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SPECIAL ISSUE • Policy expertise in times of crisis

research article

Investigating the scientific knowledge–policy interface in EU climate policy

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We provide an historical overview of the evolution of knowledge exchange architecture for climate policy in the EU. We investigate whether evolutions in the knowledge architecture reflect shifts in the politicisation of climate change. First, we outline a conceptualisation of politicisation that accounts for two types of effects: prioritisation leading to enabling conditions for knowledge exchange, and polarisation leading to constraining conditions. Next, we describe the shifting politicisation of climate change in the EU since the 1990s, followed by a discussion of the evolution of two key aspects of the knowledge exchange system: formal and informal aspects, focusing on knowledge exchange with the European Commission. Our analysis reveals connections between the development of the formal and informal aspects of the knowledge exchange architecture and the shifts in politicisation in different time periods. We find that when the politicisation of climate change led to a negative or constraining context, the informal aspects of the knowledge exchange architecture closed, making it more challenging for multidisciplinary scientific knowledge to enter the process. However, the formal aspects of the knowledge exchange architecture remained in place, even under constraining conditions. The article provides a nuanced assessment of the connections between the effects of politicisation and the potential for meaningful scientific–policy knowledge exchange, enhancing our understanding of both the politicisation of climate change and of knowledge exchange architectures.

Keywords EU climate policy • politicisation • science–policy interface • knowledge architecture • knowledge exchange • expertise

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Introduction

Scientific knowledge on the causes and impacts of climate change has featured strongly in the European Union's (EU) climate policy development, ever since the first report of the Intergovernmental Panel on Climate Change (IPCC). With

each new policy development, the European Commission (hereafter: Commission) referred to the IPCC, using the scientific basis as an argument to justify both global and EU-level climate action. EU policymakers repeatedly called for global climate decisions to be in line with scientific advice (Collier, 1996; European Commission, 2007). This foundation of relying on scientific expertise for climate action aligned with a broader push towards 'evidence-based' or 'evidence-informed' policymaking in the EU (Head, 2016; Majcen, 2017). The Commission has repeatedly called for policies to be built firmly upon scientific evidence (European Commission, 2007; 2015), and a knowledge exchange architecture developed.

We are interested in the evolution of the knowledge exchange architecture around climate change in the EU. We conceptualise this architecture as the ways and means by which multidisciplinary scientific knowledge enters the policymaking process. This architecture includes both formal elements or structures (calls for studies, research funding, expert working groups, impact assessments and consultations) and informal elements (individual connections between scientists and policymakers, ad hoc uptake of scientific research, conferences and workshops).

Climate change as a policy issue has also evolved. In the 1990s, climate scientists were busy researching the causes and scale of the problem, and the scope of the required response. In the 2000s, debates around the causes of climate change were largely settled. The debate shifted towards how to limit and tackle the impacts of climate change, and how the societal consequences of climate change and unjust climate policy action could be mitigated. The 'wicked' nature of climate change has become ever more evident, and the types of knowledge needed in the policy discourse in the 2020s has evolved beyond those required to explain the causes of climate change in the 1990s (Levin et al, 2012; Head and Alford, 2015). Accordingly, given its scale and effects, climate change has become an increasingly politicised issue: both politically salient and polarising.

Research highlights a tension between two aspects of politicisation. Politicisation means an issue becomes prioritised on the political agenda, which can have either positive/enabling effects, leading to possibilities for knowledge uptake and policy action, or it can have negative/constraining effects leading to conflict and polarisation, which presents challenges for knowledge uptake and policy development. So, the politicisation of an issue may make it more challenging for scientific expertise to enter and remain in policymaking discussions (Radaelli, 1999). But research on climate governance suggests that politicisation may be necessary to ensure policy action (Pepermans and Maeseele, 2016; Paterson et al, 2022). These seemingly paradoxical dynamics are rarely studied together to understand changes in knowledge exchange architecture. Such a study requires longitudinal data and analysis, across different eras of politicisation. In this article, we focus on whether and how the knowledge exchange architecture in the EU evolved with the politicisation of climate change. We do so by demarcating how the politicisation of climate change has vacillated over time between politicisation mainly as prioritisation and politicisation mainly as polarisation. Then, drawing on a rich set of interview data, we explore how these ebbs and flows of politicisation contributed to changes in the climate knowledge exchange architecture, focusing particularly on the Commission.

The article is structured as follows. First, we discuss the concept of politicisation and its potential consequences for knowledge exchange architectures. Second, we present our methodological approach. Third, we present our analysis, beginning with

an overview of climate change politicisation in the EU, relying on literature review and document analysis. This is followed by an analysis of the historical evolution of the knowledge exchange system in the EU climate policy context, highlighting both formal and informal aspects. For this step, we rely on literature, official EU documents and on data sources taken from official EU websites. Then, drawing extensively on an analysis of 34 interviews carried out between 2010 and 2022, we discuss the development of the knowledge exchange architecture from the 1990s onwards, highlighting the connections with different politicisation eras, as established in the third step. We conclude with reflections on our understanding of both politicisation and knowledge exchange architectures, suggesting areas for further research.

Politicisation and knowledge exchange

Politicisation describes how policy issues are elevated on the political agenda, and the consequences of this elevation for policymaking. We identify two relevant consequences of politicisation. First, politicisation, as connected to issue salience, leads to the prioritisation of an issue. This can be evidenced by high-level political actors' attention to the issue (Dupont, 2019). Second, politicisation leads to conflict or polarisation, as an issue becomes more deeply embedded in regular politics of conflict and opposition (Pepermans and Maeseele, 2016; Dupont, 2019; Bressanelli et al, 2020; Fisher et al, 2022; Paterson et al, 2022).

Literature therefore suggests there are both potential positive and negative consequences of politicisation, especially in the context of climate knowledge exchange. Politicisation through prioritisation occurs when an issue is no longer the sole concern of technical policy officers (actors who may be more likely to seek expertise and scientific knowledge) but becomes an issue of discussion among ministers and prime ministers. Along with this higher political salience comes potentially negative or positive effects for the resolution of the issue itself, and for the knowledge exchange architecture around it. Negative effects can include polarisation across political views or around the appropriate responses. This is likely to constrain action, including by delaying, diluting or deferring action, or by limiting the possibilities for (politically or societally) acceptable policy options. Positive effects of politicisation include the elevation of an issue to high-level discussions, increasing visibility for the issue and political and social openness to ranges of possible or available solutions. Such positive/enabling effects can lead to new possibilities for action, diluting political constraints to action (de Wilde et al, 2016; Zeitlin et al, 2019; Bressanelli et al, 2020).

When it comes to the role of knowledge in policymaking, there are fears that politicisation falls heavily on the side of generating conflict, or that the negative/constraining effects are more prominent. Radaelli (1999: 757) posits that the 'power of expertise is being counterbalanced by politicisation', meaning that the more politicised an issue, the less likely that scientific expertise becomes a foundation for policy development. Head agrees, arguing that 'the political nature of policy debate and decision making is generally unfavourable to science-driven perspectives' (2016: 474). However, other researchers argue that it may depend on the issue at hand. For climate change, some argue that politicisation is necessary to ensure policy action (Paterson et al, 2022), and that the necessity for policy action spurs requirements for knowledge.

We suggest, therefore, that politicisation is not static. A politicised issue may not necessarily remain tethered to the negative/constraining or to the positive/enabling

effects. If an issue remains highly politicised, intervening factors or events may shift from one type of politicisation effects to another, without necessarily requiring the issue to be 'depoliticised' (often seen as the only cure to the negative/constraining effects of politicisation) (Remling, 2018; Dupont, 2019; Bressanelli et al, 2020). Depoliticisation (of parts) of an issue can been actively pursued to shut down debate, for example by setting climate targets into binding legislation, but depoliticisation is not always beneficial for the advancement of policy on an issue, and repoliticisation may be required (Paterson et al, 2022).

This nuanced understanding of the potential negative/constraining or positive/enabling effects of politicisation suggests that the effects on the knowledge exchange architecture may vary. A highly positive/enabling politicisation of the climate issue may require detailed scientific knowledge of a wide range of policy options, with knowledge of the interactions of their broad effects, or potential consequences. This calls for knowledge from a range of scientific disciplines. However, a politicised issue that results in negative/constraining effects is likely to confirm the assertions by Radaelli (1999) and Head (2016) that politicisation and the conflictual political nature of debates limit the opportunities for meaningful knowledge exchange.

Methodological approach

Given the exploratory nature of our research, we follow a longitudinal case study structure, relying on multiple sources of data, triangulation and thick description. This approach focuses on identifying optimal cases for exploring the phenomenon of interest rather than making generalisations (Stake, 1995; Zaki and Wayenberg, 2023). The analysis proceeds in several steps. To analyse the politicisation of climate change in the EU, we rely on literature review complemented by official EU documents. To reveal the formal and informal aspects of the Commission's knowledge exchange architecture, we draw from literature review, and rely on official Commission documents and an analysis of data from relevant Commission web sources. For the core analysis on understanding the evolution of the knowledge exchange architecture along the politicisation effects described earlier, we source data from 34 semi-structured interviews carried out with senior officials in European institutions and with scientific experts between 2010 and 2022. We sought data from interviewees that also reflected on past developments, meaning that we have gathered data that reflects on policy and knowledge developments, and the politicisation of the climate issue, from the late 1990s onwards. All interviews were carried out under conditions of anonymity, and the analysis of the interviews included coding of transcriptions to highlight knowledge and politicisation effects. Our data was then deductively analysed. This focused on coding observations of (1) politicisation effects types (prioritising and enabling or polarising and constraining), (2) key elements of formal and informal knowledge exchange architectures, and (3) interest in/uptake of multidisciplinary scientific knowledge. The analysis is structured longitudinally across periods of varying politicisation effects, along which we track changes in the knowledge exchange architecture. This allows us to generate a preliminary covariational image of the relationship between our two main areas of interest: politicisation and knowledge exchange architecture for climate change.

Climate change as a politicised issue in the EU

There is general consensus among EU climate governance scholars that the issue became particularly salient in the EU from the 2000s (Dupont, 2019). The EU declared its aim to become a global climate leader, filling a leadership void left by the United States when President George W. Bush announced in 2001 that the US would not ratify the Kyoto Protocol (Bäckstrand and Elgström, 2013). From then on, climate change remained a high politics issue, regularly discussed by high-level political actors in the EU. Interestingly, there was little to no backlash from EU policymakers towards scientific expertise on climate change, and a highly marginalised climate denial movement, unlike in other industrialised parts of the world (Howlett, 2014; Tangney, 2019). Thus, climate change was politicised as a prioritised issue of high politics.

The effects of this politicisation, however, ebbed and flowed with the wider political context in the EU, particularly in the context of wider crises (Burns and Tobin, 2020). The 2000s saw positive and enabling effects of the politicisation: the high-level political attention and prioritisation of the issue moved policy decisions forward, overcoming internal disagreements (among member states) that could have delayed climate policy development. This enabling politicised context resulted in the agreement in 2007 on a target to reduce greenhouse gas (GHG) emissions by 20 per cent by 2020 compared to 1990 levels, and the adoption of a slew of policy measures to achieve that target (Oberthür and Pallemaerts, 2010).

The effects of politicisation shifted in the late 2000s and in the first half of the 2010s. The financial and economic crises that began around 2008, combined with the failure of the negotiations in Copenhagen in 2009 to agree on a new international agreement, created a context for negative or constraining politicisation of climate change (Dimitrov, 2010). The issue remained on the agenda of high-level politics (prioritised), but other crisis-related issues were also of high priority (Dupont et al, 2018). Member state divisions around climate targets and policy measures deepened, causing delays. The shape and scope of policy measures, the time taken to negotiate them, and the low number of new policies proposed meant that there was only limited progress on climate policy (Kulovesi and Oberthür, 2020). The possibilities for action were considerably constrained and debate on the issue was divisive (Skovgaard, 2014; Burns and Tobin, 2020; Paterson et al, 2022).

New opportunities for positive or enabling effects of politicisation to spur climate action emerged after 2015, with the adoption of the Paris Agreement at the United Nations' climate negotiations. Popular movements, including Fridays for Future and youth movements, pushed the climate issue further up the political agenda (Oberthür and Dupont, 2021). The Commission followed up on the Paris Agreement with policy discussions on a climate neutrality target for the EU, which was eventually agreed upon by the European Council, despite long-standing member state divisions (European Commission, 2018; Oberthür and Dupont, 2021). This positive/enabling politicised context led to the publication of the European Green Deal in 2019, which has the goal of achieving climate neutrality by 2050 at its heart (European Commission, 2019).

Since 2019, the EU has traversed two major crises: the COVID-19 pandemic and the energy crisis, connected to Russia's invasion of Ukraine. The politicisation of climate change remains high, with the issue prioritised on the EU's high-politics agenda. Nevertheless, member state voices did come out questioning the logic of implementing the European Green Deal in such times of crisis (Dupont et al, 2020; Kuzemko et al, 2022).

Given past experiences in the late 2000s and early 2010s, we could expect that such crisis situations would create constraining effects, emphasising conflict (Burns and Tobin, 2020). However, the European Green Deal has proven a resilient framework and the EU has integrated the goals of the European Green Deal into its crisis-response measures. The overall result is one of ratcheting up climate targets and advancing climate policy, even during two major crises, demonstrating that crisis situations do not necessarily lead to constraining effects of politicisation (Dupont et al, 2020; von Homeyer et al, 2022).

Reflecting on this shift in politicisation of climate change over time, we expect corresponding shifts in the climate knowledge exchange architecture. During the positive/enabling periods of politicisation (in the early to mid-2000s and again after the adoption of the Paris Agreement in December 2015) we would expect an enabling context for knowledge to enter the policy process. During periods of negative or constraining politicisation, however, we expect rather to find more challenges for multidisciplinary scientific expertise to enter the policy process (that is, especially between 2008 and 2015).

Knowledge exchange architecture in the EU on climate change

We build on a rich body of literature to study knowledge exchange architectures. We use the term knowledge exchange architecture to describe the formal and informal structures and processes by which knowledge enters the policymaking process in the EU, and we are particularly interested in how multidisciplinary scientific knowledge enters through this architecture.

First, however, it is important to discuss the shifting nature of climate change as an issue, and the knowledge or scientific expertise understanding both its causes and the potential solutions. The causes of climate change are known – the excessive emissions of GHGs through human activity – and clearly laid out in robust reviews of global climate science (IPCC, 2007; 2013; 2022). The solution can be regarded as relatively simple: reduce GHG emissions as quickly as possible (IPCC, 2022). However, climate change is far more complex to resolve in reality. It is regularly cited as a perfect example of a 'wicked' problem because the solution – although simple on paper – is complex to implement. It requires action across multiple sectors of society, within a certain timeframe, and at all levels of global society (Levin et al, 2012; Jordan and Huitema, 2014; Head and Alford, 2015). Furthermore, as we fail to respond sufficiently, or sufficiently quickly, to climate change, the complexity only grows. Consequently, the scale, speed and scope of the transformation needed increases (Fazey et al, 2018).

Hence, knowledge needed to respond to the climate crisis is multidisciplinary. Physical or natural sciences are essential for deeper understanding of the interconnections among earth systems and their evolutions in response to climate change (IPCC, 2021). However, agreeing on, responding to, and implementing solutions to these challenges can be highly conflictual. It is contingent upon political appeal, socioeconomic implications, and behavioural adjustments – all issues requiring multidisciplinary scientific knowledge (Compston and Bailey, 2008; Edmondson and Levy, 2013).

For this reason, it is important, second, to understand the underlying values around multidisciplinary scientific knowledge exchange in the EU. The principle of 'evidence-based' policymaking suggests that multidisciplinary scientific expertise should be

highly valued in EU policymaking (European Commission, 2015). When the interests of policymakers are simply to gather data on an issue, then knowledge exchange systems can be straightforward. The more 'technical' a problem is, the more likely that external, scientific expertise will be sought by policymakers. With complex issues, such as climate change, policymaker interests vary and multidisciplinary scientific expertise may be more or less welcome, or may rather be reframed for political ends (Fischer, 1990; Radaelli, 1999; Weingart, 1999; Liberatore and Funtowicz, 2003). The reality of the EU's (complex) decision-making process means that scientific expertise is not always perceived as the source of the most 'relevant' information in all stages of the policy process, nor is it as equally valued by all the policymaking institutions in the EU (Soomai, 2017).

To overcome some of these (also analytical) challenges, we analyse the knowledge exchange system with the Commission, thus focusing primarily on the agenda-setting and policy design phase of the policy cycle. The process of agenda-setting and policy design in the EU is complex, with many actors, institutions, preferences and interests involved, and with information on the potential policy directions coming from scientific expertise, industrial interests, member governments, politicians, citizens, non-governmental organisations, international partners and so on (Pollack, 2010; Head, 2016). The policymaking process includes three co-deciding legislative institutions: the Commission, which has the sole right to propose legislation in the EU, the European Parliament, directly elected by EU citizens, and the Council of the European Union, representing member state governments at the ministerial level. In addition, the European Council, a political institution in the EU that brings together heads of state and government and has no legislative role in the policymaking process, is nonetheless influential in setting the EU's priorities (Barnes, 2011; Rosamond and Dupont, 2021). There are also different knowledge exchange practices across the EU institutions, but scientific researchers highlight that they regularly interact with the Commission making the knowledge exchange architecture with this institution particularly worthy of study in a longitudinal context (Interviews 16 and 17).

Formal knowledge-exchange architecture with the Commission

With the Commission's role as the EU institution with the sole right to make legislative proposals, it has a special place in the knowledge exchange architecture, given the potential for multidisciplinary scientific expertise to influence the agenda-setting and policy design phases. The Commission usually actively seeks scientific knowledge in the development of its policy proposals. There are certain formal mechanisms and structures by which the Commission seeks such knowledge and expertise (beyond the Commission's in-house knowledge, embedded especially within the Joint Research Centre).

First, the Commission is responsible for drafting research programmes and funding research across the EU. EU-funded research projects are expected to provide input to policymaking. The research framework programmes support consortia of researchers and institutions to investigate issues or technological advances of relevance to policy. Increasingly, research projects (such as under the EU research programme Horizon 2020) require scientists to communicate their results in a policy-friendly manner. An analysis of the results of funded research programmes in the EU shows some evolution. Under the EU's Research Framework Programme from 2007 to 2013 (FP7), 1.2 per cent of funded projects included the word 'climate' in the title (a

total of 313 projects). In the Horizon 2020 programme, from 2014 to 2020, 3.9 per cent of projects funded included the word 'climate' in the title (4610 projects).[1] The Commission is responsible for setting research priorities, so an increase in share of climate-related projects could therefore also be seen as an increase in the demand for climate knowledge.

Second, the Commission regularly publishes calls for tender on specific issues linked to policy priorities. An analysis of the Commission's calls for tender from 2016 to 2022 shows that, while most of the calls for studies on policy proposals or evaluations of policy instruments related to climate change originated from the Commission's Directorate General for Climate Action (DG Clima), several other DGs have also (increasingly) published calls for studies related to climate issues (see Table 1). Such calls for tender are often granted to consultancies, although they also often work in consortium with scientific institutions (universities or research institutes). While such data should not be interpreted too deeply, it does indicate that there was a growing understanding across the Commission of the need to address the issue (Oliver et al, 2021).

Third, another formal mechanism for knowledge exchange includes public consultation processes in preparation of a policy proposal (European Commission, 2002a; 2002b). This process has been in place since the early 2000s and is a means to gather views from citizens, businesses and organisations. As such, it does not serve specifically for multidisciplinary scientific knowledge to enter the policymaking process, but provides an opportunity for individual scientists or research instititions to provide input. Scientific knowledge in this process is one voice among many.

Fourth, the impact assessment procedure is another important aspect of the Commission's formal mechanisms for knowledge gathering, a process that has been in place since the early 2000s, alongside the public consultation procedure (Renda, 2006). The impact assessment procedure is an evidence-gathering exercise to establish the environmental, economic or social impacts of a draft policy proposal. Such impact assessments are prepared inside the Commission, relying often on

Table 1: Analysis of calls for tender from Commission, 2016–2022

	Total calls for tender from Commission	Calls for studies related to climate	Of which, calls for studies from DGs other than DG Climate Action
2016	718	10	1: DG Agriculture (AGRI)
2017	767	12	2: Joint Research Centre (JRC)
2018	746	15	2: DG Energy (ENER) and JRC
2019	693	19	3: DG Mobility and Transport (MOVE) and JRC
2020	711	14	4: DG Civil Protection and Humanitarian Aid Operations, (ECHO), DG Environment (ENVI), DG AGRI and JRC
2021	745	7	4: DG ENER and JRC
2022	796	23	14: DG for Regional and Urban policy (REGIO), DG for Research and Innovation (RTD), DG ENER, DG for International Partnerships (INTPA), DG ENVI, JRC

Source: own analysis of data drawn from the EU's online tenders' portal (www.ted.europa.eu), accessed 3 April 2023.

in-house expertise, but drawing on a variety of sources. Many impact assessments therefore include references to scientific research and refer also to results of EU-funded research projects.

Finally, the Commission benefits from formal knowledge exchange through its expert groups. However, these expert groups fluctuate: some are stable, some are established in relation to a specific policy issue, but the extent to which scientific knowledge is exchanged through such expert groups varies. Many expert groups include representatives from member states, and it is up to the member state to decide whether they send an independent scientific expert or not. Expert groups can also include representatives from industry or NGOs (Tanasescu, 2009). In 2021, the European Scientific Advisory Board on Climate Change was established under the European Climate Law. This represents an EU-wide innovation in the knowledge exchange architecture, not only in reference to the Commission. But as a new body that produced its first advice in late 2022, it falls outside the timeframe of our analysis.

Informal knowledge exchange architecture in the Commission

Scientific expertise also flows to the Commission in informal ways. First, the informal aspects of the knowledge exchange system are based predominantly on relationships and personal networks (Bouwen, 2004; Coen, 2007; Gullberg, 2008). These relationships are often at the individual level between Commission official and a scientific researcher, or team of researchers. Commission officials, and particularly policy officers responsible for drafting proposals, reach out to those researchers in their networks to seek out the latest knowledge. The relationship also moves in the opposite direction, with researchers reaching out directly to Commission policymakers with their latest research findings. However, the perception that such relationships are built on lobbying activities such as those that are usually connected with informal processes of information-sharing sometimes sits uncomfortably with the ideals of the (academic) expert as a 'neutral' and detached observer of social and scientific phenomena (Juntti et al, 2009).

Second, informal knowledge exchange occurs through the ad hoc organisation of conferences, workshops and knowledge development events around a certain issue, usually organised by the Commission. For such events, the Commission often relies on a network of researchers (built up via informal individual relationships or via EU-funded research grants) to serve as invited experts. These conferences are open events, and often include other stakeholders (for example, industry, citizens, NGOs), meaning that scientific knowledge-exchange is not the sole objective.

Third, more science-led approaches to informal methods of knowledge exchange include efforts by the scientific community at science communication. These include initiatives to connect to policymakers by inviting Commission officials to scientific conferences; by publishing results in 'grey' literature; by engaging with media; and by seeking out specific policymakers to whom to communicate research directly (Janse, 2008). Here, an openness from the Commission and a proactive communication effort from the scientific community are required, which is not always an inherent part of the academic career (McNie, 2007).

Unlike the formal aspects of the knowledge exchange architecture, the informal aspects of the knowledge system are not embedded within an institutional structure.

Understanding the Commission's evolving knowledge exchange architecture for climate action

In this section, we discuss changes in the knowledge exchange architecture with the Commission on climate change, drawing in particular from the analysis of our interviews. The interviewees emphasised that scientific knowledge has been a strong feature of agenda-setting for EU climate policy development since its origins in the 1990s. It was scientific knowledge that formed a clear justification and motivation for policy action in the EU, which led, by the 2000s, to a politicisation and prioritisation of the issue among high-level political discussions (Dupont, 2019). But this underlying recognition by our interviewees of the importance of scientific knowledge in a general sense was nuanced by reflections on the evolutions over time.

All our interviewees who discussed the evolution of our knowledge around the climate issue indicated that it became increasingly complex over time and that multidisciplinary scientific knowledge was increasingly required. Indeed, the physical science basis was a key part of the development of EU climate policy in the 1990s and early 2000s. The Commission built the case for EU climate action based on available physical scientific knowledge, seeking out scientific publications and relying on the IPCC reports. In the 1990s, the Commission had some limited expertise in-house (Interview 1) that connected their understanding of the broader scientific knowledge to the EU's political objective on climate change:

> The two degree centigrade objective, which had already been set by the scientific community, and which was in a way the ultimate objective that we tried to achieve… we as environmental policymakers quoted it as this is what the scientists tell us. (Interview 2)

The scientific knowledge on climate change was highly trusted and regarded as legitimate by Commission officials. When questions arose about the necessity to act on climate change, the response by Commission officials was simply to reiterate the science, without necessarily reflecting on their own interpretation of that science for the policy and political context of the time:

> Maybe there were some disagreements from other services who said 'Is the science solid enough? If so, can we really trust this objective? So how good is it?' And then we would simply say well that's what the scientists, this is what the intergovernmental panel on climate change, which is the authoritative international group of scientists working on the topic, tell us. And who are we to doubt that, if hundreds of scientists produce a report? (Interview 2)

Nine interviewees particularly emphasised that the issue of climate change was becoming more complex, as efforts to respond adequately to the climate problem failed. Two interviewees expressed, in 2022, that this increased complexity was owing to the fact that the scope of the societal transformations required was finally beginning to be understood (Interviews 3 and 4). However, they emphasised that the social science knowledge that contributes to thinking about this aspect was still only partly embedded in the knowledge exchange system. This echoes a sentiment already expressed by two other interviewees in 2016 (Interviews 5 and 6). The complexity

of the climate issue was no longer about the physical science basis to understand the underlying mechanisms that cause global warming, but rather about the 'complex interactions and links among sectors and jurisdictions' (Interview 5); or about the need for 'systemic change and policy coherence' (Interview 4). Interviewees (in 2020 and in 2022) highlighted the social aspects, and intergenerational justice aspects of climate change, but also the multiple sources of motivation to take action: 'I am guilty every time I take my car, I feel guilty towards my children' (Interview 7); 'if we don't do something, others won't do it either. The EU has a historical legacy' (Interview 8).

Against this background of broad agreement that knowledge has always been a feature of EU climate policymaking; that climate policymaking requires scientific knowledge from multiple disciplinary backgrounds; and that the balance of knowledge requirements shifted over time as climate action failed; we then analyse interviewees' views on how knowledge enters the knowledge exchange system with the Commission, and how, whether and in what ways the formal and informal aspects evolved.

Formal knowledge exchange with the Commission

Although the formal knowledge exchange architecture remained in place, interviewees did highlight some differences in the extent to which these formal structures were used for agenda-setting by the Commission. The development in the early 2000s of the Emissions Trading System (ETS) – a carbon market first established by a 2003 EU Directive – was frequently referred to by interviewees as an area where external knowledge and expertise was desperately required by the Commission. From a formal perspective, this was done via a call for tender for two studies: one to draw lessons from US experiences of sulphur emissions trading for the design concept of a GHG ETS in the EU; and a second study on how to operationalise such a system. The Commission's proposal for an ETS drew heavily from these studies:

> They imagined how an emissions trading system might work… in the end of that contract they gave the final report to us and it was amazing. It was incredibly influential in our thinking. (Interview 9)

Such formal aspects worked well in the policy design and agenda-setting phase, as the Commission identified its own knowledge needs and knowledge gaps, especially in the early 2000s. The tendered studies contributed significantly to the policy design and impact assessment. Over time, these tools were also used more fully, as the quality of their application generally increased with experience (Jacob and Hertin, 2007). This corresponds to the period of high politicisation, understood as prioritisation – the climate issue is moving up the political agenda, with positive/enabling effects for both knowledge input and policy action.

Criticism, however, was voiced from several interviewees towards the Commission's identification of its own knowledge needs in later years, and in the Commission's use of its own formal structures for knowledge exchange. With the financial and economic crises that began in 2008, the politicisation of climate change had more negative/constraining effects (see earlier). Certain member states were reluctant to take on ambitious targets or adopt implementing legislation (Skovgaard, 2014). The Commission advanced policy slowly along previously established policy pathways,

with the ETS as the centrepiece. But interviewees highlighted that knowledge that criticised policy choices or instruments was excluded from formal knowledge exchange aspects in this period of constraining effects from politicisation: 'there is a lack of openness, particularly about the ETS, from policymakers to accept any form of scientific or critical reflection' (Interview 10). The criticism of the ETS was valid: the early phases of the ETS allowed too many free emission permits to be allocated to industries, and with the economic and financial crises that began in 2008, the price of emission permits plummeted (Wettestad and Jevnaker, 2019). But Commission officials did not request or seek out critical studies or evaluations. Independent critical analyses of the design flaws of the ETS were hard to stomach in the Commission: 'I took it [criticism of the ETS] personally' 'I felt responsible' 'we were trying to sort of patch the hole… to try to correct the situation' (Interview 9).

After the adoption of the Paris Agreement in December 2015, we hear from interviewees that the formal aspects of the knowledge exchange architecture were slowly again used in a more open manner, with knowledge of all types more welcome. Commission officials acknowledged that they were using formal knowledge exchange structures more conscientiously from about 2018 onwards. The quality of impact assessments, studies and other internal and external consultation procedures was perceived as higher, as was the ability of policymakers to draw on scientific knowledge as input to these formal processes (Jacob and Hertin, 2007; Interviews 12, 20 and 22). Interviewees explain this higher quality approach by highlighting the high political commitment to respond to climate change (politicisation as prioritisation); the 'openness' within the Commission; the realisation of the existence of 'data and knowledge gaps'; and the learning from years of experience with the formal structures (Interview 12). These broader aspects can be seen as the enabling effects of politicisation in this period.

In sum, while the existence and structure of the formal aspects of the knowledge exchange architecture with the Commission hardly changed, we do see shifts in the quality of their use and in the choice of how to use these formal mechanisms, aligned with the overall type of effects flowing from the politicisation of climate change.

Informal knowledge exchange with the Commission

While the formal aspects of knowledge exchange with the Commission remained in place under varying effects of politicisation, the same cannot be said of the informal aspects.

First, interviewees highlighted that in periods when politicisation led to enabling effects for policy development and knowledge exchange, then relations between scientists and researchers were open and constructive. In such phases (for example, the first half of the 2000s), scientific knowledge was actively sought after by Commission officials. Referring to the late 1990s and early 2000s, one Commission official remarked: 'we started learning… I was at the stage of learning… I probably ran around and talked to people… we wanted the best expertise' (Interview 9).

Second, interview data show that the informal knowledge exchange almost completely fell away during periods of politicisation with negative/constraining effects (most prominently from around 2008–2016). Interviewees in 2016 particularly lamented the limited opportunities for individual interactions for knowledge exchange: 'they [EU policymakers] need to be more open… they need to take expertise more

seriously' (Interview 6). Several interviewees underlined the lack of Commission interest in receiving different types of knowledge that were not politically welcome. Evaluative, critical or assessment knowledge on the effectiveness, efficiency or fairness of policy measures in place – such as the ETS – was not welcome. As one interviewee highlighted in 2016: 'there is a lack of openness, particularly about the ETS, from policymakers to accept any form of scientific or critical reflection', 'I think many of the policymakers have very thin skins' (Interview 10).

As EU climate policy advanced again after this challenging period (Skovgaard, 2014), there were further pushes for climate action. The adoption of the Paris Agreement in 2015, the social movements calling for more climate action from 2018, and the EU elections in 2019 all created an environment in which the politicisation of climate change spurred more positive or enabling effects for further climate action. These enabling effects seem to extend also to the informal aspects of the knowledge exchange architecture with the Commission. EU policymakers sought out a wider range of scientific expertise, especially towards the European Green Deal.

Most interviewees agree that the in-house knowledge and expertise within the Commission on the complexities of climate policy action increased over the years. In 2016, one interviewee highlighted the impressive growth in expertise on climate change in the Commission, but 'even with the recruitment of new capacity, the Commission still has limited capacity to take on and integrate all the new expertise and knowledge' (Interview 5). The capacity continued to increase and led to new informal knowledge exchange processes inside the EU institutions. Around late 2018, a group of Commission staff started a community called 'EUstaff4climate' aiming to push for more ambitious climate policy from inside the Commission, by building on the latest available science. The members of this informal network were regarded as having a 'striking level of nuanced knowledge and expertise' (Interview 12). This network also sought and invited scientific expertise from outside the Commission into their discussions.

At this stage, there was a need and demand for more knowledge on the political and social aspects of transitioning to climate neutrality. One interviewee reflected on their process of increasing their own knowledge by attending conferences and bringing this knowledge back to the Commission through workshops: 'it was first about going to conferences and making connections… we went to engage with the research communities. Then we would do a workshop or two with policy actors' (Interview 3). Another interviewee highlighted (in 2022) the reflective process of engagement with EU policymakers that took place in 2019: 'there are interactions around finding out from them their perspective and what knowledge they think they need in order to…do further policy development';'then we look at assessment needs because obviously the policy framework is not entirely comprehensive' (Interview 11). This same interviewee highlighted that one of the main avenues for bringing knowledge into the Commission at this time was via an informal conversation with a member of Commission Executive Vice-President Frans Timmermans' cabinet. The interviewee sees this informal conversation as the point where the knowledge basis for the European Green Deal was established. In 2022, another interviewee reflected on engagement with the knowledge exchange architecture as follows: 'Some interactions we had personally with people in the Commission, and that opened some doors'; 'contacts we had with people were personal'; 'people that we knew before through working relationships were called as members of, or nominated as members of, some

of these [Commission] cabinets' (Interview 3). Policymakers in the Commission were open and seeking out new, critical and evaluative knowledge.

The crises that followed in 2020 and 2022 did not lead to an overly constrained or negative politicised context for climate change. This is also reflected in later interviewees' emphasis on the imperative to take action on climate change. Certain policy actors felt that it was in the EU interest to push climate action, by drawing on scientific knowledge as a key justification. This was often highlighted as part of a wider societal movement, 'a Greta moment' (Interview 19), leading to more ambitious language around climate policy action. 'The Commission will now be bound by the narrative and language it has started to use', one interviewee commented in 2020 (Interview 20). One EU policymaker raised concerns, in 2022, that 'I think there is a lack of urgency or an understanding of the urgency' and argued for continued vigilance in pushing climate action to avoid 'greenwashing' (Interview 21). This same interviewee highlighted the important use of knowledge in setting this agenda, just as was the case in the initial stages of policy development in the 1990s and 2000s: 'the IPCC report was also saying that this decade is the closing window of opportunity, it is going to be too late in 2030 to get us to reverse or to get us back on track' (Interview 21). Such policymakers highlight their openness and their sense of duty to ensure knowledge is highly embedded in policymaking, especially during crisis periods.

In sum, all interviewees who reflected on informal knowledge exchange with Commission policymakers highlighted the importance of individual interactions and connections for meaningful knowledge exchange. However, interviewees pointed specifically to the periods of high politicisation with negative or constraining effects as the times when these informal aspects were either completely closed or very challenging. When there are negative or constraining effects of politicisation, informal exchange is at best challenging, at worst, impossible.

Concluding reflections

Our analysis reveals that politicisation of climate change in the EU has led to prioritisation of the issue on the high-level political agenda, with varying effects for both policy development and for the possibilities for multidisciplinary scientific knowledge to enter the policymaking process. With our longitudinal study, we show that knowledge entered the policymaking process through both formal and informal structures during periods of politicisation with positive or enabling effects (prioritisation without polarisation). However, we show that the informal aspects of the knowledge exchange architecture fell away or were inaccessible during periods of politicisation with negative or constraining effects (prioritisation with polarisation). Interestingly, external crises did not always lead to a constraining context. While crises in the late 2000s and first half of the 2010s contributing to a constraining effect of the politicisation of climate change, the COVID-19 and energy crisis connected to Russia's invasion of Ukraine in the 2020s did not have the same outcome.

What do these findings tell us about the EU's knowledge exchange architecture overall? While our findings provide an account of how formal and informal aspects of the climate knowledge exchange architecture with the Commission evolved across different eras and types of politicisation effects, it is important to outline some limitations. These findings do not point to specific causal interactions but do suggest patterns worth exploring further. The findings may not necessarily be generalisable

across all policy domains, or institutional settings. Climate change is a unique wicked problem, and its policy evolution can certainly interact with the institutional setting of the EU to produce patterns of co-evolution. This also does not mean that these findings cannot be transferred to other contexts, rather that future research can build on these findings to explore the extent to which there are similarities in knowledge exchange architectures in other policy domains and institutional settings.

Our research contributes new understanding to literature on both the politicisation of climate change, and to literature on understanding knowledge exchange architectures. First, on the politicisation of climate change, research has highlighted the need for politicisation of climate change to advance just and/or effective climate policy action, with calls from research to promote repoliticisation of climate change to spur action (Paterson et al, 2022). Our nuanced understanding of the effects of politicisation highlights the opportunities and challenges for relevant multidisciplinary knowledge to enter policymaking processes to assist with policymaking. This contributes to wider politicisation literature by providing further reflection on when and how (re)politicisation of climate change is desirable for advancing knowledge-based policy action.

Second, we add new insights to literature on the science–policy interface, and to understanding knowledge exchange architectures. Previous literature underlines that policymaking around a politicised issue is likely to lead to less openness to scientific knowledge, or at least to make it far more difficult for scientific expertise to be sufficiently heard given the political nature of debate (Radaelli, 1999; Compston and Bailey, 2008; Head, 2016; Lacey et al, 2018). Three specific findings from our analysis contribute to this literature. First, we show that the challenges and opportunities for knowledge to enter the policymaking process around a politicised issue are likely to depend greatly on the types of effects of politicisation. Second, we show that even under any constraining effects from politicisation, formal and institutionalised aspects of the knowledge exchange architecture remain in place – at least in the EU – meaning that opportunities exist for knowledge, although likely requiring pro-active scientists. Third, we show that informal aspects of the knowledge exchange architecture are the first to fall away in conditions of constraint. We can also consider practical implications from these findings, including the need to ensure robust formalised aspects of the knowledge exchange architecture, but also promoting reflection on how to promote knowledge exchange when informal aspects are challenged under the constraining effects of politicisation.

As such, our article suggests future research avenues to assess the interactions between different effects of politicisation and knowledge exchange architectures, in both their formal and informal aspects, across a variety of policy domains and in different institutional contexts. In particular, more longitudinal studies would be welcome to advance our understanding further.

Note

[1] Data gathered from the Commission's online Funding and Tenders' portal, accessed 3 April 2023.

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Conflict of interest

The authors declare that there is no conflict of interest.

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Annex I: List of interviews

Interview number referenced in text	Interviewee	Interview date
1	Retired European Commission official	6 February 2013
2	Retired European Commission official	21 October 2016
3	EU knowledge agency official	16 June 2022
4	EU knowledge agency official	17 June 2022
5	Retired EU knowledge agency official	5 October 2016
6	EU knowledge agency official	16 September 2016
7	EU knowledge agency official	5 February 2020
8	European Commission official	29 March 2022
9	European Commission official	2 December 2016
10	EU knowledge agency official	23 September 2016
11	EU knowledge agency official	25 May 2022
12	EU knowledge agency official	5 February 2020
13	Council official	14 June 2022
14	Council official	4 April 2022
15	Council official	20 April 2022
16	Climate researcher	11 October 2016
17	Climate researcher	17 November 2016
18	National policymaker, EU member state	3 August 2010
19	Member of the European Parliament	7 March 2022
20	EU knowledge agency official	5 February 2020
21	Member of the European Parliament	8 April 2022
22	Group interview: 3 European Commission officials	20 December 2019
23	Climate NGO representative	1 October 2012
24	European Commission official	1 August 2012
25	Member of the European Parliament	9 April 2013
26	Member of the European Parliament	27 March 2013
27	European Commission official	20 March 2013
28	European Commission official	25 June 2012
29	European Commission official	6 July 2010
30	European Commission official	6 July 2010
31	European Commission official	9 March 2022
32	European Commission official	21 March 2022
33	European Commission official	25 March 2022
34	EU knowledge agency official	25 October 2022