Technology as a driver of climate and energy politics

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Technological change as a driver of climate and energy politics

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Abstract:

Technological innovation, often induced by (sub-)national policies, can be a key driver of global energy and climate policy ambition and action. A better understanding of the technology-politics feedback link can help to further increase ambitions.

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The adoption of the Paris Agreement by the Conference of the Parties (COP) in 2016 has been hailed as a milestone in the global effort to mitigate climate change[1]. In contrast to the last major COP in Copenhagen in 2009, which was largely considered a failure, Paris delivered: all Parties agreed to limit the rise in global temperature to well below 2°C above pre-industrial levels by committing to long-term, deep carbonization from 2030 onwards. Political analysts[2] argue that political factors, foremost French diplomacy and the constructive contributions of the major powers, as well as lessons learned[3] from the failure of the 2009 COP were behind this remarkable success. While these observations are all valid, there is one additional decisive factor behind this success that should also be raised: technological innovation – particularly in energy technologies.

Innovation has brought many low-carbon energy technologies to market-readiness today. These innovations and the resulting cost reductions have been largely driven by (sub-)national policies that have pushed many low-carbon technologies along their learning curves[4], renewable energy technologies and electric vehicles being prominent examples. Importantly, technological innovations and cost-reductions were achieved much faster than expected by analysts. For instance, the prominent 2007 global abatement cost report by McKinsey substantially overestimates the future cost of renewable energy technologies and completely omits electric mobility[5]. The increased competitiveness of low-carbon technologies created new economic realities that, in turn, changed global climate and energy politics. Even governments skeptical of climate change and the global climate framework, such as the current US administration, have to acknowledge these realities[6].

The Paris agreement might ultimately represent a paradigm shift from cost minimising to opportunity seizing, and thus from a focus on emissions to one on technologies: Until recently, climate negotiations were perceived as a means to fairly split the economic burden of mitigation. This idea is also reflected in the Kyoto Protocol's key principle of emissions trading (Figure 1a). From the standpoint of national economic competitiveness, COP negotiators had an incentive to minimise negotiated national emissions reduction targets. This incentive has since changed. With the increased competitiveness of low-carbon technologies, policymakers increasingly recognize the potential to create local industries and jobs around them[7, 8], leading to strong incentives for ambitious (sub-)national policies. This trend is evident in the Paris agreement, in which negotiated national emissions targets have been replaced as the key principle for emission reductions by nationally determined contributions (NDCs) whose ambition is to be increased over time. National policies supporting these NDCs cover a wide range of policies intended to induce low-carbon technological change in the energy and transport sectors[8]. In contrast to carbon pricing schemes' burden-sharing logic, they aim at seizing economic opportunities (Figure 1b).

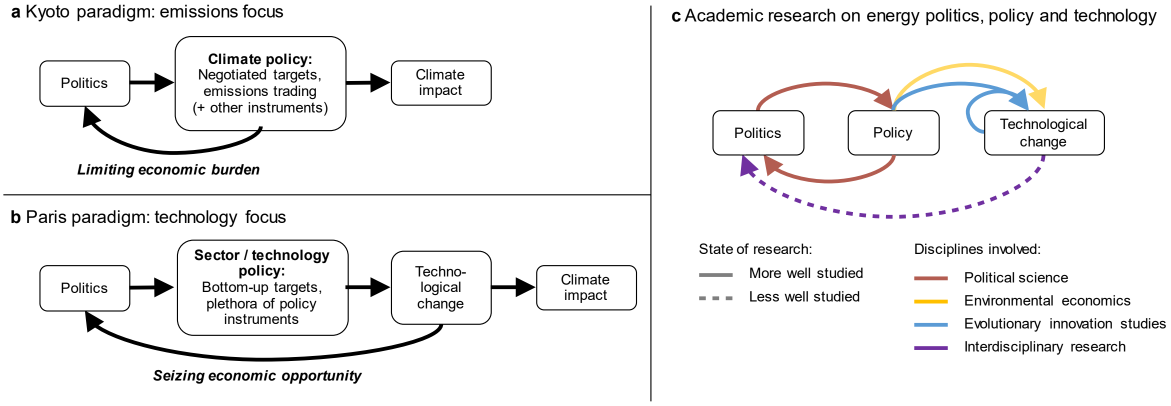

Figure 1 ¦ The interplay of politics, policy, technological change and climate change. **a**, The predominant paradigm under the Kyoto Protocol was an emissions focus. Due to the high abatement costs of most technologies, negotiators had an incentive to limit the national burden of climate change mitigation. Emissions trading served as a means to efficiently distribute the burden. **b**, The new paradigm formalised in Paris took a technology focus. Due to innovation-related technology cost reductions, policymakers' ambitions were much higher, aiming at seizing economic opportunities through technology policies. **c**, Disciplines involved in research on the interactions of politics, policy and technological change. While many interactions are well understood owing to past research, the technology-politics feedback link remains understudied, indicated by the dashed arrow. Note that climate impacts, as shown in **a** and **b** and their feedbacks to politics are not covered by this Comment and are hence absent in **c**. Also note that behavioural change, which is also needed to reach the Paris targets, is not in the focus of this Comment.

While technological innovation provided impetus to the ambitious international targets agreed upon in Paris, these targets can only be reached if effective (sub-) national policies are implemented and national ambition levels are further increased[9]. Achieving these objectives requires a better understanding of the technology-politics feedback link. Despite this relevance, systematic empirical analyses of the role of technological innovation for policy change and the underlying politics are largely lacking. This research gap might stem from the disciplinary divide between the research communities studying policy change and those studying technological change (Figure 1c): for example, most environmental economists studying the effects of innovation policy regard policy as merely an exogenous variable. Similarly, policy feedback literature in political science provides important insights into long-term policy dynamics[10], yet, it lacks an understanding of patterns of technological change. Here, insights from evolutionary innovation studies can contribute. Recent publications from the transitions-research community explicitly acknowledge the co-evolution of technology and policy, have started to bridge the gap conceptually[11, 12] and have provided individual case studies[13, 14]. However, to inform evidence-based policymaking, research needs to establish causal links, empirically test hypotheses on a quantitative basis, and provide predictive power – all of which is currently lacking.

Toward a research agenda

To help understand the feedback links between technology, politics and policy, we propose a research agenda that builds primarily on five perspectives from political science and innovation studies: geography, technology, agency, polity and diffusion. This agenda aims to integrate the disciplines listed in Figure 1 in order to guide empirical research and thereby improve evidence-based policymaking.

Geography. A country's resource endowments and economic activities can strongly impact on the technology-politics link: On the one hand, large fossil fuel resources – especially in combination with major local extraction activities and large energy-intensive industries – can obstruct policy change[15, 16]. On the other hand, high renewable resource availability can support policy change. Importantly, the presence of different economic activities and related industry capabilities allows for the localization of different shares of low-carbon technology supply chains[8]. As this affects job and wealth creation, variation in feedbacks to politics across differently developed countries can be expected. The economic geography dimension should thus always be considered when analysing the technology-politics feedback link through systematic empirical research.

Technology. While all low-carbon energy technologies contribute to climate change mitigation, they feature important differences that can affect their interaction with politics. First, their disruptive potential[17] varies significantly from technology to technology. While technologies such as carbon capture and storage reinforce the role of incumbent players, other technologies such as photovoltaics (PV) can disrupt existing energy markets, for example, through massive decentralization, which in some geographies could make the grid – the backbone of the current power system – obsolete and create prosumers with changed energy-related behaviour[18]. This, in turn, is likely to result in altered policy dynamics and substantial policy change in the mid- to long-term. Second, because of the different complexities and scales involved, different technologies feature different bottlenecks and learning rates; thus they require different policy mixes[19] and speeds of policy adjustment[4, 20]. German policymakers, for example, had to adjust feed-in tariffs for PV more frequently than for bioenergy because of the higher learning rate for PV. Finally, different technologies require different industry capabilities (see Geography, above), affecting technological options and thus the technology-politics link[8]. Apart from a few examples, current policy literature often fails to acknowledge the high variance in innovation potentials and patterns of different technologies.

Agency. Actors and their networks play a crucial role in the technology-politics feedback link: besides inventing, innovating and diffusing new technologies, actors influence policymaking and policy change. Importantly, agency forms around technologies[21] both through hard economic interests as well as beliefs and norms regarding technologies[22]. Policy interventions that nurture new technologies can thus create new actor networks that, in turn, can influence long-term policy dynamics by creating positive feedback effects. For example, technology policy interventions can nurture low-carbon business coalitions that help overcome the political opposition of incumbent firms towards carbon pricing policy[23]. However, our understanding of those policy designs that are most effective in creating and empowering new 'low-carbon' actors is very limited. Often, the existing literature either takes the form of single case studies or is rather unspecific in terms of the policy intervention studied. Future research should systematically compare policy designs to arrive at meaningful policy recommendations regarding the creation of influential low-carbon technology actors that fundamentally alter politics.

Polity. Political institutions moderate the speed, direction and stickiness of policy interventions[16, 24, 25]. For example, the observed stickiness of the German feed-in tariff for renewable energy depended strongly on the fact that reforms required majorities in both parliamentary chambers[13], whereas the lack of stability of US tax credits for wind power is related to the volatile politics of Congressional budgeting[26]. Apart from such isolated findings, however, a systematic approach to empirically studying these effects is missing. Systematic cross-country comparisons of the effects of institutions on the technology-politics feedback link are needed to provide a basis for assessing policy designs in diverging institutional contexts, such as unicameral versus bicameral legislation, federalism versus unitary government, or autocracy vs democracy.

Diffusion. Public policy literature has long established that, as a result of policy makers learning from activities in other jurisdictions, policies can diffuse, from the local level to the global level. Besides direct policy diffusion, indirect spillovers can occur as policy-induced technological change in one jurisdiction may lead to altered politics and policymaking in another[27]. For example, the German feed-in tariff was instrumental in fostering a PV industry supply chain. Then, with the production equipment available, the Chinese government enacted a manufacturing support policy, which quickly enabled China to become the world's largest PV manufacturer[28, 29]. While the body of research on the diffusion of policies across governmental levels is large, policy-induced technological change as a driver of policy change in other jurisdictions is hardly considered at all. As climate change mitigation is a global effort, it is highly important to better understand these effects across boundaries and governance levels to inform policy. Hence, systematic research on the indirect spillover-effects should be performed across geographies and at all governance levels.

Developing policy recommendations

While these five perspectives are not fully independent, they could help to structure research on the technology-politics feedback link. Cross- disciplinary collaboration, especially between public policy and innovation scholars, is essential to implement this research agenda. While some collaborative work in the transitions research community has provided conceptual contributions, more empirical and quantitative studies are needed. Data on technological change and policy dynamics needs to be prepared in ways that enable their coupling. To catalyse collaboration, the right incentives need to be set by, amongst others, high-impact interdisciplinary journals or grants that enable the formation of substantive research programs and interdisciplinary groups. Providing evidence-based and meaningful policy recommendations at all levels should be such groups' guiding principle. Current recommendations for energy and climate policy, if ignoring politics, are often unrealistic[12] or, if overlooking the technology-politics feedback-link, myopic. Myopia is particularly problematic in the energy sector, as technological change often takes place over decades[30]. Research based on the proposed agenda can overcome these limitations and, for example, inform the design of more sticky policies that are resilient to subsequent dismantling efforts from incumbent agents[25]. Also, donors, such as the Green Climate Fund, could use insights generated by such interdisciplinary research for deciding which proposed policies to support to maximize their transformational impact.

To conclude, understanding the technology-politics feedback link would enable us to provide more realistic and transformative recommendations for climate and energy policy design, which are currently often lacking[31]. Such designs can ultimately result in virtuous long-term policy-technology cycles and the 'creative destruction' of high-carbon structures[1], both of which are required to meet the target of keeping global temperature rise well below 2°C.

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