

## Energy cultures and national decarbonisation pathways

*Janet Stephenson, Benjamin Sovacool, Tor Håkon Jackson Inderberg*

### Abstract

Global climate change negotiations are delivering expectations that all nations must commit to rapidly reducing their reliance on fossil fuels. It is unclear why there is such significant variability in nations' decarbonisation ambitions. We use the lens of 'energy cultures' to explore what insights this analysis can offer to this question. We suggest that a country's 'energy culture' can be envisaged as the interplay between normative, material, institutional and policy-related attributes of the national decision-making apparatus. This provides a meta-framework which underpins our exploration of factors which previous studies suggest may shape national energy ambitions. We apply this framework to case studies of India, Denmark, China and Russia to see whether it has explanatory power across diverse cases, initially using four empirical indicators. There was no consistent correlation between the indicators and low-carbon ambitions, which led us to draw more deeply and inductively on the cultural influences evident in each nation over a 30-year period. Our findings suggest that national low-carbon ambitions are strongly cultural, contingent upon how any particular nation sees the role of energy, and the choices, policies, investments and actions that flow from this. This energy culture may constrain the extent to which nations are willing to respond to the challenge of climate change. The analysis indicates how nations require very different stimuli if they are to strengthen their low-carbon trajectories. We conclude that the concept of national energy cultures is a useful addition to approaches that are examining how to raise national low-carbon ambitions.

### 1.0 Introduction

Why do some countries have greater aspirations than others to reduce their energy-related greenhouse gas emissions? Why do they have different "architectures of constraint" with differential emission trends, adoption of legislation, policy stringency, and outcomes [1]? At the COP 21 2015 Paris climate conference, most of the world's countries agreed to act collectively to reduce the risks and impacts of climate change by keeping global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Under the COP21 Agreement, each state is required to submit successive Nationally Determined Contributions – plans for reducing domestic greenhouse gas emissions (GHGs), which for most countries primarily arise from the use of fossil fuels. In developing their NDCs, nations are required to be explicit about their planned actions for GHG reductions to support the collective interests of the globe. However the first tranche of NDCs and other national policies reveal a wide variation in ambitions [2][3]. Even ignoring the nationally-specific factors relating to resource availability, biological emissions and carbon sinks, there is still

significant variability in ambitions for reducing energy-related GHG emissions. This paper focuses qualitatively but intently on why this might be the case.

There is no single compelling reason for this variability in aspirations and resulting national low-carbon pathways. Prior research has found no consistent relationship with a country's current dependence on fossil fuels [4] or levels of wealth or development [5–7], although these may be partially influential. Other influences on energy policies have been found to include a desire to project strength and an image of modernism (e.g. France's nuclear power program) [8], to capture a new innovation or resource (e.g. the shale gas transition in the United States) [9], to attract industry and jobs (e.g. Iceland's geothermal transition) [10], citizen awareness and perceived risk of climate change [11], political leadership (e.g. New Zealand's 2019 zero carbon legislation [12]) and differences in natural resource endowments and political structures [13]. A transition to renewable energy can also strengthen or weaken a country's geopolitical standing [14]. Such studies have generally investigated just one or a few influential variables, which give partial answers to the variability in national low-carbon ambitions. In this paper we explore the potential for a more integrated approach that takes into account the dynamic melange of social, economic, political and historical factors that shape a country's 'energy culture'.

As elaborated in more detail below, energy culture is a multi-scalar concept that invites the exploration of a subject's or community's norms, practices and material artefacts and how these influence each other. Prior work has used this concept to explore energy cultures of a range of sectors (e.g. households, businesses, demographic groups) and has revealed how and why some energy cultures are locked into habitual patterns while others are dynamically changing [15]. In this paper we apply this approach for the first time to examining energy cultures at a *national* scale, interpreting 'culture' as the assemblage of nationally-specific materiality, governance norms and policy positions, and exploring how these interact (historically and currently) to shape low-carbon energy ambitions as expressed by governments.

We use four national case studies to explore whether and how a cultural framing can assist in explaining the different positions countries are taking in respect of their carbon reduction ambitions and actions. We focus on states because, while new trends in emissions governance research emphasise multi-level and polycentric influences [16], including sub-national actors (e.g. citizens; NGOs, businesses) and supra-national actors (e.g. multinational companies, pan-national alliances), the primary unit being accounted for emissions reductions, and responsible for them, is still the national jurisdiction.

Moreover, available data for NDCs, emissions abatements and related policies are predominantly organised by country [17]. This invites an analytical focus on country-level characteristics that we investigate through a cultural lens. We apply this framing to the four national case studies of Russia, China, Denmark and India. These have different levels of commitment to action to reduce their greenhouse gas emissions, with Russia classified as 'critically insufficient', China as 'highly insufficient', the EU (which includes Denmark) as 'insufficient' and India as 'compatible with a 2 degree world' [2].

In the following sections of the paper we firstly elaborate on the concept and framing of energy cultures; describe and justify the four main variables that we use to empirically contrast the countries' low-carbon trajectories. We elaborate on these and other culturally-relevant factors that appear to have influenced each country's ambitions for reducing their energy-related GHG emissions. We discuss the complexity, distinctiveness and dynamics of national energy cultures. We conclude by discussing the implications of this form of analysis and possible future extensions of the work.

## 2.0 Conceptual framework

Setting and achieving low-carbon ambitions will require governments and other national actors to look beyond their own interests and economic framings, and to consider existential questions such as ethics, morality, and the future quality of life of others on the planet [18,19]. Given the fundamental role of fossil fuels in economies and in social wellbeing, a low-carbon pathway may involve major structural changes in systems of provision and consumption of energy – a socially, politically and economically charged exercise with far-from-certain outcomes [20,21]. This brings us to ask: What factors might make a state more willing and able to significantly adjust its energy systems in order that the globe might benefit? As a normative question, this invites an approach that takes a wider scope than typical political economy framing. It invites consideration of socio-cultural factors such as how the country sees its role in relation to other states; its governance paradigms; and its socially determined material characteristics.

### 2.1 Culture and energy-related outcomes

Culture has many interpretations but generally refers to a set of shared meanings, practices, traditions, beliefs, norms and materiality that together create a distinctive assemblage that has both subjective and objective qualities [15,22]. Culture is a multi-scalar concept: it can equally apply to the characteristics of an indigenous tribe ('ethnic culture'), a workplace ('organisational culture'), a generation ('millennials'), a nation ('American culture') or a pan-national epoch ('Western culture'). Cultural assemblages, as reflected in the everyday activities of people and institutions, carry shared meanings from the past, and cast these meanings into the future, so cultural patterns are often interpreted as a force of habituation. However, cultures are rarely static – they can shift and morph as a result of changing conditions. While many cultures may be long-established and relatively consistent, it is their ability to adjust as an adaptive mechanism to changing circumstances that is also of interest here, particularly in this era of climatic change.

Culture is not a bystander when it comes to sustainability-related issues and outcomes. A number of studies, undertaken with households and businesses in a variety of countries, have identified causal links between these actors' cultural characteristics and outcomes such as relative levels of energy use [15,23–28]. In this paper we widen the scale of inquiry to consider cultural characteristics at the national level which have influenced our case studies' energy-related actions and decisions over the past 30 years. Through this framing we investigate the interplay between selected national cultural attributes and the state's declared and evident commitment to reducing energy-related carbon emissions.

The cultural attributes we are interested in are not necessarily overtly about energy - they could relate more to political, social or environmental factors – but ultimately they shape energy decision-making and consequential carbon emissions. In this way, we envision culture as combining the norms, practices and material artefacts in a society, at any scale, from individuals and groups, to organizations and even nations (the approach taken here)[29]. Culture can thus cut across debates in social science and theory about the role of agency, which sees actors as free-willed subjects, and structure, which sees the external constraints actors or institutions face [30]. Rather than considering culture as the primary result of either agency or structure, we view it as a key mechanism that mediates between agency and structure, something recursive, and which includes the materiality of energy systems and infrastructure [31,32]. As such, we acknowledge the likely existence of multiple energy

cultures with a given country, which could be explored at multiple scales and in relation to multiple sectors, all of which influence low-carbon ambitions and actions at a national level. For the purposes of this initial exploration of national energy cultures, however, we limit ourselves to features which are observable at national scale.

## 2.2 Culture and states

Many authors have identified stable and significant differences between policy and governance arrangements of states [33–36], but why these arise and persist are less clear. Numerous attempts have been undertaken to pin down the norms, values or other cultural characteristics of countries or institutions/organisations in order to analyse the effect these have on political goals, concrete policies or the outcomes of these. Approaches include discourse analysis [37], narrative analysis [38], neo-institutional approaches [39], process tracing [16], policy change literature [40–42], and varieties of capitalism [35]. The approach taken in this paper builds on this work while narrowing the focus to the low-carbon aspirations that may be shaped by relevant national cultural characteristics.

Cultural difference between nations are also evident when it comes to energy security, social legitimacy and leadership. A review of energy studies literature, for example, suggests that a national culture of energy security in the United States is more orientated towards low-cost and reliable energy services (emphasising security of supply) whereas countries such as Denmark and Germany emphasise sustainability, renewable energy, and climate change mitigation [43]. Developing but poor countries like India prioritise energy access and addressing energy poverty, while economic titans such as China focus on securing sufficiently large amounts of energy to propel economic growth. Another study analysed states acting as environmental leaders or pioneers, and determined four main characteristics that shaped national leadership, the latter three involving cultural characteristics: structural (economic power), entrepreneurial (skills in facilitating compromise solutions and agreements), cognitive (defining or redefining of interests through ideas and normative standards) and exemplary (both intentional and unintentional example-setting)[44].

Such studies collectively imply that it may be worthwhile to take a cultural lens to examining countries that have divergent low-carbon aspirations. Our interest is in the cultural attributes of the governance apparatus of the state itself: the assemblage of nationally-specific materiality, governance norms and policy positions. Material aspects includes levels of development including energy infrastructure, and a nation's economic and structural dependence on fossil fuels. Governance includes how nations perceive and enact their governance role, nationally and internationally. Policy positions include past and present policies on the development of energy resources and infrastructure, and the trajectory of change.

In light of the urgency of climate action, we are interested in the possibility that countries' cultural assemblages may constrain the scope of what is seen as 'possible' for the nation to offer or achieve. As a result, when faced by the same exogenous factors (such as the expectation that all nations will contribute to keeping global warming to well below 2 degrees) it may be difficult, because of the constraining effects of their energy culture, for some countries to adopt the new policy positions which are needed to achieve the necessary rapid transition. Other countries with a different set of cultural characteristics may be more ready to commit to playing their part in a low-carbon future. Moreover, there may be situations when a shift in one or more of these cultural qualities may spring a more

widespread shift in energy culture towards more aspirational policies. We set out to explore these ideas through four case studies.

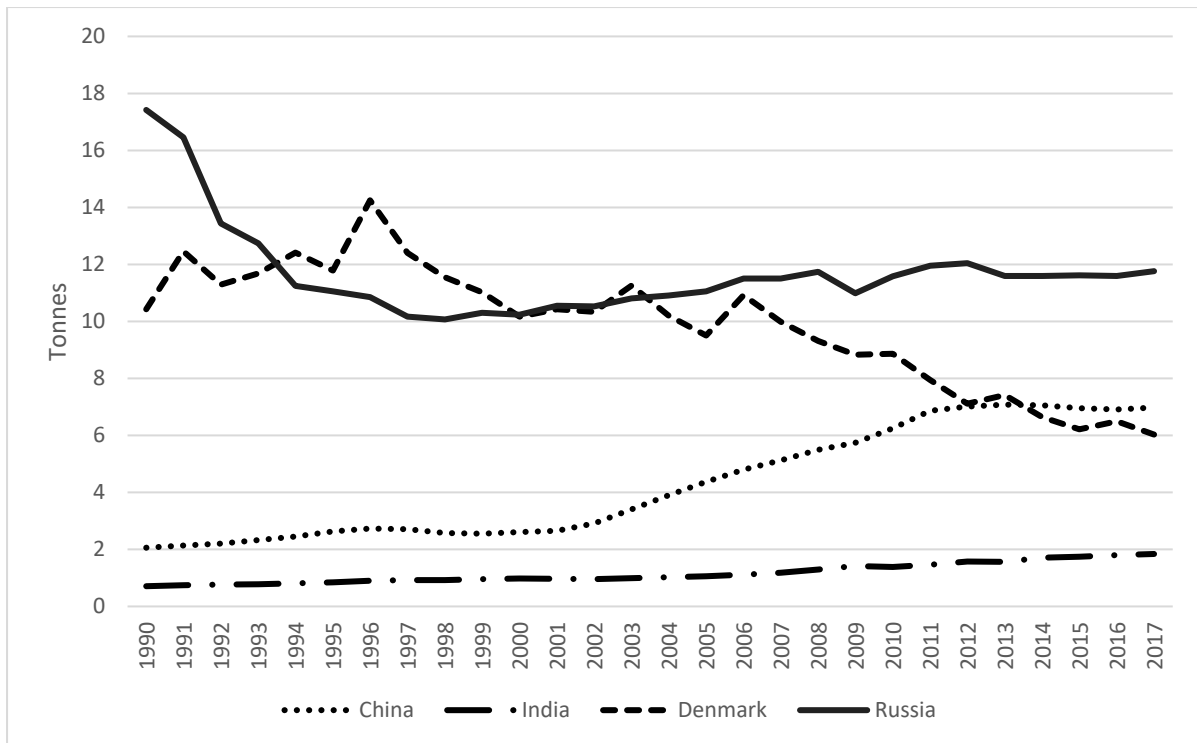
While we are primarily interested in structural explanations here, this does not mean that individual agency may not be important. Such explanations would include national leaders – individuals or political parties – that tip the scale in one way or another. Although such individual factors may be highly important in particular times or situations such as critical junctures or during an open window of opportunity [45], exploring the structural causes for high and low climate ambitions are nevertheless crucial for understanding how barriers to energy and climate policies may be overcome.

### **3.0 Research design**

For this initial exploration of the ideas outlined above, we investigate the low-carbon ambitions of four countries in relation their cultural context, focusing initially on several empirically-based indicators, and subsequently on potential explanatory factors from their energy development histories. We sought quantitative and qualitative data on factors identified in the literature discussed in section 2.2 above, although we were limited by data that was available in the same or similar form for all four case studies. We explain our choice of case studies and the dependent and independent variables below. Our investigation draws wholly from secondary sources: published literature and publicly available data and analyses.

The cases selected are India, China, Denmark and Russia. Several factors underlie the rationale for selection. They represent a mix of geographic and population sizes and global locations, different resource endowments, and a mix of market economies (including centrally planned and social democratic). The nations also have different trajectories to date with their carbon emissions: Russia the highest per capita of the four (although reduced since 1990); China starting from a low point in 1990 to now being second after Russia; Denmark dropping from a high point in the mid-90s to now coming below China, and India still extremely low per capita although gradually climbing (Figure 1).

For each case study, we set out to explore whether there is any apparent relationship between countries' low-carbon ambitions and potential explanatory factors that reflect the normative positions, policy actions and material choices of the case study nations.



**Figure 1: CO2 emissions per capita in case countries (1990-2017).**

*Data source: [46]*

### 3.1 Dependent variable – low-carbon pathway ambition

By ambition, we mean both the level of aspiration to reduce emissions, and the actual or likely achievement of emissions reductions. A nation could have a high level of aspiration, but little in the way of policies to support this; another could have very low aspirations that are met despite no policy action. Assessing what constitutes a high and low ambition for the purposes of comparison requires consideration of many factors including the distance between starting points and current policy ambitions [47]. Aldy et al propose a cluster of metrics for comparability of effort across countries [3]. Applying the metrics to China, the EU, Russia and the US they conclude that the EU proposes to do twice as much as the US, and that China and Russia propose to do so little that the numbers lie within the model’s measurement error (figures are not available for our case studies India or Denmark). The authors consider that the most comprehensive metric is cost (i.e. resources given up by society for climate change mitigation). However low-carbon choices are not necessarily more expensive than high-carbon ones (e.g. solar and wind have become cheaper than fossil fuelled generation) and this is particularly germane for our case studies. We find the work of Climate Action Tracker (CAT) more relevant to our purpose.

CAT evaluates and ranks nations’ commitments in their Nationally Determined Contributions (NDCs) made under the Paris Climate Agreement [48]. The CAT evaluations are based on information about emissions reductions commitments and effort-sharing benchmarks as well as the degree to which their policies are in line with these emissions commitments (for further details on the CAT methodology see[49]). CAT also produces a summary metric for each country’s ambitions based on whether their Nationally Determined Contributions are consistent with holding global warming at below 2 degrees or the Paris Agreement’s 1.5°C limit, or temperatures well above this (noted as insufficient, highly insufficient, or critically

insufficient). We use this metric, which captures both aspiration and effort, as the main reference point for the dependent variable *low-carbon ambition*. CAT does not produce separate scores for nations within the European Union, so the EU score is used as a first approximation of Denmark's ambition, for which a more nuanced picture is given in the case study description.

These measures are then used in three ways – for evaluating the country's aspirations to implement change, for assisting the assessment of the effort being made, and in enabling comparison between the countries.

### 3.2 Potential explanatory factors

We explore a range of potentially influential factors that reflect the accumulation of the nations' past and present normative positions, policy actions and material choices. We initially selected four empirical indicators that enable scalar (high-low) comparisons between countries. These represent two *material dimensions* and two *institutional dimensions* that have been widely but independently discussed in literature as being influential in energy policy, as outlined below. We were interested in whether these dimensions do actually bear much relationship to countries' low-carbon ambitions. The four indicators were visually controlled for dependency relations, were *a priori* selected to be separate. In a second step of analysis, in our case study descriptions, we discuss the influence of a wider range of historical, material, political and normative characteristics on countries' positionality on low-carbon ambitions. These historic accounts had an important role in reducing the chance of spurious relationships.

We acknowledge that it is not possible to be completely exhaustive as to potentially influential factors. There are many optional or additional factors identified in literature that we did not include (see section 2). These include citizen perspectives on climate science and the need for action (and the extent to which they permeate institutional decision-making), state-level environmental leadership, and relative cost and effort involved in the low-carbon transition. In some instances the data was not available for all four case studies, and in others the factors appeared too closely linked. Our selection of case study countries was also rooted in trends concerning energy supply and exports, or energy demand and imports; it thus doesn't fully capture transit countries (e.g., countries such as Turkey or Ukraine that serve as transit points for gas or pipelines) or those that re-export energy (e.g., the Netherlands, Singapore).

Our focus with this paper was exploratory rather than deterministic, seeking to investigate a potential new approach to analysis rather than perfect a method. Future studies may be able to take a different or broader range of factors into account to help refine our understanding of the cultural (and other) forces that are shaping countries' low-carbon trajectories.

#### 3.2.1 *Material dimensions*

Here we are interested in how a country's low-carbon ambitions can be shaped by those aspects of the nation-state's interests that take a tangible (economic and/or physical) form, such as energy infrastructure and production; thus capturing the idea that path-dependency can shape normative positions. Through a cultural lens, material factors are integral to a country's energy culture - they are a result of past policy and governance practices, and are tangible agents of the current energy culture. Material factors may also shape present and future policy choices because they frame decision-makers' beliefs and practices [50]. Material dimensions are prevalent in path-dependency literature for national environmental and renewables targets [51]. Economic and technological path-dependence is the result of

past economic, policy and normative choices and can constrain expectations about what is an acceptable policy response, creating a self-perpetuating ‘energy culture’.

National interests in moving to low-carbon energy infrastructure can be influenced by advantages or disadvantages *between* countries [52], or *internally* through the domestic policy structures and their inherent interest structures [53,54]. In both these cases the causal link to low-carbon transitions is the share of carbon-intensity as a source of domestic energy provision, and the material consequences of changing this share. We thus identify two quite different indicators of the material influence of fossil-fuel dependence, based on different forms of path-dependence – one financial and outward-facing (international trade in fossil fuels), and the other structural and inward-facing (national dependence on fossil fuel supplies). They work through different causal links, and each is represented with a separate measure.

The first indicator accounts for the degree of state dependence on revenue streams connected to international trade in fossil fuels. This is a well-known measure, although it is less used in the carbon lock-in literature [55]. The second indicator accounts for the degree of national (internal) dependence on fossil fuel energy sources and carriers (e.g. electricity) and recognises how relative or absolute material advantages and disadvantages may influence political ambitions to reduce energy sector emissions. This indicator is most frequently discussed, and utilized, in the burgeoning literature on energy security, along with the importance of diversifying energy supply to minimize dependence on imports or foreign fuels (55–62).

Collectively, these indicators represent two different kinds of path dependency – the first financial and budgetary, and the second structural and energy security related.

*Indicator 1. The country’s financial dependence on fossil fuels.* This dimension is measured by the value of fossil fuel exports as a percentage of the total value of exported merchandise for each case study nation [63]. This measure indicates the national economic ‘cost’ of reducing the export of fossil fuels, and we expect that the higher this cost, the lower the likelihood of high low carbon transition ambitions. It should be noted that exported fossil fuels do not figure in national GHG accounting under current arrangements.

*Indicator 2. The country’s dependence on fossil fuels as a source of domestic energy supply.* This dimension reflects the challenge of moving away from the use of fossil fuels within the domestic energy supply. This dimension is measured by the share of fossil fuels in the Total Primary Energy Supply (TPES) [64]. We expect that the higher the share of fossil fuels in TPES the lower will be the low-carbon energy ambitions.

### **3.2.2 Institutional dimensions**

Institutionally, we are interested in how countries and their internal actors perceive and enact their governance role internally and externally. Institutions, here, refer to relatively stable collection of rules and practices that are embedded in structures that enable and constrain action [39]. These socio-political matters are also part of a country’s culture, in that they reflect normative positions that are particular to its historical, social and political landscape. Such cultural factors have been shown to embed and be embedded in energy and climate related policy choices and thus influence direction and performance [65–68]. Robust evidence shows that democracies outperform autocracies regarding environmental policy [69]. We would therefore expect countries that were more globalist and more democratic to be more likely to consider themselves normatively bound to take an aspirational position on low-carbon trajectories. The German *Energiewende*, for example, which led to a significant



shift in Germany's energy culture, has been shown to have been strongly driven by both such factors – public pressure and external motivation [70].

Institutional factors are shaped by practices of policy-setting, which themselves are strongly norm-based [39]. Public administrations (and therefore also the political advice that they provide) share commonly accepted unwritten rules, which shape the perceived 'appropriate' organisational response. As countries' institutional structures tend to evolve slowly except on rare revolutionary occasions [71,72], it is highly likely that institutionalised norms will consistently influence national environmental policy ambitions, even though there have been difficulties in measuring this kind of influence [47,73–75]. However, even though these institutional settings tend to be stable, there are examples of sudden shifts caused by 'tipping points' or shifts in sentiments, often triggered by external events and facilitated by a 'ripe' institutional setting [36,40].

Drawing from these insights, we use the following two indicators of socio-political dimensions of nation-states:

*Indicator 3. The internal institutional paradigm – statist vs societal*

Political and institutional structures are relatively stable entities [13] but they vary significantly between countries [33]. They can be differentiated through a variety of dimensions, the more common being democratic-authoritarian, federal-unitary, and corporatist-pluralist. Through a cultural lens, these structures can be seen as norms and practices that are embedded in state apparatus, with features that are distinctive to each nation-state. They shape state, business and individual actions through constraint, facilitation and guidance [76].

For this indicator we are interested in whether and how top-down or bottom-up type governance paradigms relate to low-carbon ambitions, on the assumption that governments that are more permeable to citizens' concerns may be more willing to adopt a strong low-carbon trajectory. This inference is supported by evidence that democratic countries – where they have free elections, freedom of the press, and freedom of association, combined with well-functioning executive, legislative and judicial state branches that are free from corruption and clientelism – outperform less democratic (and more corrupt) states [77]. We adopt Spencer and Murtha's distinction between statist and societal arrangements, whereby a *statist* country is one where authority is located within relatively unified state structure; the state dominates public realm and guides societal activity; politics are founded on pursuit of objective national interest, and individual participation in policy formulation seen as partisan and unproductive. A *societal* country, on the other hand, is represented by countries where authority is located in society as a whole; the government seen as an instrument of society; politics is generally dominated by bargaining; and individual activism helps set agenda for government policy [34,78].

As an indicator for this dimension, we apply a quantitative score of deliberative democracy from the Varieties of Democracy (V-Dem) project [79]. The index is used for providing a quantitative measure as a reference point. The score of the variable (no. 2.1.4) spans from 0 to 1 as an interval-based index measuring how decisions are reached in the case countries, with the least deliberative democratic towards 0, and the most scoring towards 1. It is used descriptively, and measures whether "public reasoning focused on the common good motivates political decisions—as contrasted with emotional appeals, solidary attachments, parochial interests, or coercion [79]. The differences between the countries are significant, as elaborated below.

To be transparent, other candidates for metrics were initially considered, including the World Value Survey. However, these data had too many missing information points for parts of our time period, and some of the countries (Denmark) were not included. While the latter problem could have been ameliorated by complementing the international survey data with data from European Social Survey (ESS), this would not help with data for the other countries, which also saw significant limitations. Furthermore, several other Indices from the V-Dem dataset, including Egalitarian Democracy Index, Civil Society Organization entry and exit index, and Liberal Component Index were also considered, but the Deliberative Democracy Index was deemed closest for a valid measure for this dimension.

*Indicator 4. The country's externally-facing paradigm – globalist vs isolationist.*

Here we explore the assumption that countries with a global outlook (and hence, maybe, a greater sense of responsibility for action on climate change) are more likely to have aspirational goals than those with an internal focus. While measuring such a dimension validly is inherently evasive, the best proxy indicator we could find was the number of Multilateral Environmental Agreements (MEAs) signed and ratified, along with the qualitative assessment in the case study. The data is downloaded from the International Environmental Agreements Database Project from the University of Oregon [80], providing an overview of the case countries' signatures and ratification of such agreements between three or more countries. While the measure does not say much about ambitions or reasons for joining an agreement, it gives an indication of how outward-looking a country is, relative to the other case countries.

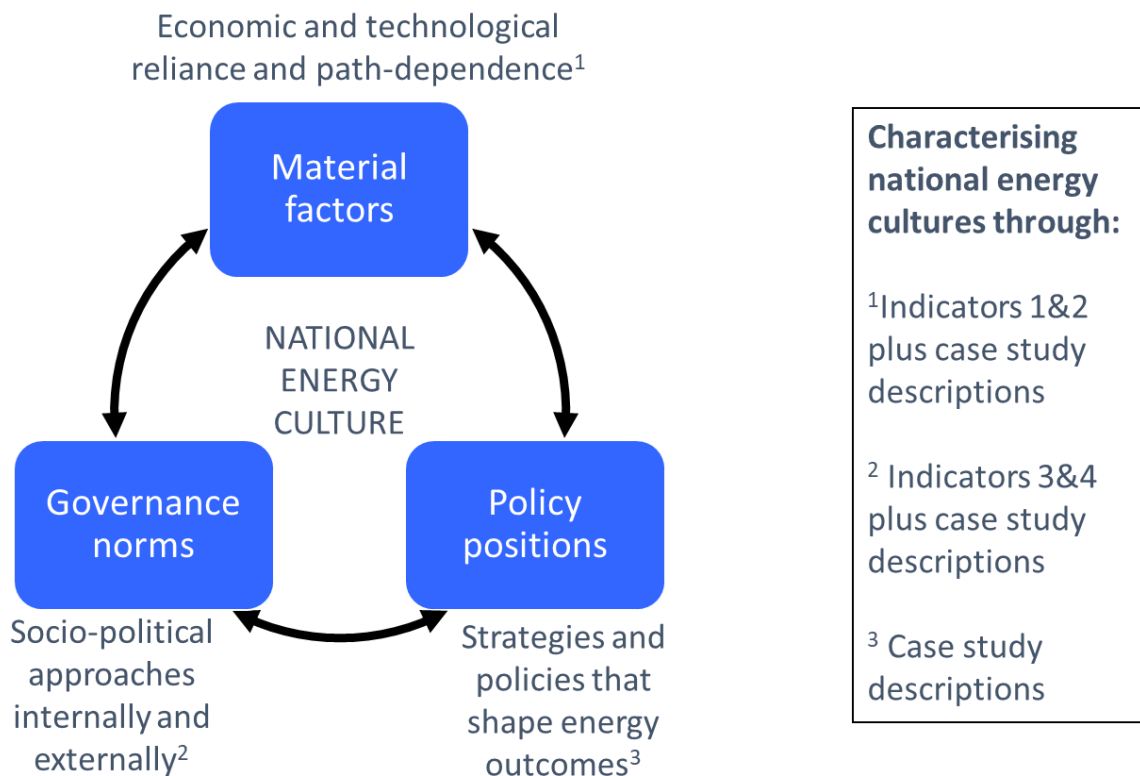
As any indicator at this level it is imperfect and can be criticised for different sources that influence validity and spurious effects. For example, smaller countries, like Denmark, tend to be more interested in international regulations, while larger and more powerful countries would be more likely to be interested in more room for political manoeuvre [81]. Furthermore, countries might invest in international institutions and agreements for a number of reasons, not always to increase ambitions [82]. Such motivations may include efforts to circumvent other and more widely based agreements like UNFCCC, and should ideally be seen in a wider context of agreements – regime complexes – to establish a highly robust placement on the globalist-isolationist continuum [83]. Furthermore, larger countries are more likely to be involved in more environmental areas that require international regulation. Last, Russia, in its special position as the former Soviet Union, is in a particular situation likely to influence this variable. However, as the variable focuses on environmental agreements (instead of a wider selection of international agreements) some of these challenges are likely to be reduced. Despite its imperfections the MEA count is the best indicator we can find for comparing nations' relative interests in global environmental issues. The agreements in some cases have implications for energy and climate change, but are a much wider measure including anything from genetic resources to WMD related non-proliferation agreements, so they should be sufficiently independent from the other variables. To be made into a simple comparative metric, the annual signed MEAs between 1990 and 2015 are summed up and compared. The lowest number of MEAs in any year is four, and the highest is 30, so there is sufficient variation on the variable to usefully compare the cases, to be further described for each case and comparatively below.

Initially other metrics were considered for this indicator too. These include membership in Intergovernmental Organisations (IGOs), as well as the abovementioned survey data. The survey data sets proved unfeasible to use for the same reasons as for Indicator 3. For IGO Membership, the sources, which included the Correlates of War and the Polity Project datasets, turned out to be insufficiently updated. As other indicators ranging from military

expenditures to investment profiles appear to have lower validity or potential issues with independence from the material indicators, the MEA data, even with its shortcomings, represent a reasonably valid indicator and was therefore used.

### 3.3 Case study descriptions

The four indicators of the material and institutional dimensions are supplemented by qualitative descriptions for each case study country. These descriptions give an overview of the energy and policy context for each country from the early 1990s which saw the first serious attempts at introducing a global sense of responsibility for climate change through the 1994 UN Framework Convention on Climate Change. While the indicators are proxies for some culturally-determined factors, the case studies allow us to consider the role of a much wider range of cultural attributes in national low-carbon ambitions.



**Figure 2: Methodological summary: exploring national energy cultures using indicators and case study descriptions.**

### 4.0 Results

We discuss the case studies of India, Denmark, China and Russia, following the order of the lowest current per capita emissions to the highest. Table 1 summarises the indicators for the dependent variable (low-carbon aspiration and sufficiency of action) and the four independent variables (indicators of potential explanatory factors) discussed above. For each case study, we describe additional historic and current factors which could be interpreted as part of the ‘energy culture’ of each country.

**Table 1: Dependent and independent variables – key indicators**

Sources: 1. [46]; 2. [2]; 3. [84]; 4. [85]; 5. [79]; 6. [86].

	India	Denmark	China	Russia
Per capita CO <sub>2</sub> emissions (2017) <sup>1</sup>	1.84t	6.03t	6.98t	11.76t
<b>Dependent variable: low-carbon ambition</b>				
Global warming implications of NDC <sup>2</sup>	<2 °	<3 °	<4 °	4°+
Sufficiency of action <sup>2</sup>	2° compatible	Insufficient	Highly insufficient	Critically insufficient
<b>Independent variables – material dimension</b>				
<i>Indicator 1: Financial dependence on fossil fuels</i>				
Proportion of GDP from exports of fossil fuels (2017) <sup>3</sup>	12%	4%	1.6%	59%
<i>Indicator 2: Structural dependence on fossil fuels</i>				
Proportion of fossil fuels in TPES (2017) <sup>4</sup>	75%	64%	89%	90%
<b>Independent variables – institutional dimension</b>				
<i>Indicator 3: Internal institutional paradigm (statist v societal)</i>				
Liberal Democracy Index (2018) <sup>5</sup>	0.37	0.84	0.11	0.18
<i>Indicator 4: Externally facing paradigm (globalist vs isolationist)</i>				
Intergovernmental environmental agreements <sup>6</sup>	236	350	246	338

#### 4.1 India

India has a population of 1.3 billion and ranks 114<sup>th</sup> in the world for median wealth per adult [87]. It is the fourth largest energy consumer in the world and the third largest carbon emitter. Yet, annually, the average Indian citizen uses 15 times less energy than a U.S. citizen, and uses 30 times less electricity [88]. As a result, average per capita carbon dioxide (CO<sub>2</sub>) emissions are very low compared to the other case studies: 0.71t per capita in 1990, rising to 1.84t in 2017 [46] (Figure 1).

Compared to the other case studies, India has a mid-range structural dependence on fossil fuels (around 75% of TPES). Its economic dependence on fossil fuel exports has been decreasing since 2013, and although still significant at 12.2% of export value, this has declined since the high of 20% in 2013 (Table 1).

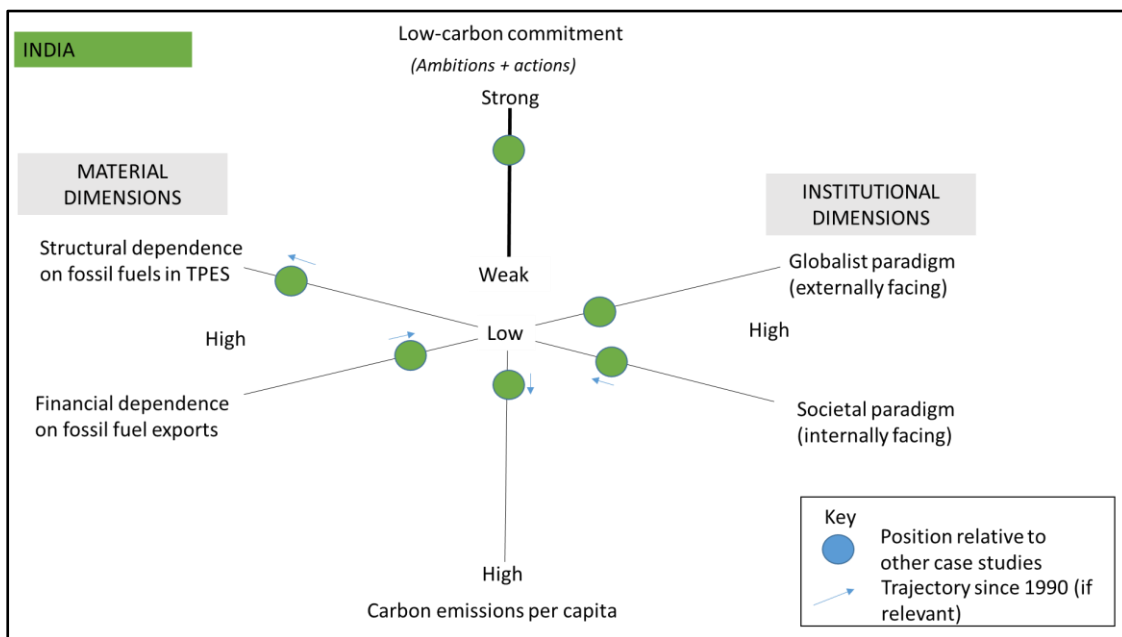
India is a parliamentary republic. Its 2018 Liberal Democracy score of 0.37 is higher than China or Russia, but significantly lower than Denmark. From 1990 to 2010 this score was in the 0.6 to 0.7 range, but it has fallen to below 0.4 since 2018. India has signed up to relatively few MEAs, in a similar range to China, suggesting that it is more concerned with internal affairs than global issues.

In 1990, only about one-third of India’s energy supply was met from imported fuel—coal, oil, and natural gas. Dependence on imports grew for all fuels over the subsequent decades. Despite some domestic production of oil, India has had to continue importing to meet growing demand, and the discovery of new oilfields has only occurred at the pace that production from older ones is phased out [89]. During the 1990s, India also became both the third largest consumer and producer of coal in the world, much of which was used in the electricity sector.

The 2000s saw the adoption of a legal and institutional framework to promote energy efficiency throughout all sectors of the economy and an Integrated Energy Policy to enable India to meet its goals to grow the economy alongside improving energy provision and security. This included components focused on expanding renewable energy, continuing to invest in coal, promoting energy efficiency, and minimizing transmission losses, among others [90]. These energy policies collectively resulted in an overall expansion of supply, but did so in relatively inefficient ways, accounting for poor performance metrics related to energy efficiency or energy intensity. Major ongoing challenges include dependence on coal-fired electricity, poor reliability, and import dependence.

India’s most recent power-sector policy, the National Electricity Plan 2018, shows a strong commitment to transforming the Indian electricity sector to enhance energy access and security, with renewables acknowledged as the least-cost source of new electricity capacity. Largely driven by rapidly reducing costs, especially with solar, renewable energy investments have topped fossil fuel-related power investments for the past 3 years, and installations of renewable energy capacity in 2017 and 2018 were more than twice that of net new installations of thermal power (1), (66), (67). However alongside this India proposes a continuation of growth in coal-fired power in the short term, with a likely capacity addition of 176,140 MW in the next five years [93].

India has ratified its NDC which includes an unconditional target of 33-35% below the 2005 emissions intensity of its GDP by 2030, and a conditional target of a 40% renewable share of cumulative power generation by 2030. India is ranked by CAT to be on track to overachieve this “2°C compatible” rated targets [2]. We conclude that their low-carbon trajectory is strong in relation to the other case studies.



**Figure 3: Summary of key national energy culture indicators for India**

## 4.2 Denmark

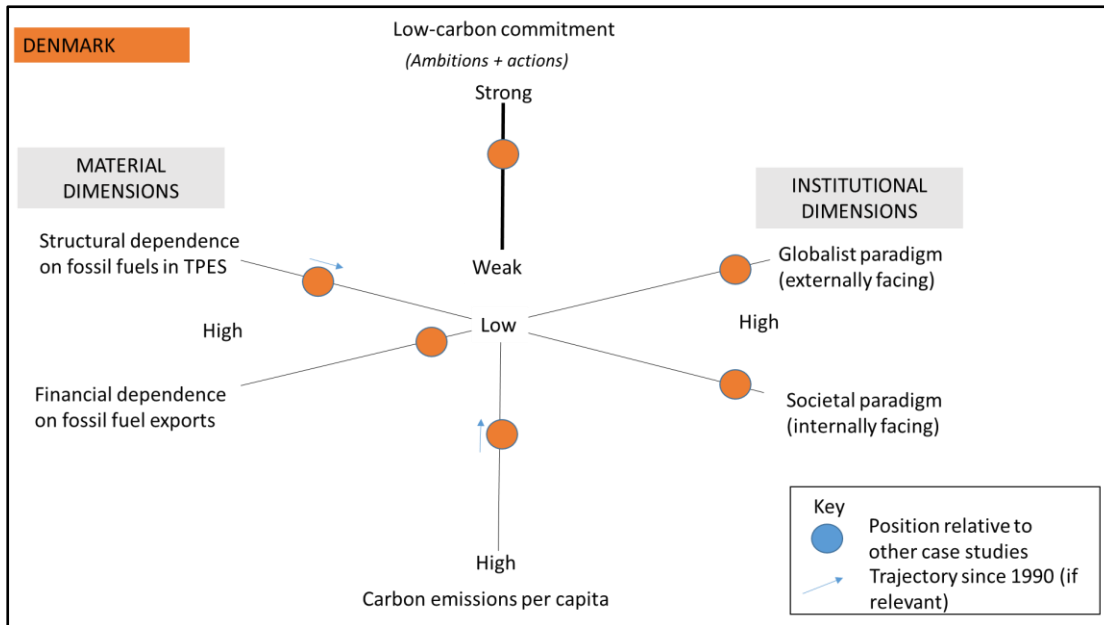
Denmark has a population of 5.7 million and ranks 23<sup>rd</sup> in the world for median wealth per adult [94]. Denmark's economic dependence on the export of fossil fuels has hovered between 3-7% since 1990. Its reliance on fossil fuels in the TPES was 62% in 2017 [85]. Denmark's emissions of CO<sub>2</sub> per capita peaked at 14.25t in 1996 and has fallen quite steeply since then to its 2017 level of 6.03t [46].

Denmark is a constitutional parliamentary monarchy, and its Deliberative Democracy score of 0.84 for 2018 is the highest of all the case study countries. This has consistently remained in the 0.8 to 0.9 range over the period under study. Denmark has signed up to 350 MEAs over the period, more than the other case studies, suggesting it has a strongly global outlook.

Fossil fuels constituted 93% of TPES in 1990, and were still at 88.5% in 2000, but this reliance has dropped rapidly to 62% in 2017. This is largely the result of Denmark's purposeful policy agenda for low-carbon electricity generation. In 1990 the Danish Parliament placed a moratorium on coal use and announced that no new coal-fired power plants would be permitted, a proclamation later formalized in 1997 when the Danish parliament passed the "coal stop", functionally outlawing the construction of new coal fired power stations, with exceptions given only to two 450 MW plants. Additionally, Denmark is endowed with some of the best wind conditions in Europe. Spurred by a global oil crisis, policymakers embarked on a government-sponsored wind research program in the 1970s and led wind turbine innovation globally at a time when it was considered expensive and unnecessary [95]. The country has significantly supported growth in low-carbon sources of electricity (notably wind but also biomass and solar energy to a degree), aggressively supported low-carbon district heating, while also developing oil and gas resources in the North Sea.

In 2006 the Danish Prime Minister announced a long-term target of 100 percent independence from fossil fuels and nuclear power, later presented as part of the national Energy Plan of 2006 [96]. Policy since then has continued to be supportive of renewables, with wind generation contributing 43 % of electricity by 2017 [97], and re-confirmation of the aspiration of 100% renewable energy by 2050 [98]. The Danish energy sector is still over 60% powered by fossil fuels, and is notably reliant in the transport sector, but this figure is the least of all four case studies (Table 1).

The European Union, of which Denmark is part, has committed in its NDC to reduce GHG emissions at least 40% below 1990 levels by 2030, and aims to get to 80-95% below 1990 levels by 2050. Like other EU member states Denmark is bound by a set of commitments that is diversified across the Union, and regulated by a number of instruments including the EU emissions trading scheme for large industry, the Effort Sharing Regulation for other sectors, and the Renewables Energy Directives. CAT's assessment is that the EU is on-track to meeting its pledge and appears likely to exceed it if current targets are implemented. However the EU's NDC is not compatible with a 2 degree world, and even increasing the 2030 target to a 55% reduction (as called for by the European Parliament) would not be enough to get there. Denmark itself however has a much stronger renewable energy commitment than the EU collectively, so we position it as having a relatively strong low-carbon commitment (Figure 4).



**Figure 4: Summary of key national energy culture indicators for Denmark**

### 4.3 China

China has a population of 1.4 billion. It is the world's second largest economy [99] and ranks 44<sup>th</sup> in the world for median wealth per adult [94]. Fossil fuel exports made up 8.3% of export revenue in 1990 but this reduced to 1.6% by 2017 [84]. However fossil fuels have become an increasingly important part of China's TPES, rising from 76% in 1990 to 88.7% in 2017 [85]. Emissions of CO<sub>2</sub> rose rapidly during the 2000s but levelled off between 2011 and 2017 at around 7t per capita, less than half that of the US [46].

As a one-party state, China's Deliberative Democracy score has hovered between 0.1 and 0.2 for most of the period since 1990, and has been at the lower end of that range since 2012, ranking 0.11 in 2018 [79]. Despite its economic power, China has a surprisingly low MEA score, only slightly higher than India, which appears to reflect its focus on internal affairs as opposed to global citizenship (Table 1).

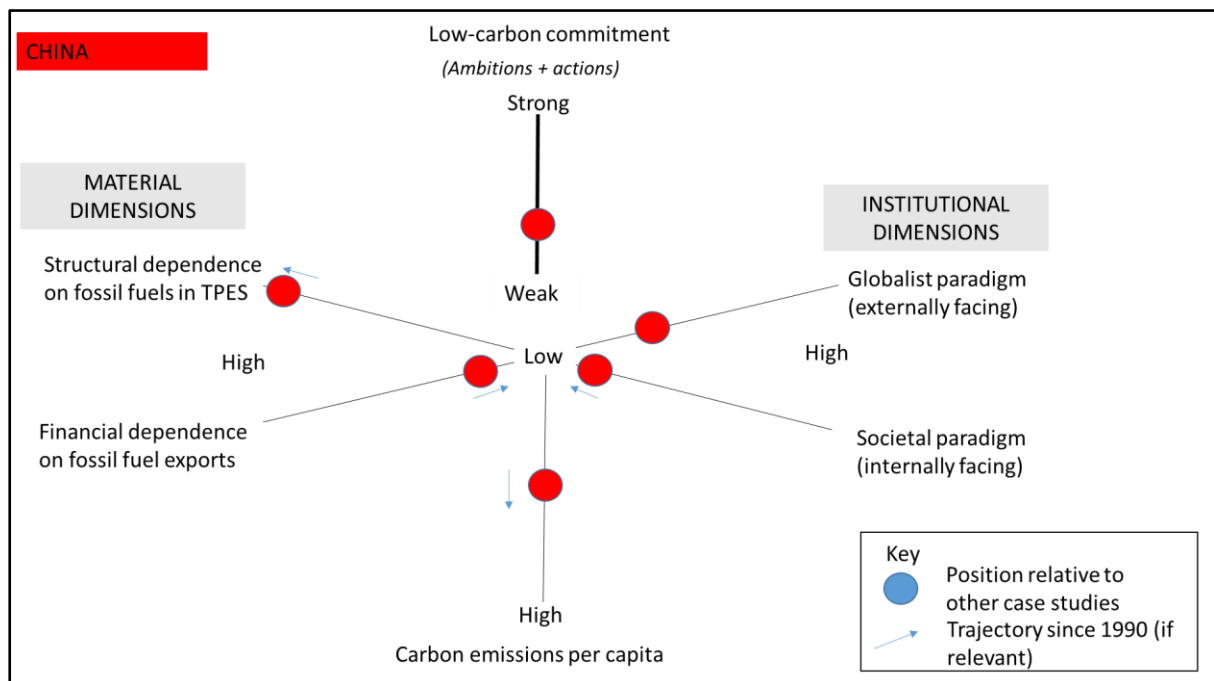
China is the world's largest energy consumer [100] and the biggest emitter of carbon dioxide [101]. It is the fifth largest producer of oil, seventh largest producer of natural gas [103], and the largest miner of coal (78, 79), almost all of which is used internally. At the same time, China is the world's largest solar technology manufacturer and exporter [106].

China started on a path towards rapid industrialization in the 1980s, when economic reforms were adopted after its period of Cultural Revolution. The 1970s and 1980s were punctuated by low levels of energy demand, an underdeveloped electricity sector, and a generally lagging economy [107]. Energy shortages were seen as the principal culprit behind these problems, so Chinese planners aggressively promoted the development of energy resources especially those that facilitated industrial growth. The strategy was successful in that between 1990 and 2010 China's economy grew almost fivefold, and its energy use more than doubled [108].

During the 1990s, a broad package of market reforms enabled a transition from a centrally planned economic system to one more market oriented, which had profound impacts on the country's domestic energy sectors [109]. More than three-quarters of all coal-fired power plants world-wide were built in China, generating about 80 percent of Chinese electricity

generation [110]. The combination of growth and fossil fuel developments meant that China’s share of global total emissions rose from 7.8% in 1980 [107] to 27.2% in 2017 [101].

At the same time, policy initiatives from the 1990s sought to diversify national supply to renewable sources of energy. China set high targets for growth in non-fossil (hydro, wind, solar, nuclear) generation in its 2016-2020 Five Year Plan, and further growth in renewable energy continues to be a main policy goal. However the total share of renewable energy actually decreased due to the pace of development and its need for energy [111]. In 2018, China started construction of 28 GW of new coal-fired power capacity after a previous construction ban was lifted, bringing its total coal capacity under construction to 235 GW. China’s CO2 emissions rose by an estimated 2.3% during 2018 following an apparent levelling between 2014 and 2018 [112]. Alongside this, solar and wind energy continued to grow to make up roughly 8% of China’s primary energy supply by mid-2020 [113]. China has ratified its NDC which includes unconditional targets for 2030 for a renewables share of 20%, peaking of CO2 emissions, and a reduction in carbon intensity of 60-65% below 2005 levels. Although it appears that China will meet these targets under current policy projections, the targets are rated as ‘highly insufficient’ by Climate Action Tracker as they are not consistent with limiting global warming to 2°C.



**Figure 5: Summary of key national energy culture indicators for China**

#### 4.4 Russia

The Russian Federation has a population of 145 million, and it ranks 107th in the world for median wealth per adult [94]. Fossil fuels make up around 60% of Russia’s exports by value, from a peak of 71% in 2013 [84]. Internally, fossil fuels have contributed around 90% of TPES since 1990 [85]. The country is thus heavily reliant, both economically and structurally, on fossil fuels. Of all the case study countries, Russia has the highest levels of CO2 per capita: these peaked in 1990 at 17.42t, before dropping rapidly during the 1990s and stabilising at around 11-12 t per capita since the mid-2000s [46].

On paper, Russia is a republic, and its Deliberative Democracy score has varied considerably since 1990, hovering at around 0.4 between 1992 and 1999, and falling over subsequent years



to below 0.2 since 2013, but still slightly higher than China at 0.18 in 2018 [79]. Russia has signed up to 338 MEAs (notably, 30 in 1992 before falling away, but an increase again since 2009). The total is slightly below Denmark's score but well above China and India, indicating a stronger interest in global affairs [86].

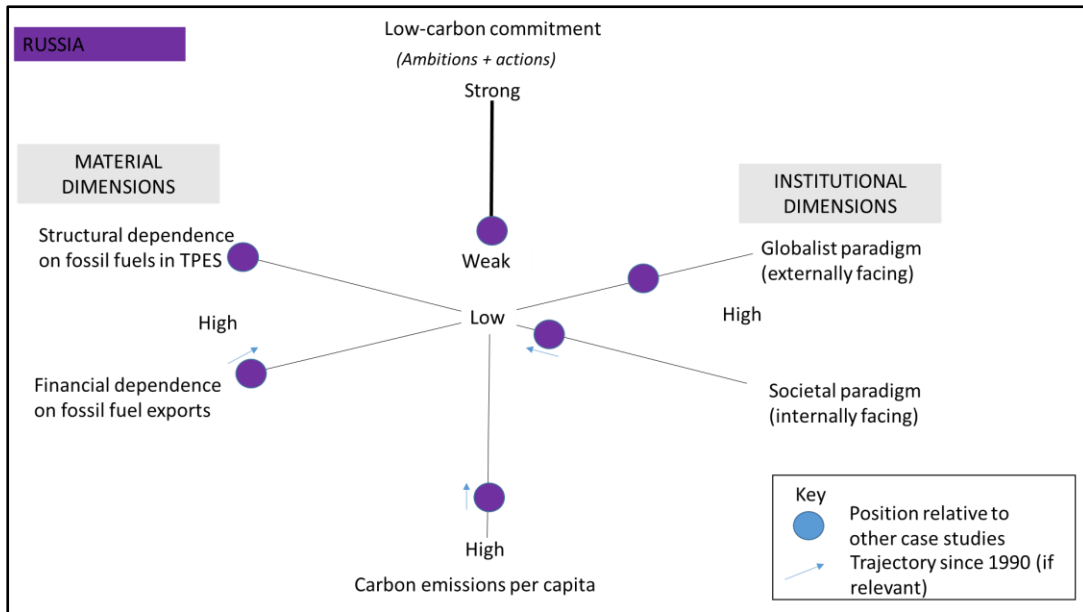
Russia is rich in fossil fuel resources [114] holding the world's largest natural gas reserves (second in production behind the United States), second largest coal reserves (sixth in production), and seventh largest oil reserves (third in production behind Saudi Arabia and the United States) [115].

The 1990s saw the collapse of the Soviet Union which ushered in broad political and economic reforms which decentralized state planning. Mikhail Gorbachev came to power on a platform of economic liberalization and instituted market reforms. The collapse of the Union also brought daunting social and economic problems including hyperinflation, food shortages, and electricity blackouts within Russia and its former republics [116]. A weak regulatory framework allowed well-connected state elites to use insider trading and asset-stripping to transfer wealth from state energy enterprises into private hands [117]. Economic reforms ended in 1998 with a domestic financial crash, an economic decline which reverberated throughout the energy sector by depreciating the value of capital stock and the strength of the rouble.

The trajectory of Russia's energy system altered dramatically under the reign of Vladimir Putin, who entered into power in 2000. Russia reshaped its foreign policy around energy exports, intended to counter the growing influence of NATO and to expand Russia's sphere of influence into Europe [117]. Much of this ascendance has been attributed to Russia's ability to use its energy resources as leverage or a "weapon" to attain higher prices or favourable agreements with countries such as Belarus, Germany and Ukraine. Russia also invested significantly in fossil fuels—for domestic use as well as export—over this period [118].

Russia has had notably weak policies for decarbonisation. For example, the government adopted a target of 4.5% electricity supply from renewables by 2020 [119], one that hardly tapped the full technical potential of wind, solar, and other sources [120]. In May 2018, Putin called for a national technological, environmental and economic breakthrough, but none of the provisions in the resulting "Ecology" (Экология) programme relate directly to GHG emissions reduction. The budget that had been initially planned for the Plan was also significantly cut. The government is considering the establishment of a cap-and-trade system for major carbon emitters by 2025 and require companies to report their emissions [121].

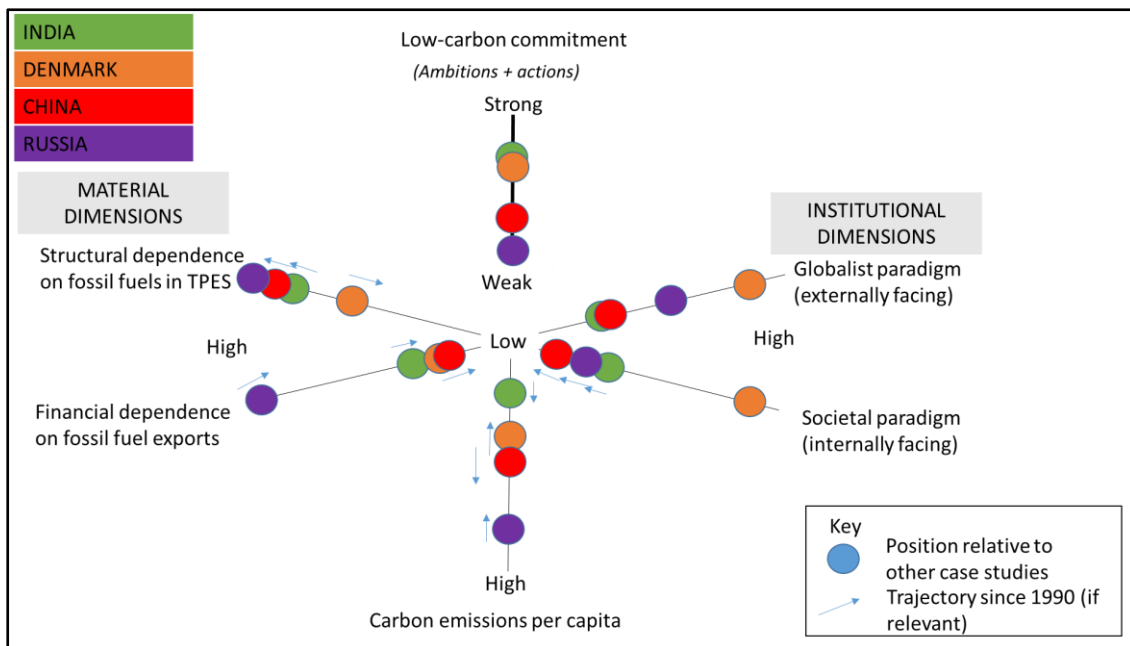
Russia is the only major country that has not yet ratified the Paris Agreement. Its INDC suggests a 25-30% reduction in emissions below 1990 levels by 2030. Climate Action Tracker's assessment is that Russia is likely to achieve this unambitious target simply with the continuation of current policies, and that these align with more than 4 degrees of global warming. Much more ambitious targets and policies would be required to shift Russia from its 'critically insufficient' rating [2]. Both Russia's ambition and action are well below par.



**Figure 6: Summary of key national energy culture indicators for Russia**

#### 4.5 Comparative synthesis

Figure 7 combines and compares the indicators for the four case studies. As will be discussed further in section 6, we found that none of the indicators, either individually or collectively, has a consistent alignment with low-carbon ambitions. Countries' structural and financial dependence on fossil fuels, in and of themselves, do not necessarily relate to countries' low-carbon ambitions and actions: with Russia it appears there could be a correlation, but not with China or India. Similarly, neither of the institutional dimensions is consistently aligned with low-carbon commitments; it could be argued that Denmark's globalist outlook and strongly societal paradigm align with its purposeful action to reduce emissions, yet India which scores low on both counts has the only NDC which would achieve a less-than 2 degree world. All else being equal, there seems to be no reason why an autocratic state such as China would be less likely to achieve a low-carbon transition than a democracy. In short, the four indicators may have partial but certainly not consistent explanatory power, and their influences may vary between the case study nations.



**Figure 7: Comparison of indicators for case study countries, showing no consistent correlation between any of the dimensions and the countries' low-carbon ambitions.**

The case study descriptions introduced a number of other potentially influential factors in low-carbon ambitions (see Table 2 for a summary). The relative 'starting point' level of per-capita carbon emissions (itself a derivative of historic events and resource availability) means that the relative distance to achieve low-carbon targets differs markedly between countries, and while this appears to be a factor it is not a dominant one. India's very low per-capita emissions could arguably mean that its transition will be less difficult than for nations with much higher emissions, but this ignores the fact that India is at the same time attempting to massively improve energy access for all. Denmark's per capita emissions during the 1990s were the highest of all the case studies but are now lower than all apart from India.

Relative levels of development are a factor, but not an overriding one; for example India ranks 114<sup>th</sup> globally for median wealth per adult, and Russia 107<sup>th</sup>, yet they score at the two extremes of low-carbon commitments.

**Table 2: Summary of energy culture characteristics from case studies**

	<b>India</b>	<b>Denmark</b>	<b>China</b>	<b>Russia</b>
Key historic drivers of energy trajectory	Poor energy access & reliability; weak economy	Leadership in wind power technologies; energy self-reliance; reducing GHG emissions	Industrial development and economic growth; energy shortages	Economic development; regional geopolitical influence
Energy aspirations	Grow economy; improve energy provision and security	Low-carbon electricity; independence from fossil fuels	Energy resource development; diversification of energy supplies	Development of and trade in fossil fuel resources
Energy materiality	Significant reliance on coal alongside increasing	Falling domestic oil and gas production alongside increasing	Dominated by coal-fired power generation; but significant solar	Near-total domestic reliance on coal, oil and gas;

	installations of low-cost renewables	wind, district heating	manufacturing and low-carbon transport investments	significant infrastructure for gas exports
Current energy policies	Improve efficiency, increase renewables in electricity sector; continue coal-fired power in short term	Moratorium on coal; reduce reliance on fossil fuels for transport and heating; grow renewable generation	Grow renewable energy; reduce carbon intensity, electrify transport; decrease coal consumption	Support coal, oil and gas sectors for the foreseeable future; weak focus on decarbonisation.

It is clear that history matters. The low-carbon ambitions of the case study countries are in part shaped by their past resource development choices and political arrangements, including those that predate global concern about climate change. For example, Russia’s politically and economically turbulent past has heightened the importance of fossil fuels for leveraging a return to greater regional influence. China’s market reforms in the 1990s drove a massive increase in fossil-fuelled power generation, locking it in to a path dependency for the lifetime of the plant. These histories continue to shape these countries’ willingness and ability to take decisive action to reduce carbon emission, but are not deterministic; for example, Denmark has a history of North Sea oil and gas developments, but alongside this undertook a strategic programme of investment in wind innovations.

Normative positions are also relevant. Denmark’s reduction in fossil fuel dependency has been the result of purposeful policies and investments; Russia’s reluctance to ratify the Paris agreement is consistent with its use of fossil fuels as both an economic and hegemonic instrument.

Together, the case study results suggest that countries’ low-carbon ambitions are the result of multiple interacting factors, with all of those discussed above having some part to play, and none being consistently dominant.

## 5.0 Discussion: complexity, distinctiveness and dynamics

In this section we discuss how these factors can usefully be interpreted as an interacting assemblage or ‘energy culture’ that is distinctively different for each country, as well as temporally dynamic. We first discuss the extent to which our initial assumptions about the four indicators have been borne out by the evidence. We then highlight distinctive differences between the energy cultures of our four case studies. Finally we discuss temporal variation and cultural dynamics – both how the case study energy cultures have changed over time, and what it might take for these to transform even further to achieve a low-carbon future.

### 5.1 Complexity: limitations of the proposed explanatory variables

Our methodology, described in section 3, included identifying four variables that we anticipated might assist us in explaining the differences in the low-carbon ambitions of our case study countries. Here we return to our initial assumptions and discuss whether their influence has been borne out by the evidence. Our findings highlight that national energy cultures are complex, dynamic, and interactive with our variables.

For Indicator 1 (financial dependence on fossil fuel exports) we hypothesised that higher dependence = lesser ambitions. Our findings suggest that this is likely the case with Russia, with nearly 60% of its export income from fossil fuels, although the situation is not just about financial dependence but the influence that this allows Russia to extend to the wider region given the scale of its exports. However, indicating the complexity of the issue, the hypothesis does not seem to be borne out in the case of India, where about 12% of its export-related GDP is from fossil fuels, yet its aspirations and actions on carbon mitigation are the best of all the case studies.

For Indicator 2 (structural dependence on fossil fuels) we hypothesised that a higher share of fossil fuels in TPES = lesser ambitions. China and Russia have highest shares, at 89% and 90% respectively, and have the lowest ambitions, and this may in part reflect (as expected) the difficulty of a low-carbon transition at this scale. But the influence is not necessarily always causal in that direction. Again indicating complexity, Denmark has the lowest share of fossil fuels in its TPES but this has been result of intentional low-carbon changes, so a change in energy culture has preceded its achievement of a lower structural dependence on fossil fuels.

With Indicator 3 we hypothesised that countries that had a stronger deliberative democracy would have higher ambitions. Our case studies suggest that this is not necessarily the case. Denmark scored as the most societally oriented and has high ambitions, and Russia scored low societally and has the lowest ambitions. Yet India, with the highest ambitions, scores relatively low in the societal score, this having dropped significantly since 2010. China is even more statist than Russia but it has stronger low-carbon ambitions.

For Indicator 4, we used the number of intergovernmental environmental agreements as a proxy for how globally-oriented the case study countries were. We hypothesised that more globalist countries would have higher ambitions. Again, we found that this was not necessarily the case. India has the highest ambitions but scores as least globalist. On the other hand Denmark's strongly globalist outlook does seem to be connected to its low-carbon ambitions – e.g. its clear intention to take global leadership in wind technology development.

Overall, the indicators were a useful starting point for considering some of the differences between the countries, but are only partly helpful as explanations as there are exceptions with each indicator. This reinforces that many factors may have some influence, but that there is no single compelling reason for variability in ambitions.

Drawing on the descriptive material from the case studies helps to build multi-factored cases for why countries have very different low-carbon ambitions. The ways in which a country has chosen (or not) to develop any fossil fuel resources and to build (or not) a high level of dependence on those resources, is strongly contingent upon (and influential of) beliefs, normative choices and policy positions and actions.

## **5.2 Distinctiveness: characterising national energy cultures**

A national energy culture includes the material assets, institutions, policies and actions that are shaped by the national jurisdiction, and that in turn shape how (and whether) energy resources are developed and used. Energy is not simply a vector that allows work to be done: from a cultural perspective it is imbued with meaning and significance. Considering a hypothetical question such as: 'If Denmark's energy culture was transposed to Russia, how different might be its low-carbon trajectory?' indicates how energy choices are largely socially and politically determined. In this section we revisit our case studies and attempt to

distil the key characteristics of the four countries' energy cultures that have implications for transitioning to a low-carbon future.

*India's "access-focused" energy culture: low-cost pathways to improve energy security and availability*

India's history of relatively poor energy provision has unintentionally had the side effect of very low per capita emissions compared to the other case studies. In terms of the four indicators, it has a low financial dependence on fossil fuel exports, but other indicators suggest it would not necessarily be a candidate for low-carbon ambitions: it has a high dependence on fossil fuels in its TPES, it scores low in global outlook and tends more to statist than societal. However its energy policy seeks to improve energy access and security, and India is taking a pragmatic approach to support economic development, seeking low-cost pathways. Institutions are still seeking to develop coal-fired power stations in the short term but at the same time aspiring to increase renewable energy generation. The lower installed costs of solar and wind generation compared to more traditional centralised generation are an important influence on energy culture, enabling aspirations that could put India at the global forefront of low-carbon ambitions. A low-carbon trajectory is thus not a 'cost' for India: living standards can be improved cost-effectively with a mix of renewables and efficiencies. These aspirations are reflected in national energy policies that support changes in energy practices and energy infrastructure for a lower-carbon future, and a relatively strong low-carbon commitment.

*Denmark's "proactive" energy culture: innovating for low-carbon wellbeing*

Denmark has a strong global outlook, is strongly societal, has very low dependence on fossil fuel exports, and has the lowest structural dependence on fossil fuels of all four countries. In the early 90s, Denmark had high per capita GHG emissions and strong dependency on fossil fuels, but a significant shift in national energy aspirations saw a focus on innovation in wind generation. The effect of this commitment was a notable fall in emissions per capita over 20 years, along with establishing Denmark as a global leader in wind technologies. Alongside this, Denmark continued to develop offshore oil and gas, but now has aspirations for achieving a low-carbon society supported by 100% renewable energy by 2050. This strong normative component of their energy culture is resulting in new policies, actions and investments for a low-carbon future – an ongoing dynamic change in its energy culture.

*China's "fungible" energy culture: growing the economy through energy & technology*

China has a high structural dependence on fossil fuels but they form a very minor part of its exports. Its strongly statist and inward-focused government has driven massive growth in energy resource development since the 1990s to support modernisation and the delivery of new wealth. This economic trajectory continues to be a dominant influence in its energy culture. While there has been continued development of coal-fired power stations, alongside this is significant investment in renewable technologies, distributed generation and electrified transport. As an autocracy and one of the world's major economies, China has the internal influence and economic heft to quickly alter the focus of its policies and investments. This latent fungibility, whereby the ends are more important than the means, and change can occur rapidly, is a distinctive aspect of China's energy culture. Even though it has a weak low-carbon aspiration at present, this could quickly change.

*Russia's "hegemonic" energy culture: geopolitical dominance and economic restoration*

Russia is second only to Denmark in terms of the globalist indicator but this does not seem to have a bearing on its low-carbon aspirations. Russia's energy culture is shaped by the shockwaves of the breakup of the Soviet Union and the financial crash in late 1990s. Its

strongly statist political and institutional structures are still focused on economic rebuilding and geopolitical influence, and fossil fuels are a means of achieving this. It is the most heavily dependent of the case study countries on non-renewable energy, both structurally and as a component of its international trade. As well as comprising over 50% of export earnings, fossil fuels are also a means of influencing the region through Russia's ability to control price and availability. There is no aspirational leadership for low-carbon change, and its very weak low-carbon commitments seem unlikely to change in the near future given its energy culture.

These brief descriptions are intended to indicate how distinctively different are the energy cultures of each country. The lens of energy cultures helps to reveal how the positions of each country with respect to their low-carbon ambitions are shaped by multiple factors arising from both historic and contemporary influences. Each country has quite different expectations about the role of energy now and in the future, and this has implications for their low-carbon trajectory.

### **5.3 Dynamics: cultural instability and change**

Culture can be understood as a distinctive array of socially-derived characteristics that have a degree of permanence, but these are by no means static. A country's past energy-related investments, institutions and infrastructure will always create some degree of path-dependence, but it is clear from our case studies that energy cultures do change, both in response to shocks (e.g. Russia's financial crash) and through intent (e.g. Denmark's moratorium on coal use).

Temporally, energy culture changes at a national level may include adoption of new policies (e.g. India's National Electricity Plan), new forms of energy governance (e.g. China's market reforms), new infrastructure (e.g. Russia's pan-Europe gas pipelines) and new normative positions (e.g. Denmark's commitment to 100% renewable energy supply by 2050). Each of these changes has resulted in concomitant changes in other aspects of energy culture (e.g. new policies driving different infrastructure investments), so that an energy culture can iteratively change its key attributes over time, resulting in quite different outcomes (e.g. Denmark's significant reduction in the fossil fuel component of its TPES). While some energy cultures are much more static (e.g. Russia) it is evident that energy cultures can and do shift quite radically under the right circumstances.

National energy cultures can arguably also affect the energy cultures of other countries. Examples include Russia's geopolitical influences in Europe through trade in fossil fuels, and China's mass production of increasingly inexpensive solar technologies for international markets. We suggest that national energy cultures can also influence other countries normatively: India and Denmark's leadership in low-carbon ambitions, for example, can provide a point of reference and comparison for others.

Cultural attributes are shaped and reinforced within a culture group but can also be influenced by factors outside of their control [15]. Similarly, the stimulus for changes in energy cultures can arise from factors internal to a country (e.g. discovery of new energy resources; emergence of citizen demands for climate action), or from external influences outside of their control (e.g. response to EU policies, climate change impacts), or a mix of both. The cultural framing helps identify possible factors, specific to each country studied, that could effectively drive a shift to their energy culture towards low-carbon outcomes.

For India's energy culture, with its key focus on improving energy access and security, a key factor for a faster low-carbon transition would be the availability of low-cost renewable generation at a scale that could provide for industry as well as citizens. Internally, change

could also be stimulated if India started to see itself as an influential global leader in how developing states can leap directly to smart distributed renewables.

Denmark has a societally-responsive democracy, and a citizen call for more rapid low-carbon change would be one scenario that could see a shift in its energy culture towards even more rapid action. Denmark also has a strong global outlook, so positioning itself as a global leader could strengthen commitments to a low-carbon future.

Altering to a more low-carbon energy culture for China may involve a mix of internal and external influences. An example of an external influences could be the continued expansion of international markets for its renewable technologies, and internal influences could include a strengthened intention to reduce particulate emissions in cities through widespread adoption of electrified transport and industrial energy. As an autocracy, China has the ability to change very rapidly once new aspirations are adopted, and to scale up change in a way that is not achievable by most countries.

Russia has a seemingly more entrenched energy culture, and given its low and deteriorating liberal democracy scores, it is unlikely that change would be driven by citizen voices, so it is likely to only change as a result of external factors, without a change in political system. These could include declining markets for their fossil fuel exports, continued relative decline in the price of installed wind and solar, or increasing impacts of climate change on Russia's economy and wellbeing. All of these would have implications for Russia's geopolitical influence and a new source of influence may be developed.

By seeing energy cultures as dynamic, and paying attention to the key characteristics and how they have changed over time, it becomes evident that shifting to a low-carbon energy future may require very different sets of stimuli for India's access-focused energy culture, Denmark's proactive energy culture, China's fungible energy culture, and Russia's hegemonic energy culture.

## 6.0 Conclusions

At the start of the paper we asked: *What factors might make a state more willing and able to significantly adjust its energy systems in order that the globe might benefit?* In the initial stages of this paper, we explored whether four indicators, representing diverse but coherent variables that literature suggested may influence a nation's low-carbon ambition, had explanatory power. These were its financial dependence on fossil fuels, its dependence on fossil fuels in the primary energy supply, its internal institutional paradigm (statist vs societal) and its externally facing paradigm (globalist v isolationist). We found that while in some cases there was an apparent relationship between an indicator and low-carbon ambition, there was no consistent correlation for our four case studies (Figure 7). From the case descriptions, we then drew more deeply and inductively on the cultural influences evident in each nation over a 30-year period, which enabled a more multi-factored elaboration of their energy cultures and how these could be seen to influence their low-carbon ambitions.

As these findings reveal, energy culture at a national scale can be described as the interplay between normative, material, institutional and policy-related attributes that are, to a large extent, contingent upon each other. We have described and differentiated the energy cultures of our four case study countries using both qualitative and quantitative data, resulting in four relatively distinctive typologies of 'energy culture' that draw from both the historic accounts and the current indicators: access-focused India, proactive Denmark, fungible China and hegemonic Russia. Our findings suggest that national low-carbon ambitions are strongly



contingent upon what energy means for any particular country: how it sees the role of energy, and the choices, policies, investments and actions that flow from this. The interactive nature of these attributes may create a mutually reinforcing arrangement that is hard for countries to shift away from, as with Russia, thus constraining their ambition to respond to the challenge of climate change mitigation. On the other hand, some national energy cultures showed highly dynamic development, and we tracked significant changes in China, India and Denmark resulting from internal and/or exogenous influences.

We conclude that there is no single set of factors that shape low-carbon ambitions and/or national energy cultures. Each country has a relatively unique set of circumstances which can usefully be explored through a cultural lens to shed light on the complex interplay of factors that shape their current low-carbon ambitions, and on the very different stimuli that may be required if they are to strengthen their low-carbon trajectory. Our findings suggest that, depending on the country, adjustments towards a low-carbon energy culture are likely to involve nationally-distinctive combinations of endogenous and exogenous catalysts.

Although our case study descriptions have mainly focused on national-scale actors and actions, we note that such cultural dynamics may also be shaped by supra-national influences such as global geopolitics and climate change impacts, as well as sub-national influences such as citizen collectivisation or business lobbying. The roles of multi-level and polycentric influences could be included in future work looking at their roles in maintaining the status quo or driving change in energy cultures. Future research could extend the analysis to a wider range of nations building on the methodological learnings from this paper, especially the relevance of both historic and current factors in shaping an energy culture. Other avenues for future work include exploring the relative influence of different cultural (and other) factors on national energy cultures, and examining energy cultures at different scales (such as supra-national cultures, multi-level or sub-cultures and even counter-cultures) and regions (e.g. the Middle East, the Arctic, or Sub-Saharan Africa).

Notwithstanding this call for future research, and the limitations described in section 3.2, we are confident that national energy cultures play a salient role in driving both historical national actions on climate change and energy and shaping future decarbonisation pathways. This finding, though it may seem obvious to some, offers an alternate perspective to overly reductionist approaches that try to value one single attribute or dimension in their assessment of low-carbon transitions, such as availability of resources or the cost of a carbon pathway. Instead, national ambitions and pathways are co-constituted through a mosaic of material, institutional, and social factors that cannot be reduced to a single variable. Promisingly, our analysis points the way for those seeking to understand or even influence or change an energy culture towards a low-carbon pathway, or to maintain a current pathway that is low-carbon. It also enables those advocates looking for like-minded cultures as they seek to form international partnerships or influence global negotiations.

Although not a complete explanation of countries' low-carbon ambitions, the framing of national energy culture offers a more nuanced conceptual device than many more reductive approaches for understanding the distinctiveness, dynamics, and complexity of decarbonisation pathways. Promisingly, it also offers a compelling tool that policymakers and activists can use to propel national energy systems towards more ambitious carbon emissions reductions.

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