criterion*). An indirect (or mediated) effect is any forward connection between an exogenous variable and an outcome that goes through an intermediate variable. In our model, there is an indirect effect of the exogenous variables on the outcome variables through an intervening or mediating variable (namely, *Politic*). The causal effect is the sum of the direct and indirect effects (Mitchell-Olds & Bergelson, 1990). Finally, as we believe that the exogenous variables are correlated, we have put double-headed arrows between them, although those correlations are not usually studied.

4. Results

A total of 766 males and 299 females completed the survey fully (28.08% female vs. 71.92% male). The other 52 respondents did not answer all the questions and were eliminated from the analysis. Eight hundred and forty-two (i.e., 79.06%) respondents were politicians, and 223 (20.94%) were bureaucrats. Approximately 57% of respondents indicated that they did not have a higher education degree, while a little over 43% indicated that they did. Almost half of the respondents (46.29%, n = 493) belonged to municipalities with up to 500 inhabitants, with only 15 respondents (1.41%) working in large municipalities. Table 1 groups these frequencies and percentages by gender.

Table 1 also includes the results of the Chi-square test intended to check whether gender and *Higher Education*, being a *Politician* or a *Bureaucrat*, or the *size of the city* are related. The table reports two cases where the p-value is smaller than the significance level of 0.05. Hence we can reject the null hypothesis of independence between gender and being a *Politician* or a *Bureaucrat*, as well as between gender and the *size of the city*. In these two cases, the variables are definitely dependent on one another.

The path analysis undertaken in our study included testing the fit between the data and the model illustrated in Figure 1. For each variable, we estimated standardized coefficients as well as the standard errors (Std. Err), test statistics (z-values), and p-values (P(>|z|)). We explored direct effects, indirect effects (by multiplying the path coefficients connecting the causal variable to the outcomes [Tarling, 2008]), and total effects (by summing direct and indirect effects). All the effects coefficients are shown in Table 2. Also, our model is just-identified or saturated (df = 0); hence it perfectly fits the data.

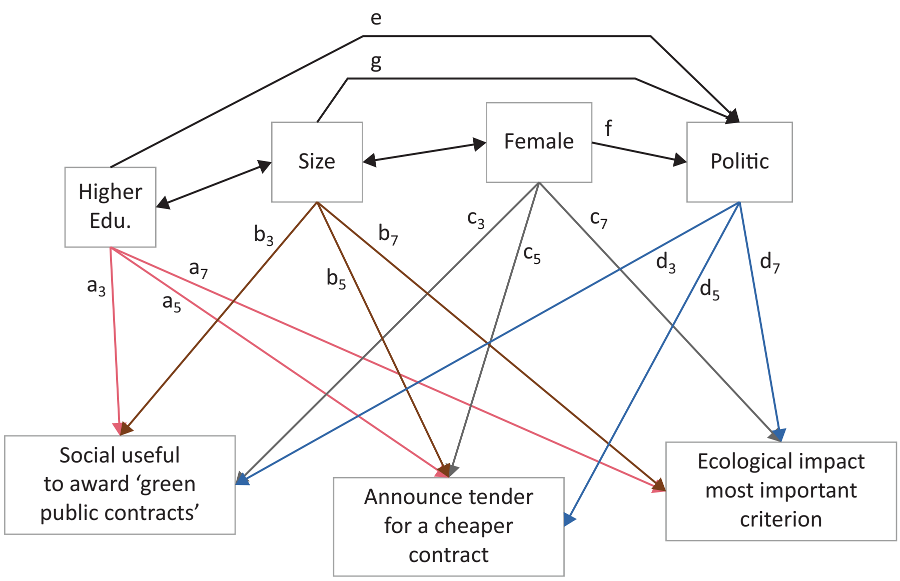

Figure 1. The hypothetical model. All calculations were performed using the statistical program R, version 3.6.3 (R Core Team, 2021), and the *lavaan* package version 0.6-9 (Rosseel, 2012).

Table 1. Respondents' characteristics. Frequencies and percentages by gender.

	Female	Male	Total	Female Percentage	Male Percentage	Pearson's Chi-squared test X-squared	p-value
Higher Education Degree							
No	163 (54.52%)	440 (57.44%)	603 (56.62%)	27.03%	72.97%	0.74972	0.38660
Yes	136 (45.48%)	326 (42.56%)	462 (43.38%)	29.44%	70.56%		
Politic							
No	40 (13.38%)	183 (23.89%)	223 (20.94%)	17.94%	82.06%	14.35600	0.00015 ***
Yes	259 (86.62%)	583 (76.11%)	842 (79.06%)	30.76%	69.24%		
Size category of municipality							
50,000 and more	2 (0.67%)	13 (1.70%)	15 (1.41%)	13.33%	86.67%	10.15700	0.03787 *
10,000–49,999	6 (2.01%)	32 (4.18%)	38 (3.57%)	15.79%	84.21%		
1,000–9,999	68 (22.74%)	221 (28.85%)	289 (27.14%)	23.53%	76.47%		
501–999	71 (23.75%)	159 (20.76%)	230 (21.60%)	30.87%	69.13%		
Up to 500	152 (50.84%)	341 (44.52%)	493 (46.29%)	30.83%	69.17%		
Total	299	766	1065	28.08%	71.92%		

Note: Signif. codes: 0 "***" 0.001 "**" 0.01 "*" 0.05 "." 0.1

Our findings allow the following interpretation of the validity of the proposed assumptions.

> Assumption 1: Gender is associated with public procurers' preference for GPP.

The assumption is confirmed. *Female* (c_3) is a significant variable directly affecting the responses received. However, neither *Size* nor *Higher Education* turned out to be significant.

> Assumption 2: In awarding public contracts, the public procurer's preference for the price criterion rather than for environmental criteria is not associated with gender.

The assumption is confirmed because the relationship between *Female* and the preference for the price criterion over environmental impact (c_5) is not significant.

> Assumption 3: Gender will affect the decision-making of public procurers facing the trade-off between environmental impact and other social sustainability criteria.

The assumption was confirmed because we found gender directly affected the responses related to public procurers' choice of environmental criteria versus other social sustainability criteria (c_7).

> Assumption 4: In the above-mentioned assumptions, public procurers' decision-making preferences are associated with women's positions in local politics or public procurement administration.

The assumption is confirmed because the relationship between *Female* and *Politic* (f) is found to be significant and positive.

Regarding the mediating effect of the *Politic* variable, the findings in Table 2 reveal that *Female***Politic* has an insignificant influence on assumptions 1 and 2 (i.e., both $e*d_3$ and $e*d_7$ are insignificant). Thus we can conclude that *Politic* fails to moderate the relationship between *Female* and *Socially useful to award "green public contracts"* on the one hand, and *Female* and *Ecological impact most important criterion*, on the other. However, the $e*d_5$ coefficient is significant and positive, thus suggesting that *Politic* mediates the impact of gender on decision-making concerned with the choice between the environmental and alternative social criteria.

Table 2. Results of path analysis.

	Estimate	Std.Err	z-value	P(>|z|)
Socially useful to award "green public contracts" ~				
Higher Edu. (a_3)	0.087	0.053	1.649	0.099 .
Size (b_3)	0.033	0.028	1.169	0.242
Female (c_3)	0.111	0.055	2.015	0.044 *
Politic (d_3)	−0.003	0.065	−0.039	0.969
Announce tender for a cheaper contract ~				
Higher Edu. (a_5)	−0.111	0.064	−1.730	0.084 .
Size (b_5)	−0.077	0.034	−2.294	0.022 *
Female (c_5)	−0.101	0.067	−1.511	0.131
Politic (d_5)	0.233	0.079	2.953	0.003 **
Ecological impact most important criterion ~				
Higher Edu. (a_7)	−0.235	0.064	−3.686	0.000 ***
Size (b_7)	−0.058	0.034	−1.722	0.085 .
Female (c_7)	0.143	0.067	2.146	0.032 *
Politic (d_7)	−0.008	0.078	−0.106	0.916
Politic ~				
Higher Edu. (e)	−0.010	0.025	−0.418	0.676
Female (f)	0.077	0.026	2.982	0.003 ***
Size (g)	−0.141	0.012	−11.418	0.000 ***
Defined Parameters				
$e*d_3$	0.000	0.001	0.039	0.969
$f*d_3$	−0.000	0.005	−0.039	0.969
$g*d_3$	0.000	0.009	0.039	0.969
total3	0.228	0.099	2.316	0.021 *
$e*d_5$	−0.002	0.006	−0.414	0.679
$f*d_5$	0.018	0.009	2.098	0.036 *
$g*d_5$	−0.033	0.012	−2.859	0.004 **
total5	−0.074	0.120	−0.617	0.538
$e*d_7$	0.000	0.001	0.102	0.918
$f*d_7$	−0.001	0.006	−0.11	0.916
$g*d_7$	0.001	0.011	0.106	0.916
total7	−0.157	0.119	−1.319	0.187

Note: Signif. codes: 0 "***" 0.001 "**" 0.01 "*" 0.05 "." 0.1.

5. Concluding remarks

The empirical results reported in the present article break new ground in the scholarship on GPP in the Czech Republic. Our central finding is that gender is associated with public procurers' preference for GPP. We also found that the relationship between the *Female* variable and the preference for the price criterion over environmental impact is not significant. We have shown the *Female* variable to directly affect the public procurers' choice of environmental criteria versus other social sustainability criteria. We have proven that public procurers' decision-making preferences are associated with women's positions in local politics or public procurement administration. These results confirm our feminist standpoint about the superior sensitivity of women to sustainability issues, and about female engagement being a crucial resource for promoting GPP in the Czech Republic. We have used this empirical basis to argue that gender equality is not only a political goal in its own right but also a valuable political instrument for achieving GPP goals.

These results open up a new research program exploring the impact of gender on GPP. First of all, we still lack a systematic understanding of the behavior of public procurers and politicians responsible for public procurement. One dimension of this behavior is the availability of goodwill and intrinsic motivation. We suggest that in the GPP context, goodwill and intrinsic motivation may be at least partly associated with gender, and thus add new nuance to Lapuente and Suzuki's (2021) argument that the behavior of public procurers can be approached from two different perspectives: demographic (focusing on personal factors such as gender, education, and socioeconomic base) and structural (focusing on organizational factors). Further research is needed to clarify the extent to which the relative importance of these perspectives is influenced by acknowledging the role of gender in GPP decision-making.

On a methodological note, we call for further research to undertake external validity checks of our study. We are aware that our case might be country-specific and could be affected by specific administrative traditions, the level of economic development and perceived corruption, current regulation, or other contingent factors. Thus it is important to test country-level associations. We are also aware of the methodological problems of using survey-based data in political science. Ansolabehere and Hersh (2013) rightly point out that using surveys for capturing relationships between demographic variables, such as gender and political behavior, is potentially subject to survey biases and nonlinear effects of variables. Our results are based on a perception-based survey. Thus, in detecting the statistically significant effect of gender on the preference for GPP, we cannot deny the possibility of bias, but we did not observe the same pattern in the case of the willingness to pay a higher price for GPP contracts. This leads us to call for further research which would more explicitly contrast the claims made by politicians and administrators with their actual behavior in reality (see Badell & Rosell, 2021; Rosell & Allen, 2020).

Conflict of Interests

The authors declare no conflict of interest.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

References

Alhola, K., Ryding, S. O., Salmenperä, H., & Busch, N. J. (2019). Exploiting the potential of public procurement: Opportunities for circular economy. *Journal of Industrial Ecology*, *23*(1), 96–109.

Ali, S. B., Bishu, S., & Alkadry, M. (2018). Why men and women want to leave? Turnover intent among public procurement officers. *The American Review of Public Administration*, *48*(7), 668–684.

Ansolabehere, S., & Hersh, E. (2013). Gender, race, age and voting: A research note. *Politics and Governance*, *1*(2), 132–137.

Badell, D., & Rosell, J. (2021). Are EU Institutions still green actors? An empirical study of green public procurement. *JCMS: Journal of Common Market Studies*, *59*(6), 1555–1572.

Bauhr, M., & Charron, N. (2020). Do men and women perceive corruption differently? Gender differences in perception of need and greed corruption. *Politics and Governance*, *8*(2), 92–102.

Bassarab, K., Clark, K., Santo, R., & Palmer, A. (2019). Finding our way to food democracy: Lesson from US policy council governance. *Politics and governance*, *7*(4), 32–47.

Ben-Amar, W, Chang, M., & McIlkenny, P. (2017). Board gender diversity and corporate response to sustainability initiatives: Evidence from the carbon disclosure project. *Journal of Business Ethics*, *142*, 369–383.

Cheng, W., Appolloni, A., D'Amato, A., & Zhu, Q. (2018). Green public procurement missing concepts and future trends—A critical review. *Journal of cleaner production*, *176*, 770–784.

Detkova, P., Tkachenko, A., & Yakovlev, A. (2021). Gender heterogeneity of bureaucrats in attitude to corruption: Evidence from list experiment. *Journal of Economic Behavior & Organization*, *189*, 217–233.

Džupka, P., Kubák, M., & Nemec, P. (2020). Sustainable public procurement in Central European countries. Can it also bring savings? *Sustainability*, *12*(21), Article 9241.

Ergas, C., & York, R. (2012). Women´s status and carbon dioxide emissions: A quantitative cross-national analysis. *Social Science Research*, *41*(4), 965–976.

European Union. (2020). *Circular economy action plan*. https://ec.europa.eu/environment/strategy/circular-economy-action-plan_cs

Fazekas, M., Kazmina, Y., & Wachs, J. (2020). *Gender in European public procurement: Extent, distribution, and impacts*. European Bank for Reconstruction and Development. http://www.govtransparency.eu/gender-in-european-public-procurement-extent-distribution-and-impacts

Finocchiaro Castro, M., & Guccio, C. (2021). *Does greater discretion improve the performance in the execution of public works? Evidence from the reform of discretionary thresholds in Italy*. SSRN. https://doi.org/10.2139/ssrn.3984189

Frenova, S. (2021). Orchestrating the participation of women organizations in the UNFCCC led climate finance decision making. *Climate*, *9*(9), Article 135.

Gay Antaki, M. (2020). Feminist geographies of climate change: Negotiating gender at climate talks. *Geoforum*, *115*, 1–10.

Grandia, J., & Voncken, D. (2019). Sustainable public procurement: The impact of ability, motivation, and opportunity on the implementation of different types of sustainable public procurement. *Sustainability*, *11*(19), Article 5215.

Igarashi, M., de Boer, L., & Fet, A. (2013). What is required for greener supplier selection? A literature review and conceptual model development. *Journal of Purchasing and Supply Management*, *19*(4), 247–263.

Igarashi, M., de Boer, L., & Pfuhl, G. (2017). Analyzing buyer behavior when selecting green criteria in public procurement. *Journal of Public Procurement*, *17*(2), 141–186.

Jenssen, M., & de Boer, L. (2019). Implementing life cycle assessment in green supplier selection: A systematic review and conceptual model. *Journal of Cleaner Production*, *229*, 1198–1210.

Kovaleva, M., Leal, W., & Borgemeister, C. (2021). Gender issues within climate change research: A bibliometric analysis. *Climate and Development*. Advance online publication. https://doi.org/10.1080/17565529.2021.1980365

Lapuente, V., & Suzuki, K. (2021). The prudent entrepreneurs: Women and public sector innovation. *Journal of European Public Policy*, *28*(9), 1345–1371.

Lau, J. D., Kleiber, D., Lawless, S., & Cohen, P. J. (2021). Gender equality in climate policy and practice hindered by assumptions. *Nature Climate Change*, *11*(3), 186–192.

Lerusse, A., & Van de Walle, S. (2021a). Local politicians' preferences in public procurement: Ideological or strategic reasoning? *Local Government Studies*. Advance online publication. https://doi.org/10.1080/03003930.2020.1864332

Lerusse, A., & Van de Walle, S. (2021b). Public managers' valuation of secondary policy objectives in public procurement—Results from a discrete choice experiment. *Journal of Behavioral Public Administration*, *4*(1). https://doi.org/10.30636/jbpa.41.206

Li, C. C. (1975). *Path analysis. A primer*. Boxwood Press.

Lindfors, A., & Ammenberg, J. (2021). Using national environmental objectives in green public procurement: Method development and application on transport procurement in Sweden. *Journal of Cleaner Production*, *280*(2), Article 124821.

Liu, J., Xue, J., Yang, L., & Shi, B. (2019). Enhancing green public procurement practices in local governments: Chinese evidence based on a new research framework. *Journal of Cleaner Production*, *211*, 842–854.

Magnusdottir, G. L., & Kronsell, A. (2015). The (in)visibility of gender in Scandinavian climate policy-making. *International Feminist Journal of Politics*, *17*(2), 308–326.

McCrudden, C. (2004). Using public procurement to achieve social outcomes. *Natural Resources Forum*, *28*, 257–267.

Mitchell-Olds, T., & Bergelson, J. (1990). Statistical genetics of an annual plant, Impatiens capensis. II. Natural selection. *Genetics*, *124*(2), 416–421.

Nadeem, M., Badahar, S., & Igbal, U. (2020). Are women ecofriendly? Board gender diversity and environmental innovation. *Business Strategy and the Environment*, *29*(8), 3146–3161.

Nelson, J. A. (1995). Feminism and economics. *Journal of Economic Perspectives*, *9*(2), 131–148.

Nelson, J. A. (2006). Can we talk? Feminist economists in dialogue with social theorists. *Signs: Journal of Women in Culture and Society*, *31*(4), 1051–1074.

Nemec, P., Kubak, M., & Dzupka, P. (2021). The transition of the Visegrad countries toward sustainable public procurement. *Eastern European Economics*, *59*(5), 487–512.

Nikolaou, E., & Loizou, C. (2015). The green public procurement in the midst of the economic crisis: Is it a suitable policy tool? *Journal of Integrative Environmental Sciences*, *12*(1), 49–66.

Nuber, C., & Velte, P. (2021). Board gender diversity and carbon emissions: European evidence on curvilinear relationships and critical mass. *Business Strategy and the Environment*, *30*(4), 1958–1992.

Ochrana, F., Plaček, M., & Křápek, M. (2019). Ministerial staff of the Czech Republic 25 years after the "Velvet Revolution." *Teaching Public Administration*, *37*(1), 46–66.

Orser, B., Liao, X., Riding, A. L., Duong, Q., & Catimel, J. (2021). Gender-responsive public procurement: Strategies to support women-owned enterprises. *Journal of Public Procurement*, *21*(3), 260–284.

Orser, B., Riding, A., & Weeks, J. (2018). The efficacy of gender-based federal procurement policies in the United States. *International Journal of Gender and Entrepreneurship*, *11*(1), 6–37.

Ortega, O. M., & O'Brien, M. C. (2017). Advancing the respect for labour rights globally through public procurement. *Politics and Governance*, *5*(4), 69–79.

Pacheco-Blanco, B., & Bastante-Ceca, M. J. (2016). Green public procurement as an initiative for sustainable consumption. An exploratory study of Spanish public universities. *Journal of Cleaner Production*, *133*, 648–656.

Plaček, M., Ochrana, F., Půček, M., Nemec, J., & Křápek, M. (2018). Devolution in the Czech and Slovak institutions of cultural heritage. *Museum Management and Curatorship*, *33*(6), 594–609.

Plaček, M., Vaceková, G., Svidronova, M. M., Nemec, J., & Korimova, K. (2021). The evolutionary trajectory of social enterprises in the Czech Republic and Slovakia. *Public Management Review*, *23*(5), 775–794.

Plaček, M., Valentinov, V., del Campo, C., Vaceková, G., Ochrana, F., & Šumpíková, M. (2021). Stewardship and administrative capacity in green public procurement in the Czech Republic: Evidence from a large-N survey. *Environmental Sciences Europe*, *33*(1), Article 94.

R Core Team. (2021). *The R project for statistical computing*. https://www.r-project.org

Rainville, A. (2017). Standards in green public procurement—A framework to enhance innovation. *Journal of Cleaner Production*, *167*, 1029–1037.

Rosell, J., & Allen, J. (2020). Test-riding the driverless bus: Determinants of satisfaction and reuse intention in eight test-track locations. *Transportation Research Part A: Policy and Practice*, *140*, 166–189.

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, *48*(2), 1–36.

Sarter, E. K. (2020). The development and implementation of gender equality considerations in public procurement in Germany. *Feminist Economics*, *26*(3), 66–89.

Sarter, E. K., & Thomson, E. (2020). Fulfilling its promise? Strategic public procurement and the impact of equality considerations on employers' behaviour in Scotland. *Public Money & Management*, *40*(6), 437–445.

Sönnichsen, S. D., & Clement, J. (2020). Review of green and sustainable public procurement: Towards circular public procurement. *Journal of Cleaner Production*, *245*, Article 118901.

Suzuki, K., & Avellaneda, C. N. (2018). Women and risk-taking behaviour in local public finance. *Public Management Review*, *20*(12), 1741–1767.

Tarling, R. (2008). *Statistical modelling for social researchers. Principles and practice*. Routledge.

Tseng, M.-L., Islam, M. S., Karia, N., Fauzi, F. A., & Afrin, S. (2019). A literature review on green supply chain management: Trends and future challenges. *Resources, Conservation and Recycling*, *141*, 145–162.

World Economic Forum. (2021a). *Global gender gap report 2021*. https://www.weforum.org/reports/global-gender-gap-report-2021

World Economic Forum. (2021b). *Why female leadership is crucial to tackle climate change and other crises.* https://www.weforum.org/agenda/2021/11/why-female-leadership-is-crucial-to-tackle-climate-change

Yang, S., Su, Y., Wang, W., & Hua, K. (2019). Research on developers green procurement behavior based on the theory of planned behavior. *Sustainability*, *11*(10), Article 2949.

Yu, C., Morotomi, T., & Yu, H. (2020). What influences the adoption of green award criteria in a public contract? An empirical analysis of 2018 European public procurement contract award notices. *Sustainability*, *12*(3), Article 1261.

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Article

Framing Climate Policy Ambition in the European Parliament

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Abstract

The European Union's climate policy is considered quite ambitious. This has led to a growing interest among political scientists investigating the European Parliament's ability to negotiate such ambitious climate legislation. These studies generally focus on the voting behaviour of members of the European Parliament, which allows us to know more about their positions when it comes to accepting or rejecting legislative acts. However, we know surprisingly little about how they debate and justify their positions in Parliament. In these debates, members of the European Parliament not only identify the problem (i.e., climate change and its adverse effects) but also discuss potential solutions (i.e., their willingness or ambition to fight and adapt to climate change). In addition, plenary debates are ideal for making representative claims based on citizens' interests on climate action. Therefore, this article aims to understand how climate policy ambitions are debated in the European Parliament and whose interests are represented. We propose a new manual coding scheme for climate policy ambitions in parliamentary debate and employ it in climate policy debates in the ninth European Parliament (2019–present). In doing so, this article makes a methodological contribution to operationalising climate policy ambition from a parliamentary representation and legitimation perspective. We find debating patterns that connect quite detailed ambitions with clear representative claims and justifications. There is more agreement on what to do than how to get there, with divides emerging based on party, ideological, and member-state characteristics.

Keywords

climate policy ambition; content analysis; European Parliament; fragmentation; parliamentary debates; policy change

Issue

This article is part of the issue "Exploring Climate Policy Ambition" edited by Elina Brutschin (International Institute for Applied Systems Analysis) and Marina Andrijevic (International Institute for Applied Systems Analysis).

1. Introduction

The fight against climate change has become a pressing issue on the agenda of the European Union (EU). The 2019 European elections demonstrated that EU citizens considered climate change to be a major challenge for the Union, which translated into a much higher share of votes for green parties and the adoption of a European "Green Deal" as a major goal of the new Commission's work programme (Braun & Schäfer, 2022). After a period in which climate and environmental issues had been relegated to the bottom of the agenda (Burns, 2019), the start of the ninth legislative period (2019–2024) offered the European Parliament (EP) a renewed opportunity to push for more ambitious policy goals. Indeed, if the EP were still the "green champion" it portrayed itself as since the 1980s (Burns, 2021), it should profit from this new political context and push for substantive policy change. At the same time, the EP faces increasing internal and external pressures that often call its "green" ambitions into question. For one, its gradual empowerment in legislative decision-making has forced it to compromise and become more "realistic"; in addition, its composition has become more varied, both in terms of ideology (with a substantial increase in populist and Eurosceptic parties) and geography. As a result, we see that the EP increasingly faces a trade-off between influence and ambition (Burns, 2019; Wendler, 2019).

This article focuses on investigating the ambition of the EP in the area of climate policy through legislative debates. We argue that this is an ideal method to capture the complexity of this policy area. It allows us to observe how individual members of the European Parliament (MEPs) not only frame the nature of the problem (i.e., climate change and its adverse effects) but also justify solutions (i.e., their willingness, or ambition, to fight and adapt to climate change). Therefore, debates reveal the type and justification of policy ambitions rather than their quantity and can help us understand whether different understandings are driven by ideological (left–right), territorial (East–West), or institutional (for/against EU integration) conflict. We develop a conceptualisation of climate policy ambition that can be applied to parliamentary and other political debates. To this effect, we propose a new manual coding scheme for climate policy ambitions based on existing conceptualisations of climate policy activity (e.g., Gravey & Buzogány, 2021; Schaffrin et al., 2015) and complemented by codes to capture the political debate dynamics around representation and justification. In line with this thematic issue, we have a threefold aim: conceptualising climate policy ambition in political (parliamentary) debate, showcasing a new content analysis method to capture kinds and justifications of such ambition, and opening up a new research agenda.

The article first presents the state of research on climate policy ambitions in the EP and provides an overview of how they have been conceptualised and operationalised. We then build on this literature by providing a more systematic coding scheme that allows us to better understand the patterns of representation and justification in EP debates. The results of the content analysis are presented in the following section. In the end, we conclude that debating patterns connect quite detailed ambitions with clear representative claims and justifications. There is more agreement on what to do than how to get there, with the main conflicts being based on ideological, institutional, and territorial divisions.

2. The European Parliament: Still a "Green Champion"?

The Single European Act brought two major changes to EU policy-making: First, it provided a more solid legal base for EU environmental action; second, it established a new procedure (cooperation), which made it possible for the EP to introduce amendments to the Commission proposal. The Environmental committee (ENVI) used these competences to gain a reputation as an "environmental champion" and push for the empowerment of the EP more generally. This was reinforced with the introduction of the co-decision procedure in the Treaty of Maastricht (1992), which turned the ENVI committee into a laboratory for new forms of cooperation between the two co-legislators (the EP and the Council). Although the Treaty of Lisbon was less of a game-changer in the area of environment, it was significant for climate change in a wider sense, since it enlarged co-decision rights to areas that had been dominated by intergovernmental concerns, notably agriculture and fisheries. It also extended the right of the EP to ratify international agreements, which had important repercussions on the external dimension of climate change—especially in areas connected to trade and environmental policies (Biedenkopf, 2015; Burns, 2021).

2.1. A Trade-Off Between Influence and Ambition?

The last decade has shown that, despite having more legislative influence, the EP has not always fought for more ambitious climate goals. Indeed, it increasingly faces a trade-off between exerting influence and acting as a "green champion." This trade-off relates to various internal and external changes.

First, the EP's role as an environmental and climate advocate has been limited by the state of polycrisis, moving these issues lower on the Commission and member states' agenda. With fewer legislative proposals coming through, the EP had fewer opportunities to make a difference (Burns, 2019). In addition, the role of the EP also became more differentiated when it came to advocating climate ambitions on external and internal actions. In the field of external action, the EP continued to act as a "green leader," especially with the use of resolutions and own-initiative reports. It also intensified its expertise and informal contacts with other EU and external actors to be more influential in international negotiations. In comparison, when it comes to internal actions, where the EP acts as a co-decider, its ambitions became more moderate, often offering concessions and flexibility to member states, especially on issues related to (implementation) costs. Therefore, non-legislative resolutions tended to be seen as "cheap talk" and portrayed more adversarial interactions, while legislative debates tended to be more technical and prone to accommodating contrasting views (Biedenkopf, 2019; Burns, 2019; Petri & Biedenkopf, 2021; Vogeler, 2022; Wendler, 2019). This behaviour is not unique to this policy area; with the extension of co-decision, we have seen an increasing distinction between non-legislative actions, where the EP can be more ambitious and formulate "wish lists", and legislative actions, where it needs to be more "realistic" or "responsible" in order to find compromises with the Council (Burns, 2013; Ripoll Servent, 2015).

Second, the trade-off between ambition and influence is also linked to internal EP dynamics, which have become more complex due to the EU's enlargement and the increasing fragmentation and polarisation among its political groups. This increasing diversity in the EP's composition is particularly visible in the area of climate, which calls for a dialogue between different policy issues and, hence, a diverse group of actors. The shift of focus from the environment to climate has broken the monopoly of the ENVI committee on these issues and given a stronger voice to committees dealing with competitive goals, such as the economy, trade, agriculture, and industry. This, of course, opens a window of opportunity for less climate ambitious actors to frame the problems and propose alternative solutions (Burns, 2013; Gravey & Buzogány, 2021). These conflicts are more likely in the current composition of the EP, which has become more fragmented and polarised (Ripoll Servent, 2019). While this offers more opportunities for smaller groups such as the Greens and the Liberals to act as kingmakers, it also makes it more difficult to find compromises that go beyond the status quo and push for ambitious climate policies (Buzogány & Ćetković, 2021; Petri & Biedenkopf, 2021; Vogeler et al., 2021). In addition, the increase in (right-wing) Eurosceptic and populist parties increased the number of critical voices towards EU climate ambitions, especially when new proposals concern the distribution of competences between the EU and its member states (Buzogány & Ćetković, 2021; Forchtner & Lubarda, 2022; Petri & Biedenkopf, 2021; Vogeler, 2022). Finally, enlargement gave a bigger voice to the less ambitious countries—those concerned about the socio-economic repercussions of transition measures. Among those, Viségrad—and especially Polish and Czech MEPs—emerged as the most vocal critics of climate ambitions (Burns, 2019; Buzogány & Ćetković, 2021; Zapletalová & Komínková, 2020). However, the balance between climate ambition and distributive costs continues to be a major concern for many member states and one of the main reasons why MEPs might vote against their EP political group (Buzogány & Ćetković, 2021).

These dynamics lead us to expect that debates on climate policies will be structured around three conflict lines (cf. Wendler, 2019): First, an *ideological conflict* based on a left–right divide around the regulatory aspect of climate targets and implementation measures; second, a *territorial conflict* based on potential distributive costs for specific countries, regions, and constituencies; finally, an *institutional conflict* related to the extent of EU integration, especially when it comes to providing a budget for supranational actors or giving them control over implementation and sanctioning.

2.2. Capturing the Growing Complexity of Climate Policy Ambition

The existing literature has used several methods to capture the EP's climate policy ambition. The earliest and most widespread studies focused on the policy process and used amendments and documentary analysis to study specific (salient or conflictual) cases. This helped establish who had won and lost, both within the EP and from an inter-institutional perspective (e.g., Burns, 2013; Burns & Carter, 2010; Judge & Earnshaw, 1994). Studies focusing on the policy process are generally accurate in their measurement of policy ambitions since this is necessary to determine the extent of influence exerted by specific institutional actors (Burns, 2019; Gravey & Buzogány, 2021). However, with increasing informality in the negotiation process, it has become more difficult to trace the authorship of amendments and policy solutions. In addition, documentary analysis can determine collective positions (e.g., of a particular political group or the EP as a whole) but does not reveal individual preferences and justifications.

Other authors have focused on the policy output, using roll-call votes to analyse individual positions on policy outcomes. Defining policy ambition is problematic, especially for large-N studies; Buzogány and Ćetković (2021) used the support of the Greens in the votes to signal ambition, although they recognised that this might be an imperfect proxy because even the Greens often support policies that outsiders criticise for not being ambitious enough. Indeed, roll-call votes in the EP plenary are known for being highly consensual since conflicts are "internalised" and dealt with in previous decision-making phases—notably within committees and in trilogues (Bowler & McElroy, 2015; Wendler, 2019).

Here, parliamentary debates can offer this "missing link" since they provide data about individual and group positions on policy instruments. Like most working parliaments, EP plenary debates are well known for their declaratory rather than negotiation character (Lord, 2018). However, plenary speeches fulfil different public functions, from explaining one's position to signalling agreement or disagreement with the EP political group (EPG) or domestic parties, as well as speaking on behalf of specific constituencies (e.g., EU citizens, domestic citizens, and particular social groups; Lord, 2013; Proksch & Slapin, 2010; Slapin & Proksch, 2010). Therefore, they allow us to capture more complex dynamics of agenda-setting, argumentation, and justification. Some authors have recognised these advantages and used parliamentary debates to study the emotions and the quality of deliberations (Roald & Sangolt, 2012), the level and type of climate scepticism among far-right groups (Forchtner & Lubarda, 2022), as well as individual and meso-level dynamics in discursive networks (Vogeler, 2022; Vogeler et al., 2021; Wendler, 2019).

However, current studies tend to focus on the quality of debates and are often rather vague on how policy ambitions/change have been operationalised in the coding scheme. They tend not to differentiate types of ambitions such as climate mitigation and adaptation from environmental ambitions. In contrast, we use parliamentary debates to study the actor's perspective on climate policy ambitions because MEPs discuss the ambitiousness of the proposals on the table and publicly shape the willingness to do something about climate change. They do not only state what they want vis-à-vis the Commission and the Council as their negotiation partners; they also highlight for whom they want this and why, thereby fulfilling key representation and legitimation functions (e.g., Kinski, 2021, p. 87; Martin & Vanberg, 2008, p. 507). This provides us with a more nuanced picture of climate policy ambitions *within* the EP, which can also help us uncover to what extent the EP has the potential to be influential in *inter-institutional* negotiations. We know that the EP often uses its internal unity and its representative claims to press the Council and Commission for more ambitious policy reform. Therefore, revealing intra-EP dynamics and conflict is essential to better understand the room for manoeuvre that EP negotiators might enjoy in trilogues.

3. Conceptualising and Capturing Climate Policy Ambition in European Parliament Debates

3.1. Debates on the European Green Deal and the European Climate Law

An increasing number of EU member states, including, for example, Germany, France, and Finland, have adopted national climate laws to define their climate policy ambitions and make long-term commitments to the low-carbon transition of their economies (Duwe & Evans, 2020, p. 10). As a central part of the European Green Deal, the European Climate Law (Regulation of 30 June 2021, 2021) establishes an EU governance framework for achieving climate neutrality, thereby amending the existing Governance Framework for the Energy Union and Climate Action (Regulation of 11 December 2018, 2018).

To capture how members of the ninth EP debate climate policy ambitions, we analyse plenary debates at different stages of this policy-making process (for an overview of the timeline, see Erbach, 2021). In the early agenda-setting phase, the European Green Deal debate of 11 December 2019 (EP, 2019) offered MEPs a chance to detail their "wish list" of ambitions. It resulted in the Parliament's resolution of 15 January 2020 (EP, 2020a), which led to the Commission's proposal for a European Climate Law, presented on 4 March 2020 (European Commission, 2020). In the European Climate Law debate of 6 October 2020 (EP, 2020b), the EP adopted its negotiation position (EP, 2020c) before entering trilogues. Such pre-negotiation debates allow ambitions to be communicated clearly; they reflect not only potential internal conflicts but also the efforts made to reach a common position.

3.2. Methodological Approach and Empirical Strategy

We develop a new manual coding scheme that adapts existing conceptualisations and measures of (climate) policy output and activity to investigate the kinds and justifications of climate policy ambitions in parliamentary debates. We build upon previous studies that investigate the contents of policy instruments (Schaffrin et al., 2015), legislative amendments (Gravey & Buzogány, 2021), and electoral manifestos (Huber et al., 2021). At the same time, we take into account that plenary debates are very different from legal texts, policy documents, and amendments, given their interactive character centred on political exchange, coalition dynamics, and linkages to various principals. Therefore, we ask *what kinds of* climate policy ambitions MEPs discuss and how they *justify them* and *in the name of whom* rather than *how ambitious* they are.

Table 1 summarises these main variables with some of their sub-codes and coding questions. For the full codebook and coding instructions/examples, see Section A.1 of the Suplementary File.

First, in defining climate policy ambitions, we start with the well-known distinction between *mitigation* and *adaptation ambitions* (Intergovernmental Panel on Climate Change [IPCC], 2018). The former refers to

Table 1. Coding climate policy ambition in parliamentary debates.

Variable	Categories	Coding Question
Type of ambition	Mitigation Adaptation	Does the policy ambition relate to fighting climate change or living with/becoming more resilient to climate change impacts?
Targets	(Non-)quantifiable	Can the target be measured?
	(Non-)sectoral (including an inductive list of actual targets)	Is it an economy-wide target, or does it refer to a specific sector (primary/secondary), e.g., manufacturing, transport, primary energy sources?
	Time horizon	Does the target refer to 2030 (short-term) or beyond (long-term)?
Scope	Demand vs. supply side	Does the policy ambition target demand (citizens, households), and/or supply side (business, industry)?
	Energy sources: • Fossil (coal, oil, gas) • Nuclear • Renewable (wind, solar, hydro, biomass, heat and power)	To which energy sources does the policy ambition refer?

Table 1. (Cont.) Coding climate policy ambition in parliamentary debates.

Variable	Categories	Coding Question
Implementation	Policy fields Directives and strategies Mechanisms and instruments	Which policy measures are (to be) taken to reach the target? (including inductive list)
	Sanctioning	Are infringement procedures or other sanctioning mechanisms discussed?
	Budget/public investment	Are costs, public investment, and budgetary implications discussed?
	Procedures and actors	Are specific implementation procedures and responsibilities discussed?
	Mainstreaming requirements	Are mainstreaming requirements into other policy areas discussed?
	Policy integration	Is policy instrument discussed in relation to other policy instruments, the entire governance framework?
Monitoring	Reporting Evaluating (academic advisory board) Updating	Are monitoring processes discussed (reporting, evaluating and updating requirements)? Is the role of an independent academic advisory board in monitoring progress discussed?
Stakeholder involvement	Citizens NGOs and interest groups Scientists	How far do actors discuss the involvement of citizens, civil society/interest groups, and scientists in the climate policy process?
Position (each on target and implementation)	Neutral/no position Positive Negative Ambivalent	How does the actor evaluate the climate policy ambition?
Representation	European citizens Member states Future generations, youth, children Business, companies Farmers, foresters, fishers …	Whom does the actor represent when speaking about a climate policy ambition?
Justification	Urgency Intergenerational justice Credibility Solidarity Social justice Fairness Competitiveness Prosperity Feasibility …	How does the actor frame and justify climate policy ambition?

Source: Authors' own work based on and adapted from Duwe and Evans (2020), Gravey and Buzogány (2021), and Schaffrin et al. (2015).

human actions *to fight* climate change, i.e., to "reduce the sources or enhance the sinks of greenhouse gases" (IPCC, 2018, p. 554). The latter focuses on what can be done *to live with* the consequences of climate change, i.e., "the process of adjustment to actual or expected climate" (IPCC, 2018, p. 542). Mitigation measures include strengthening renewable energy sources, technologies and materials in a circular economy, expanding public transportation, or changing industrial farming practices and food production. Adaptation measures are, for example, protecting the economy, infrastructure, and people against floods, heat waves, or rising sea levels, but also responding to the health risks associated with climate change. Both academic and public debate has long focused on mitigation ambitions rather than adaptation ambitions (as criticised by, e.g., Pielke, 1998), while more recent research has looked into possible trade-offs and synergies between the two (e.g., Bosello et al., 2013; Moser, 2012). In its most recent series of reports, the Intergovernmental Panel on Climate Change (IPCC, 2022) dedicated special attention to adaptation measures. In this article, we focus on which kinds of ambitions MEPs talk about, how they talk about them, and in the name of whom they speak, rather than making an a priori judgment about which kinds of ambitions are more important, feasible, or desirable. In this actor-centred approach, we want to uncover which ambitions MEPs, as central political actors, focus on.

In a second step, we define five core elements of climate policy ambitions based on Duwe and Evans (2020), Gravey and Buzogány (2021), and Schaffrin et al. (2015): *targets*, *scope*, *implementation*, *monitoring*, and *stakeholder involvement*. What distinguishes our approach from theirs is that we use these core elements to capture *kinds of climate policy ambitions in political (parliamentary) debates* rather than creating an index of how ambitious different legal provisions and policy instruments are.

Targets refer to the mitigation and adaptation objectives that are to be achieved. We can distinguish (a) (non-)quantifiable, (b) sectoral/economy-wide, and (c) short and long-term goals (Duwe & Evans, 2020; Nachmany & Mangan, 2018). Do MEPs talk about specific, measurable targets with a clear time horizon, e.g., achieving climate neutrality by 2050 or reducing greenhouse gas emissions by 60% by 2030? Alternatively, do they simply state that there needs to be action to protect the climate and reduce global warming? Research on national climate legislation has repeatedly found that clear targets signal credible commitment to stakeholders, international partners, and citizens, and provide benchmarks for evaluation (Nachmany & Mangan, 2018, p. 2). By publicly debating the merits and flaws of such well-defined goals rather than making vague calls to action or solely emphasising the adverse effects of non-action, MEPs play an important role in providing these linkages. To capture the overall *scope* of a climate policy ambition, we code in how far MEPs consider (a) the supply (i.e., industry, business, and companies) and demand sides (i.e., citizens, consumers, and households) of a policy ambition as well as (b) different energy sources (fossil, renewable, and nuclear; Schaffrin et al., 2015, pp. 267–268).

Implementation encompasses all policy measures, tools, and instruments to achieve the targets (Duwe & Evans, 2020, pp. 14–15). Here, we distinguish by the specificity of the solutions MEPs propose: (a) *specific policy instruments and mechanisms*, such as the CO_2 border adjustment mechanism, carbon taxes, or the European Emissions Trading System; (b) *EU directives and strategies*, such as the Directive on Carbon Capture and Storage or the EU Forest or Farm-to-Fork Strategies; (c) entire *policy areas,* such as the Common Agricultural Policy or trade policy. Further, we record how far MEPs mention *budget/set expenditure*, *implementation procedures and actors*, *sanctioning mechanisms*, *mainstreaming requirements,* and *policy integration* (Schaffrin et al., 2015, pp. 267–268; see also Table 1 and Section A.1 in the Supplementary File).

MEPs may further discuss *monitoring* which includes *reporting*, *evaluating*, and *updating* both targets and implementation steps. Here, we also record what MEPs say about an *independent academic advisory board* involved in progress monitoring (Duwe & Evans, 2020, pp. 32–34). Finally, MEPs may want to publicly debate *stakeholder involvement* through formal consultation procedures and other participatory formats, be it *citizens and voters*, *civil society organisations and interest groups*, or *scientists* beyond monitoring roles (Duwe & Evans, 2020, pp. 35–38).

Besides these core elements of climate policy ambitions—well known to researchers who study policy change and diffusion—we bring in additional elements to capture the political dynamics of how MEPs debate these ambitions. First, and unsurprisingly, this regards the *positions* that MEPs take on targets and implementation. This distinction is worthwhile because we may well see a positive stance on climate neutrality coupled with a negative assessment of a specific measure used to implement this goal. Second, we include the *representation* dimension, namely whom MEPs claim to represent when discussing climate policy ambitions (de Wilde, 2013). When debating decarbonisation or energy transition, do they speak on behalf of businesses and farmers, or do they stress the needs of vulnerable population groups and future generations? Do they claim to represent European citizens or member state interests on climate action (Kinski & Crum, 2020; Vogeler et al., 2021)? Finally, the *justification dimension* identifies the different frames MEPs use to justify why they advocate for or against certain policy ambitions. Broadly speaking, research on justification frames in parliamentary discourse distinguishes between resource-based, norms-based, and cultural justifications (cf. Wendler, 2016, pp. 35–39). On the one hand, resource-based justifications follow the logic of consequentiality in that MEPs stress the costs and benefits of climate (in)action, including economic consequences and feasibility concerns. On the other hand, norms-based and cultural justifications align with the logic of appropriateness in that MEPs highlight certain values, principles, and moral standards when justifying climate policy ambitions. Like the representation dimension, this dimension was coded inductively and encompassed norms-based frames such as responsibility and urgency, solidarity and social justice, alongside resource-based frames such as prosperity, competitiveness, and feasibility, as well as cultural frames including sovereignty and cultural identity (for a detailed description of the individual frames, see Section A.1 in the Supplementary File, pp. 10–11).

The *coding unit* was every individual climate policy ambition within a speech given by an individual MEP as part of the entire plenary debate. The coding involved a two-step process: First, climate policy ambitions were identified as mitigation and/or adaptation ambitions; second, their core elements were coded, including MEP position, representation, and justification. Two coders coded the debates based on the detailed instructions in the codebook (Section A.1 in the Supplementary File) using MAXQDA. A reliability test was conducted and exceeded accepted standards (see Section A.5 in the Supplementary File). Formatting plenary debates as so-called "focus groups" allowed us to automatically identify MEPs as speakers in the documents and merge metadata on their EPG affiliation and member state of origin. Non-English EP debates were translated into English using DeepL and sample-checked by native German, Spanish, and Greek speakers. Results were highly accurate, including reliable named-entity recognition. It was virtually impossible to distinguish translated from original English speech contributions. This practice has proven robust and is increasingly used when researching multilingual, political communication (e.g., Reber, 2019).

The following section presents key results on debating patterns around climate policy ambition in the EP to show that our conceptualisation makes sense empirically and showcase our method for uncovering these patterns. Naturally, this cannot include all patterns and codes. Therefore, our aim is rather to highlight the main findings that we see as a starting point for a new research agenda on climate policy ambitions in political debates.

4. Results

4.1. (Un)Ambitious for Whom, on What, and Why?

In the coded debates on the European Green Deal and the European Climate Law, 134 different MEPs gave 152 speeches containing 791 climate policy ambitions, with over 60% being mitigation ambitions. Interestingly, adaptation ambitions were virtually absent from the debates (under 2%). What we do see is a frequent reference to "general ambitions" (27%) and "environmental ambitions" (10%); hence, we added these categories inductively during the coding process. The former included generic calls to action such as "we must protect the planet" or "we must be more ambitious on climate change." The latter contained calls to protect biodiversity or stop nature pollution and deforestation. Usually, they were linked to mitigation and adaptation, such as in the case of clean air, reforestation as a carbon sink, and acting upon the loss of biodiversity because of climate change:

> People's lives like the life of Sanna Vanar. She is from the Saami culture from Sweden and the culture is based on the cultivation of reindeer, but the reindeer are on the verge of getting extinct due to the climate crisis. Sanna says: "If we lose the reindeer, we lose the Saami culture too." We are here in the European Parliament; we are here to represent them, and we can do something about their future. (Michael Bloss, Greens/European Free Alliance [EFA], Sweden, Climate Law Debate, 6 October 2020)

Frequently, however, environmental ambitions were not explicitly connected to climate policy ambitions, and sometimes were even in clear opposition to them: "The Renewable Energy Directive has led to perverse incentives and environmental damage caused by expensive wind farms that kill migratory birds and bats and harm our precious marine resources" (Robert Rowland, Identity and Democracy [ID], UK, Green Deal Debate, 11 December 2019). Regarding adaptation, we do see talk about the adverse effects of climate change, but there is surprisingly little on how to become more resilient to them. On agriculture, for example, MEPs acknowledged the negative consequences of droughts but debated whether and how to change EU farming practices to mitigate climate change rather than how to adapt to changed environmental conditions for farming.

Regarding *targets* and *implementation*, we see three distinct patterns. First, the debates centred on quantifiable, non-sectoral, short- and long-term targets. The most frequently discussed targets were climate neutrality by 2050, greenhouse gas emission reductions by 2030 by various percentage points and ending the fossil economy. MEPs especially debated sectoral targets for the primary energy sector, farming and livestock, as well as the transportation sector.

Second, while 70% of positions towards targets were positive, the discussion on implementation steps was much more reserved, with around 60% of positions being either negative or ambivalent. While many MEPs agreed on where to go, they disagreed on how to get there. MEPs aimed to implement climate policy ambitions through many different strategies and mechanisms, ranging from energy, agriculture, and trade, to technology and innovation or infrastructure and transport (Section A.2 in the Supplementary File).

Third, MEPs also clearly established a representative connection by emphasising who all of this is for and why they advocate certain policy ambitions. Figure 1 displays all representative claims (left side, n = 369) and justifications (right side, n = 723) scaled to their frequency.

Almost one-fourth of all representative claims went to citizens, followed by an equal share of claims to represent member states (14.6%) and business, companies, and industry (14.4%). Overall, these three constituencies made up more than 50% of all representative claims, suggesting the existence of ideological, territorial, and integration-based dynamics. MEPs used urgency as the most dominant frame to justify climate policy ambition (14% of all frames) but also employed both social justice (9.1%) and competitiveness (8.6%) as frames, suggesting undesirable consequences of such ambition. Leadership frames, emphasising the EU as an ambitious climate pioneer (8.4%), and adequacy frames, pointing to the need to support worthy and sufficient ambitions given the severity of the threat (8.2%), were closely

Figure 1. Representative claims and justification frames of climate policy ambitions. Note: Detailed frequencies in Section A.3 of the Supplementary File.

followed by feasibility and prosperity frames (6.8 and 6.2%, respectively), again indicating doubts about climate policy ambitions and their practicality.

Overall, this points to diverse debating patterns on climate policy ambitions that need more unpacking, along with ideological, territorial, and integration-based conflicts.

4.2. Ideological, Territorial, and Integration-Based Debate Dynamics

First, the differences between EPGs with regard to how their members evaluated the targets and implementations of climate policy ambitions (Figure 2) show both a left–right and a Europhile–Eurosceptic divide.

Both Eurosceptic and Europhile left-wing MEPs were more positive towards targets, such as 2050-climate neutrality, while the Eurosceptic right (but also, to some extent, the EPP) were more sceptical about them. Although all EPGs were more sceptical about implementation ambitions than targets, this was particularly visible for Eurosceptic MEPs. This is in line with Forchtner and Lubarda's (2022) study, which showed that far-right MEPs criticised how anthropogenic climate change was addressed (process) rather than being sceptical about its existence.

We also see interesting dynamics when we turn to representation and justification patterns along party group lines. While all MEPs spoke in the name of citizens, the prominent representation of member states was mainly driven by MEPs from ECR and ID; in turn, business representation came largely from Renew, EPP, and ID (Table 2). The Eurosceptic left tended to represent vulnerable groups and workers, while the Greens spoke on behalf of future generations. This again indicates both an ideological and, to some extent, an integration-based conflict, at least when it comes to the Eurosceptic right.

Justification patterns by EPGs largely confirm these observations (see Section A.4 of the Supplementary File), although they also show a distinct climate change divide: Those for ambitious targets talked about urgency and adequacy, while sceptics framed their criticism in terms of competitiveness, feasibility and—for ID MEPs—also sovereignty.

As for territorial divisions, Figure 3 suggests that MEPs from the East and West were more divided on their assessment of climate targets than their implementation. Although the majority of positions for both

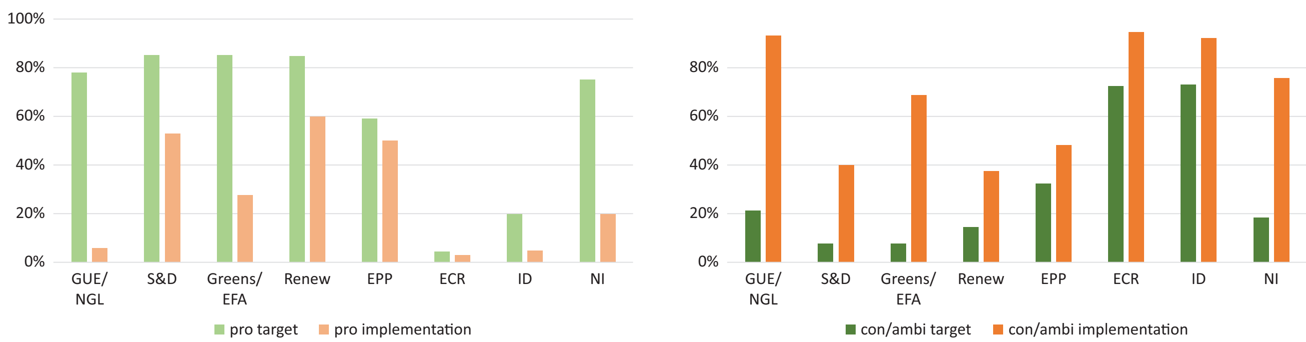

Figure 2. EPGs in % of target/implementation ambitions. Note: Targets in green and implementation in orange; positions in favour on the left (lighter colours) and critical and/or ambiguous positions on the right (darker colours); neutral positions are excluded; GUE/NGL—Confederal Group of the European United Left/Nordic Green Left, S&D—Socialists & Democrats, Greens/EFA—Greens/European Free Alliance, Renew—Renew Europe, EPP—European People's Party, ECR—European Conservatives and Reformists, ID—Identity and Democracy, NI—Non-Inscrits.

Table 2. Representative claims by EPG (in %).

	GUE/NGL	S&D	Greens/EFA	Renew	EPP	ECR	ID	NI
Citizens	36	23	30	27	23	24	22	36
Member states		12	5	5	11	41	22	9
Business, companies, industry	7	9		29	19	9	22	9
Next generations, youth, children	7	16	22	5	8		2	
Regions		10	5	12	11	7	2	9
Workers	14	5	3	5	9	4	8	18
Vulnerable, marginalised, poor	29	7	14	5	3	2	6	9
Farmers, foresters, fishers		5	5	7	8	9	6	
Protesters	7	6	14		1			
Families		1	3		3	2	4	9
Miners		4			1	2		
Consumers		1		2	3			
Small producers, SMEs				2	1		4	
Total	100	100	100	100	100	100	100	100
N claims (Speeches)	14 (9)	97 (35)	37 (17)	41 (23)	101 (33)	46 (15)	49 (13)	11 (7)

groups towards targets were still positive, Central and Eastern European (CEE) MEPs used a more critical tone. On implementation, they were actually more united, but this unity was in opposition to the measures proposed by the Commission.

MEPs from CEE framed climate policy ambitions rather in terms of feasibility and competitiveness. Being especially coal-dependent, they feared the loss of prosperity and frequently questioned the feasibility of the low-carbon and ecological transition, advocating for technological neutrality and gas as a bridging technology. MEPs from the West stressed the need for urgent and ambitious action (Table 3). Regarding representation, CEE MEPs claimed to represent their national interest in 26% of their claims, whereas Western European MEPs only did so in 9% of the cases (see Section A.4 of the Supplementary File). CEE MEPs also specifically spoke about the needs of their coal regions (in 10% of the claims) and the coal miners. Their colleagues from Western Europe, on the other hand, referred to business needs and future generations (10 and 6% of claims, respectively). Despite these differences in representation, MEPs largely agreed that the ecological transformation must be fair, solidary, and just so that it does not leave anyone behind.

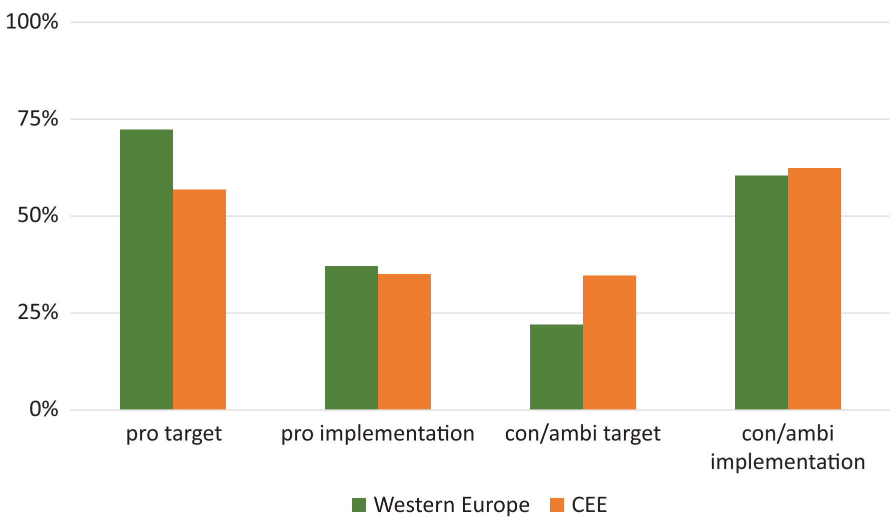

Figure 3. MEPs from Western Europe and CEE in % of target/implementation ambitions. Note: Neutral positions excluded.

Table 3. Justification CEE and Western Europe (in %).

	CEE	Western Europe
Urgency[a]	11	15
Social justice[a]	10	9
Competitiveness[b]	8	9
Leadership[a]	6	9
Adequacy[a]	6	9
Feasibility[b]	11	5
Prosperity[b]	10	5
Fairness[a]	7	6
Responsibility[a]	6	6
Solidarity[a]	5	4
Credibility[a]	2	5
Inclusiveness and accessibility[a]	5	3
Intergenerational justice[a]	4	3
Consistency and coherence[b]	2	3
Sovereignty[c]	4	3
Health[a]	3	2
Cultural identity[c]	1	1
Transparency[a]	2	0.4
Accountability[a]	2	0.4
Negotiation tactics[b]	0	1
Total	100	100
N frames (speeches)	201 (48)	522 (104)

Notes: [a]Norm-based, [b]resource-based, and [c]cultural justifications (cf. Wendler, 2016).

5. Conclusions

This article set out to investigate the climate ambitions of the EP. In a new legislative term, where climate and the environment have become one of the priorities of the EU, it is important to understand the position of the EP. We need to uncover not just who is in favour or against ambitious climate goals but also what these positions actually mean and how they are justified towards (specific) constituents. To this effect, we introduced a new manual coding scheme of climate policy ambitions suitable for the analysis of parliamentary debates; one of its major advantages is that it allows us to, first, get a much more nuanced picture of ambitions, and, second, it also captures the dimension of representation and justification.

Substantively, we find quite detailed debate on policy ambitions, more sceptical and polarised on implementation than on targets. We also show that MEPs establish representative linkages by making claims and justifying their positions on ambitions. However, these claims assemble very different types of constituencies: While most refer to citizens, there is a significant proportion of claims that speak on behalf of member states as well as businesses, companies, and industries. This diversity shows that there are important divides along the ideological, territorial, and integration fault lines that might give rise to climate change conflict, pitting those in favour of ambitious targets against more sceptical MEPs worried about competitiveness, feasibility, and even sovereignty.

Therefore, our method of analysis has produced valid results that correspond to common patterns we know, while also uncovering nuances that we would not have seen by only looking at voting behaviour or limiting our analysis to policy content (e.g., amendments). Coding parliamentary debates provides a much richer insight into the policy-making process since it uncovers dynamics not only at the meso-level (e.g., EPG) but also at the individual level. It also helps better understand how positions change over the policy process and how these changes are justified. It also allows us to determine where unity and fragmentation exist within the EP. This can help us uncover the conditions under which the EP might have (or not) success in influencing policies during inter-institutional negotiations. For instance, it indicates that while the EP negotiators could rely on a wide degree of support for pushing for more climate ambitions, they might struggle to commit member states to tighter targets and implementation. There, national concerns and worries about specific constituencies (e.g., industry or business) might make it difficult for the EP to speak with a single voice—opening a door for the Council or specific member states to co-opt sectors of the EP or specific national delegations to support less ambitious policies. Future research could investigate this link between internal (dis-)unity and inter-institutional influence in climate policy more closely.

Therefore, this article shows that using parliamentary debates to examine the different policy and justification frames is a valid method that opens a new research agenda for the study of (parliamentary) climate ambitions. First, we can use our manual coding scheme to further explore the nature of the EP's climate ambitions and the driving forces behind specific conflicts. There, we could also compare to what extent the driving forces behind these conflicts (ideological, territorial, and institutional divides) are also present in MEPs' voting behaviour. This would allow us to investigate whether and why there is a gap between discursive and voting positions. Similarly, we could examine how positions change between different stages of the policy-making process and whether different types of debates (legislative vs. non-legislative) lead to different types of frames.

Second, while we only had limited space here, it may be worthwhile to investigate whether expertise (e.g., being a relais actor or part of a certain committee), nationality (e.g., centre-periphery dynamics), and gender (female MEPs talking differently about climate policy ambitions or claiming to speak on behalf of women) lead to different positions and forms of justification. Finally, our coding scheme can be used in other parliaments and possibly even other forms of political debate to uncover the factors that shape how political actors speak about climate policy ambition.

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Conflict of Interests

The authors declare no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

References

Biedenkopf, K. (2015). The European Parliament in EU external climate governance. In S. Stavridis & D. Irrera (Eds.), *The European Parliament and its international relations* (pp. 92–108). Routledge.

Biedenkopf, K. (2019). The European Parliament and international climate negotiations. In K. Raube, M. Müftüler-Baç, & J. Wouters (Eds.), *Parliamentary cooperation and diplomacy in EU external relations* (pp. 449–464). Edward Elgar.

Bosello, F., Carraro, C., & De Cian, E. (2013). Adaptation can help mitigation: An integrated approach to post-2012 climate policy. *Environment and Development Economics*, *18*(3), 270–290. https://doi.org/10.1017/S1355770X13000132

Bowler, S., & McElroy, G. (2015). Political group cohesion and "hurrah" voting in the European Parliament. *Journal of European Public Policy*, *22*(9), 1355–1365.

Braun, D., & Schäfer, C. (2022). Issues that mobilize Europe: The role of key policy issues for voter turnout in the 2019 European Parliament election. *European Union Politics*, *23*(1), 120–140.

Burns, C. (2013). Consensus and compromise become ordinary—But at what cost? A critical analysis of the impact of the changing norms of codecision upon European Parliament committees. *Journal of European Public Policy*, *20*(7), 988–1005.

Burns, C. (2019). In the eye of the storm? The European Parliament, the environment and the EU's crises. *Journal of European Integration*, *41*(3), 311–327.

Burns, C. (2021). The European Parliament. In A. Jordan & V. Gravey (Eds.), *Environmental policy in the EU: Actors, institutions and processes* (4th ed., pp. 54–70). Routledge.

Burns, C., & Carter, N. (2010). Is co-decision good for the environment? An analysis of the European Parliament's green credentials. *Political Studies*, *58*(1), 123–142.

Buzogány, A., & Ćetković, S. (2021). Fractionalized but ambitious? Voting on energy and climate policy in the European Parliament. *Journal of European Public Policy*, *28*(7), 1038–1056.

de Wilde, P. (2013). Representative claims analysis: Theory meets method. *Journal of European Public Policy*, *20*(2), 278–294. https://doi.org/10.1080/13501763.2013.746128

Duwe, M., & Evans, N. (2020). *Climate laws in Europe: Good practices in net-zero management*. European Climate Foundation. https://www.ecologic.eu/17233

Erbach, G. (2021). *European climate law* (PE 649.385). European Parliamentary Research Service. https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/649385/EPRS_BRI(2020)649385_EN.pdf

European Commission. (2020). *Proposal for a Regulation of the European Parliament and of the Council establishing the framework for achieving climate neutrality and amending Regulation (EU) 2018/1999 (European Climate Law)* (COM/2020/80 final). https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2020:80:FIN

European Parliament. (2019). *Debates: Wednesday,* *11 December 2019—Brussels*. https://www.europarl.europa.eu/doceo/document/CRE-9-2019-12-11-ITM-007_EN.html

European Parliament. (2020a). *Resolution on the European Green Deal* (2019/2956(RSP)). https://oeil.secure.europarl.europa.eu/oeil/popups/ficheprocedure.do?lang=en&reference=2019/2956(RSP)

European Parliament. (2020b). *Tuesday, 6 October 2020—Brussels*. https://www.europarl.europa.eu/doceo/document/CRE-9-2020-10-06-ITM-011_EN.html

European Parliament. (2020c). *Amendments adopted by the European Parliament on 8 October 2020 on the proposal for a regulation of the European Parliament and of the Council establishing the framework for achieving climate neutrality and amending Regulation (EU) 2018/1999 (European Climate Law)* (P9_TA(2020)025). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=EP%3AP9_TA%282020%290253

Forchtner, B., & Lubarda, B. (2022). Scepticisms and beyond? A comprehensive portrait of climate change communication by the far right in the European Parliament. *Environmental Politics*. Advance online publication. https://doi.org/10.1080/09644016.2022.2048556

Gravey, V., & Buzogány, A. (2021). For farmers or the environment? The European Parliament in the 2013 CAP Reform. *Politics and Governance*, *9*(3), 16–28.

Huber, R. A., Maltby, T., Szulecki, K., & Ćetković, S. (2021). Is populism a challenge to European energy and climate policy? Empirical evidence across varieties of populism. *Journal of European Public Policy*, *28*(7), 998–1017.

Intergovernmental Panel on Climate Change. (2018). Annex I: Glossary. In *Global warming of 1.5 °C: An IPCC special report on the impacts of global warming of 1.5 °C* (pp. 541–562). https://www.ipcc.ch/sr15/chapter/glossary

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation and vulnerability*. https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii

Judge, D., & Earnshaw, D. (1994). Weak European Parliament influence? A study of the Environment Committee of the European Parliament. *Government and Opposition*, *29*(2), 262–276.

Kinski, L. (2021). *European representation in EU national parliaments*. Palgrave Macmillan.

Kinski, L., & Crum, B. (2020). Transnational representation in EU national parliaments: Concept, case study, research agenda. *Political Studies*, *68*(2), 370–388. https://doi.org/10.1177/0032321719848565

Lord, C. (2013). No representation without justification? Appraising standards of justification in European Parliament debates. *Journal of European Public Policy*, *20*(2), 243–259.

Lord, C. (2018). The European Parliament: A working parliament without a public? *The Journal of Legislative Studies*, *24*(1), 34–50. https://doi.org/10.1080/13572334.2018.1444624

Martin, L. W., & Vanberg, G. (2008). Coalition government and political communication. *Political Research Quarterly*, *61*(3), 502–516. https://doi.org/10.1177/1065912907308348

Moser, S. C. (2012). Adaptation, mitigation, and their disharmonious discontents: An essay. *Climatic Change*, *111*(2), 165–175. https://doi.org/10.1007/s10584-012-0398-4

Nachmany, M., & Mangan, E. (2018). *Aligning national and international climate targets*. Grantham Research Institute on Climate Change and the Environment. https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2018/10/Aligning-national-and-international-climate-targets-1.pdf

Petri, F., & Biedenkopf, K. (2021). Weathering growing polarization? The European Parliament and EU foreign climate policy ambitions. *Journal of European Public Policy*, *28*(7), 1057–1075.

Pielke, R. A. (1998). Rethinking the role of adaptation in climate policy. *Global Environmental Change*, *8*(2), 159–170. https://doi.org/10.1016/S0959-*3780*(98)00011-9

Proksch, S.-O., & Slapin, J. B. (2010). Position taking in European Parliament speeches. *British Journal of Political Science*, *40*(3), 587–611.

Reber, U. (2019). Overcoming language barriers: Assessing the potential of machine translation and topic modeling for the comparative analysis of multilingual text corpora. *Communication Methods and Measures*, *13*(2), 102–125. https://doi.org/10.1080/19312458.2018.1555798

Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action. (2018). *Official Journal of the European Union*, L 328. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.328.01.0001.01.ENG

Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'). (2021). *Official Journal of the European Union*, L 243. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R1119

Ripoll Servent, A. (2015). *Institutional and policy change in the European Parliament: Deciding on freedom, security and justice*. Palgrave Macmillan.

Ripoll Servent, A. (2019). The European Parliament after the 2019 elections: Testing the boundaries of the "*cordon sanitaire*." *Journal of Contemporary European Research*, *15*(4), 331–342.

Roald, V., & Sangolt, L. (2012). *Deliberation, rhetoric, and emotion in the discourse on climate change in the*

European Parliament. Eburon.

Schaffrin, A., Sewerin, S., & Seubert, S. (2015). Toward a comparative measure of climate policy output. *Policy Studies Journal*, *43*(2), 257–282.

Slapin, J. B., & Proksch, S.-O. (2010). Look who's talking: Parliamentary debate in the European Union. *European Union Politics*, *11*(3), 333–357.

Vogeler, C. S. (2022). The integration of environmental objectives in the common agricultural policy—Partisan politics in the European Parliament. *Zeitschrift Für Vergleichende Politikwissenschaft*, *15*(4), 551–569.

Vogeler, C. S., Schwindenhammer, S., Gonglach, D., & Bandelow, N. C. (2021). Agri-food technology politics: Exploring policy narratives in the European Parliament. *European Policy Analysis*, *7*(S2), 324–343.

Wendler, F. (2016). *Debating Europe in national parliaments: Public justification and political polarization*. Palgrave Macmillan.

Wendler, F. (2019). The European Parliament as an arena and agent in the politics of climate change: Comparing the external and internal dimension. *Politics and Governance*, *7*(3), 327–338. https://doi.org/10.17645/pag.v7i3.2156

Zapletalová, V., & Komínková, M. (2020). Who is fighting against the EU's energy and climate policy in the European Parliament? The contribution of the Visegrad Group. *Energy Policy*, *139*, Article 111326.

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