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Climate change vs energy security? The conditional support for energy sources among Western Europeans

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ABSTRACT

The decarbonisation of Western societies requires a fundamental reorganisation of energy supply and fierce debates around the future energy mix have begun in many countries. However, we still know little about how concerns about energy security affect the public's energy preferences in view of the critique that renewable energies might compromise energy security. This paper argues that there is a perceived trade-off between energy security and climate protection that affects energy supply preferences in Western Europe. Using the European Social Survey's 'Public Attitudes to Climate Change' module, the findings from multilevel regressions demonstrate that there is indeed a perceived trade-off in energy preferences among Western Europeans. People concerned about energy security prefer coal, gas, and nuclear power over renewable energies. People worried about climate change prefer solar and wind energy over nuclear and fossil forms of energy. The analysis further identifies four different groups representing the trade-off between energy security and climate protection among Western Europeans. The paper thus identifies why energy preferences might collide and why some countries observe a polarisation of views around energy supply that policymakers need to address to realise a successful and publicly acceptable transformation of energy supply.

1. Introduction

The decarbonisation of Western societies requires a fundamental reorganisation of energy supply. With fossil forms of energy due to be phased out gradually over the next decades in almost all developed countries, the future energy mix has become an intensive topic for discussion among scientists, policymakers, industry actors, and the public. This can be illustrated by the high salience of energy and environmental issues in the last elections for the European Parliament and the debate around the European Commission's decision whether gas and nuclear power should be classified as transitional energy sources to mitigate climate change (European Commission, 2022). More generally, any politically successful and feasible restructuring of the energy mix requires a broader acceptance and lasting consensus for replacing fossil forms of energy with sustainable and CO_2-neutral forms of energy supply (see Dermont et al., 2017; Drews and van den Bergh, 2016). This is the socio-political acceptance component of renewable energy transitions (Wüstenhagen et al., 2007; Dermont et al., 2017).

From previous research, we know that people concerned about climate change support renewable and non-carbon-based sources of energy (e.g. Hazboun and Boudet, 2020; Karasmanaki and Tsantopoulos, 2021; Nisbet and Myers, 2007). However, we know little about whether and how concerns about energy security affect the public's energy preferences. This is crucial given the critique that large-scale deployment of renewable energy sources might compromise energy security and thus give rise to a trade-off between energy security and climate protection among the public (Bang, 2010; Brown and Huntington, 2008; Gracceva and Zeniewski, 2014; Hache, 2018; Sinn, 2017).

Accordingly, it is crucial to understand what drives support for different energy sources and whether such a postulated trade-off exists. Shedding light on the existence of a climate protection vs energy security trade-off is also relevant in view of the energy security concerns, which have escalated as a consequence of Russia's attack on Ukraine and the sanctions and boycotting of energy from Russia in 2022.

Empirical studies on how the perceived trade-offs between energy security concerns and climate change concerns affect energy source preferences among the public have however been scarce (see Demski et al., 2014), although both worries are often used to argue in favour or against the use of specific energy sources (e.g. Teräväinen et al., 2011). Crucially, successful energy policies require that policymakers can gauge public reactions to policy ideas and policy solutions. This requires a thorough analysis of public opinion beforehand (Prakash and

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Bernauer, 2020: 431; Visschers and Siegrist, 2014; Schmid et al., 2021).

Existing work in this regard has mostly focused on one single form of energy, especially nuclear energy (e.g. Bell et al., 2013; Chung and Kim, 2018; Corner et al., 2011; Gupta et al., 2019; Teräväinen et al., 2011), or drawn on single country case studies of energy source preferences (e.g. Engels et al., 2013; Ertör-Akyazı et al., 2012; Greenberg, 2009; Hobman and Ashworth, 2013; Karlstrøm and Ryghaug 2014; Koto and Yiridoe, 2019; Plum et al., 2019; Roddis et al., 2019; Vieira and Dalgaard, 2013; Visschers and Siegrist, 2014). This means we lack comparative analyses of public attitudes towards different energy sources (Schmid et al., 2021), and more specifically about perceived trade-offs between climate change and energy security (see Hazboun and Boudet, 2020 for a similar critique).

To fill in this lacuna, I use the module "Public Attitudes to Climate Change" from the eighth wave of the European Social Survey (2016) to analyse how concerns about climate change and energy security affect the attitudes towards seven different energy sources in 14 Western European countries. I seek to investigate whether trade-offs between climate change and energy security exist in the minds of the public and how such trade-offs condition support for different energy sources. In this regard, the main contribution of the paper is empirical.

The findings show that although renewable energies receive higher average support than fossil fuels, there is indeed a perceived trade-off between climate change concerns and energy security concerns among parts of the public. Those who are more concerned about energy security than about climate change do favour fossil forms of energy production (coal and gas) and nuclear energy over renewable energies such as solar or wind energy as the former are regarded as more stable sources of energy. The opposite is true for citizens who place less importance on energy security but are more concerned about climate change. Hydroelectricity and biomass occupy an intermediate position in this perceived trade-off.

The remainder of this paper is structured as follows. I first review the literature on energy source preferences to derive three testable hypotheses. I then describe the data and methods applied, before presenting the empirical results. The final section discusses the implications of the findings.

2. Preferences towards energy sources and worries about climate change and energy security: A literature review

Not least with the Chernobyl nuclear accident in 1986, scientists from various disciplines began to study the support for energy sources intensively, mostly focusing on nuclear energy as the politically and socially most controversial source of energy (see Gupta et al., 2019 for a longitudinal study of the U.S., and Ho and Kristiansen, 2019 for a recent review of studies). With the intensifying debate about climate change in recent decades, empirical research on energy preferences has focused particularly on support for renewable forms of energy such as wind, solar or hydroelectric power (e.g. Greenberg, 2009; Hazboun and Boudet, 2020; Karlstrøm and Ryghaug 2014; Plum et al., 2019; Visschers and Siegrist, 2014). While public opinion research has demonstrated a general support for renewable energy sources such as wind and solar energy (e.g. Hobman and Ashworth, 2013; Hazboun and Boudet, 2020; Visschers and Siegrist, 2014; see Karasmanaki and Tsantopoulos, 2021 for a recent review of the empirical literature), we lack a more systematic understanding of which energy sources are supported by citizens and whether the postulated trade-off between climate protection and energy security exists in the minds of the public during the process of decarbonisation (see Demski et al., 2014).

This is relevant since several scholars of energy policy and economic policy have pointed out that renewable energies – at least under certain circumstances – might compromise energy security and could thus reflect a trade-off between energy security and climate protection (Bang, 2010; Brown and Huntington, 2008; Gracceva and Zeniewski, 2014; Hache, 2018; Sinn, 2017). The same concerns have been issued by policymakers who are facing the challenge to provide reliable energy supply during the transition to a CO_2-neutral energy supply for their citizens and industry (e.g. DECC, 2009; Deutscher Bundestag, 2021; World Economic Forum, 2006).

Critics of renewable energies have often pointed to the more unstable energy supply provided by these energy sources as solar and wind energy are dependent on weather conditions. On that score, the economist Hans-Werner Sinn used the derogatory term "Jittering Power" (*Zappelstrom*) to point out one flip side of the German Energiewende (Sinn, 2014). Since electricity supply from sun and wind is less stable and predictable than Germany's traditional sources of energy (coal, lignite, and nuclear power), the country would become more vulnerable to interruptions of power supply or even blackouts (Sinn, 2017). A related downside of the decarbonisation of domestic energy supply is the increased dependence on natural gas from Russia to guarantee stable electricity during the initial phase of the Energiewende. Hence, the Energiewende would in the first place jeopardise energy security and increase the country's dependence on Russia – an authoritarian regime – to maintain stable energy supply. The higher dependence on foreign energy supply and other resources, such as the need to import precious metals, during the phase of decarbonisation has also been pointed out by other authors (cf. Hache, 2018; see Bang, 2010 for an overview over the U.S. debate).

In view of the posited trade-off between climate protection and energy security, it is striking that empirical analyses of energy preferences have typically only included the concern for climate change or the environment as predictors of energy preferences, but not investigated both concerns in the study of energy preferences and support for renewable energies. Only the studies by Corner et al. (2011) and Gupta et al. (2019) on attitudes towards nuclear power have accounted for trade-offs between climate protection and energy supply security (see also Ho and Kristiansen, 2019 for a review of the arguments). Corner et al. (2011) investigated whether the framing and perception of nuclear energy affects the support for this energy source. They found that although nuclear power is per se unpopular among the British public, support for this energy source increases if it is framed as a solution to climate change and energy security. This is labelled the 'reluctant acceptance' framing, since respondents who are concerned about energy security might support nuclear energy as a compromise or interim solution if this form of energy is able to mitigate climate change. Similarly, Gupta et al.'s (2019) longitudinal study showed that concerns about energy security increased the support for nuclear energy in the U.S. Using the Energy Security Risk Index (ESRI) from the U.S. Chamber of Commerce, their longitudinal analysis documents that public support for nuclear energy was positively correlated with concerns for energy security.

Demski et al. (2014) provided one of the few empirical studies covering the postulated trade-off between energy security and climate change and showed that public concerns around energy security had emerged among the British public. These concerns were affected by how energy security was portrayed in comparison to climate change concerns. A further study by Demski et al. (2018) showed that national context conditions such as energy imports, electricity costs, and economic wealth affect concerns about energy security. However, energy security concerns were used as the dependent variable in this study and not as a predictor of energy source preferences. One untested implication from Demski et al. (2018) is that citizens concerned about energy security are more supportive of lignite as energy source but do oppose renewable energies.

Accordingly, beyond the two single case studies on conditional support for nuclear power (Corner et al., 2011; Gupta et al., 2019), we know little about how perceived trade-offs between energy security and climate change concerns affect energy source preferences across nations (Brown and Huntington, 2008; see also Stadelmann-Steffen and Eder, 2021). I therefore seek to test the following hypotheses on worries about climate change, energy security and energy source preferences.

Hypothesis 1. Higher worries about climate change increase the support for renewable energies and decrease the support for fossil forms of energy.

Hypothesis 2. Higher worries about energy security decrease the support for renewable energies and increase the support for fossil forms of energy.

Hypothesis 3. People with strong worries about energy supply and weak worries about climate most strongly support for fossil forms of energy and oppose renewable energies, whereas renewable energies enjoy the highest support among people who are worried about climate change but not energy security.

3. Data and methods

3.1. Data

I use the module "Public Attitudes to Climate Change" from the eighth wave of the European Social Survey (2016) to investigate the conditional support for seven different energy sources in 14 Western European countries (Austria, Belgium, Finland, France, Germany, Great Britain, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, and Switzerland). The ESS is a high-quality cross-country survey conducted on a biannual base.[1] The module "Public Attitudes to Climate Change" consists of a comprehensive item battery measuring attitudes towards environmental policies, climate change, climate policies, and energy production/consumption. Particularly, it consists of items capturing the worries about climate change, energy security, and preferences for seven different energy sources. The raw data for the 14 countries consists of 27,521 respondents with national sample sizes ranging between 1270 (Portugal) and 2852 (Germany). The response rates vary between 30.6% (Germany) and 67.7% (Spain). I chose these 14 Western European countries because recent analyses of issue priorities demonstrated that climate change concerns and political conflicts around energy supply are highly salient among Western Europeans but not among Eastern Europeans (Braun and Schäfer, 2021; Eurobarometer, 2019). Moreover, conflicts around energy sources, especially nuclear power, became never virulent in post-communist countries, where one main goal is to reduce energy dependence on Russia.

Using the ESS module on climate change attitudes allows tapping into the socio-economic acceptance dimension in the transition to renewable energies (Wüstenhagen et al., 2007; Dermont et al., 2017). Naturally, it does not allow to examine other dimensions of social acceptance in the transition to renewable energies such as local community preferences (including NIMBY effects) or market and consumer acceptance of concrete energy sources (see Wüstenhagen et al., 2007; Dermont et al., 2017). This is a limitation of the present study because this type of survey data can be used to analyse and detect broader patterns and statistical associations between variables. These might however not always reflect real-world and manifest support for a given energy source in a concrete situation. For instance, citizens who are generally favourable towards wind energy production might nonetheless oppose wind turbines if they are built in their immediate proximity (see Stokes, 2016). Nevertheless, various contributions have pointed to the problem that a successful energy transition requires a critical mass of support and thus socio-political acceptance for specific energy sources beforehand as policymakers need to gauge public reactions to policy ideas and policy solutions (Dermont et al., 2017; Prakash and Bernauer, 2020: 431; Visschers and Siegrist, 2014; Schmid et al., 2021). This speaks in favour of a thorough analysis of public opinion using survey data despite its natural limitations (see Prakash and Bernauer, 2020).

3.2. Independent variables

The independent variables are the worries about climate change and energy security and a trade-off measure constructed based on both worries. The worry about climate change was measured along a five-point Likert-scale in the ESS where the respondents were asked "How worried are you about climate change?" and could choose between the following answers.

1 "Not at all worried"
2 "Not very worried"
3 "Somewhat worried"
4 "Very worried"
5 "Extremely worried"

The worries about energy security were measured by a self-constructed index. I followed a narrow conceptualisation of energy security that is based on technical risk and geopolitical risk sources (Winzer, 2012) as policymakers have more control over these aspects of energy security than over natural disasters or sabotage, which are included in some broader definitions of energy security (risks). Critics of renewable energies have also typically focused on power cuts, insufficient capacity, and dependence on foreign imports as main points (Sinn, 2017).

Accordingly, I created an additive index using four items from the climate change item battery in the ESS. The respondents were asked "How worried are you that energy supplies could be interrupted? [by SOURCE of disruption]. The sources of disruption were "power cuts", "energy supply interrupted by insufficient power generated", "technical failures", and "too dependent on energy imports".

All four items applied the following five-point scale.

1 "Not at all worried"
2 "Not very worried"
3 "Somewhat worried"
4 "Very worried"
5 "Extremely worried"

Cronbach's item reliability test yielded $\alpha = 0.773$ and therefore allowed me to create an additive index. This was recoded to apply the same five-point scale as the worry about climate change to maintain direct comparability between the two measures. Further validity tests reported in the Online Appendix (Tables A1-A2) indicated that all four items follow one direction and have high interitem correlations and interitem covariances.

To capture the hypothesised trade-off between climate change and energy supply, I created a categorical variable that captures the four different possible combinations in the *climate change vs. energy security trade-off* plus a control group of indifferent respondents. This is the core independent variable of the analysis. This trade-off variable is based on the two five-point scales for climate change and energy security worries and takes into account whether respondents placed themselves as below or above three – the natural mean for both worry variables – for both worries. This yielded four combinations of worries plus a control group of indifferent respondents. The four combinations are [1] "not worried about either" (both variables score less than three), [2] "worried about climate, not about energy security" (climate concern larger than three, energy concern less than three), [3] "worried about energy security, not about climate" (climate concern less than three, energy concern larger than three), and [4] "worried about both" (both worries score larger than three). The control group of indifferent captures those respondents who scored indifferent (=3) on either or both of the two variables [0]. This variable is used to capture the energy preferences across the different combinations of worries – and thus to model the effects of the perceived trade-off between energy security and climate change directly. This is not possible if the two five-point scales from the ESS are used separately.

[1] The data are available under https://ess-search.nsd.no/en/all/query/.

3.3. Dependent variable: support for different energy forms

The dependent variable in the analysis is the support for energy generation from seven different sources. The respondents were asked “How much electricity in [country] should be generated from [energy source]?”. The seven energy sources mentioned were “coal”, “natural gas”, “hydroelectric power”, “nuclear power”, “solar power”, “wind power”, and “biomass energy”. For each of the seven sources, the respondents were asked which amount of production they prefer from each given source on a scale from 1 “A very large amount” to 5 “None at all”. The scale was reversed to create a scale on which higher values indicate stronger preferences for a given energy source.

1 “None at all”
2 “A small amount”
3 “A medium amount”
4 “A large amount”
5 “A very large amount”

Respondents who had not heard of a given energy source before were removed to retain the Likert-scales. I use these seven scales to capture the support for the seven underlying energy sources.

3.4. Previous energy mix and energy sources

As energy policy is a slow-moving policy area with long cycles of policy implementation, we need to account for path-dependency in the study of attitudes towards energy sources. Borrowing from the study of public policy the notions of path dependencies and increasing returns to scales (Pierson, 2000), previous energy policy choices should have created country-specific energy mixes and trajectories. The energy sources and energy mix that have been introduced in the past have likely shaped the energy preferences of citizens enduringly (Aklin and Urpelainen, 2013; Fouquet, 2016; Lee and Gloaguen, 2015). The policy image of energy sources is shaped by politicians, stakeholders, and experts who act as agenda-setters in the discourse on a given energy source. This might imply that this energy source is not scrutinised or considered effectively. This is known as cognitive lock-in the study of public policy (Blyth, 2001). For instance, countries that base their energy supply considerably on nuclear power should have a higher support for this energy source on average (e.g. France) than countries that never decided to use nuclear power (Norway) or abandoned it before the first regular power plant came on stream (e.g. Austria or Denmark). Recent studies by Fritz and Koch (2019) and Stadelmann-Steffen and Eder (2021) have shown that such a path-dependency is at play in the energy preferences of Europeans. This stability might be disturbed by external shocks such as the Fukushima Daiichi incident, which spurred a debate on the use of nuclear energy in several countries and led to the phasing out of nuclear energy in Germany and other countries (Aklin and Urpelainen, 2013).

Accordingly, as different energy sources enjoy different images in different countries and previous energy choices have likely shaped the energy preferences of later generations and thus provide a key rival explanation, I control for the energy mix of each given country in 2000. I use the energy mix from 2000 to account for socialisation effects and effective cognitive locks from the past.[2] The data for the energy mix was obtained from the International Energy Agency (IEA, 2022). I used the IEA’s (2022) rich database “World Energy Balances” containing total energy supply (TES) by source, year, and country. I obtained the TES for all countries in the ESS dataset for 2000 (and several other years for robustness checks). The data from the IEA were merged with the ESS data. The energy sources in the IEA data are coal, oil, gas, nuclear power, hydroelectric energy, energy from biomass, and wind and solar energy (combined). One difference to the energy sources covered in the ESS is that oil appears as separate, distinct energy source, which the ESS’s energy preferences battery did not cover. Another difference is that the IEA uses a joint category for wind and solar energy in contrast to the ESS. This is a weakness but, in my view, tolerable as both are renewable energy sources and the joint share of wind and solar energy in the IEA data should have a reasonably similar effect on different energy preferences on my dependent variable. Since the energy mix consists of compositional variables (Aitchison, 1986), I used the share of oil as reference category.

I calculated the share of each energy source by dividing its absolute production in Terajoule by the total energy produced for each country in 2000 (again in Terajoule) based on the TES data. This yields the energy mix in percentages for each source by country. In case a country did not use a given energy source at all, it was scored 0 per cent. This applies for instance in countries that do not use nuclear energy at all during the period under review (Austria, Denmark and Norway). Descriptive statistics for the energy mix in 2000 appear in the Online Appendix, Table A3.

3.5. Control variables

Since existing research has identified various attitudinal predispositions and demographic variables as factors for energy preferences (e.g. Brieger, 2019; Ziegler, 2017: see Drews and van den Bergh, 2016 for a comprehensive review), I control for age, education, gender, income, urban-rural domicile, and social class (Oesch, 2006). The detailed coding and operationalisation of these control variables can be found in the Online Appendix, Part I. To capture pre-existing ideological dispositions that might drive attitudes towards energy sources, I control for left-right self-placement (0–10 scale), egalitarian attitudes, attitudes towards immigration, and trust in politicians. Trust is included as additional control since high political trust is associated with higher support for environmental protection, and thus a potential driver of support for renewable energies (Fairbrother et al., 2019; Stadelmann-Steffen and Eder, 2021).

On the national level, I control for GDP per capita at current market prices, birth rate, net migration rate, population density and the unemployment rate to account for country-specific differences in wealth and demography. Again, a detailed description of these variables appears in the Online Appendix. This is because previous research has shown that environmental concerns are higher in affluent countries whereas energy security concerns are higher in countries that are doing less well in terms of economic and human well-being (e.g. Brieger, 2019; Fairbrother et al., 2019).

3.6. Method

Because the ESS data represents a hierarchical data structure, it is necessary to account for this to obtain unbiased standard errors (Hox, 2002; Rabe-Hesketh and Skrondal, 2012). I therefore use multilevel regression models to analyse the effects of climate change and energy security worries on preferences for energy sources. Since the data is collected with countries as main clusters, the fourteen countries serve as level-two units for the analysis presented below. In view of the current debate on the sufficient number of units on the contextual level for accurate estimation of multilevel models (Bell et al., 2014; McNeish and Stapleton, 2016; Stegmueller, 2013; Schmidt-Catran et al., 2019), I also run the models with Restricted Maximum Likelihood (REML) instead of the ordinary ML estimators to obtain more conservative estimators for models with limited number of Level-2 units (cf. McNeish and Stapleton, 2016). To account for the low number of Level-2 units, the models were also run with NUTS-2 regions as Level-2 variables, and I added Eastern European countries as robustness check. I further used an ordinal logistic multilevel regression and a fixed effects specification to further

[2] I provide robustness checks with different baseline years for the energy mix in the Online Appendix, Tables B17-B23.

inspect the robustness of the findings. These robustness checks do not change the main findings and conclusions drawn. They appear in the Online Appendix in Tables B1-B7.

4. Analysis

4.1. Main results

I begin with a brief descriptive analysis of the general support for the seven energy sources under review. Fig. 1 compares the average support for the different energy sources in the 14 countries.

The comparison of the subgraphs illustrates that coal and nuclear energy are clearly the most unpopular energy sources among Western Europeans. A majority of respondents rejects these two sources or only want a small amount of energy to be produced from them. In contrast, a clear majority wants at least a large amount of energy to be produced from hydroelectric power, solar or wind energy. This confirms previous studies on energy preferences (Roddis et al., 2019; Hazboun and Boudet, 2020). Gas and biomass enjoy a somewhat balanced support as sources of energy.

Having shown and compared the support for different forms of energy sources descriptively, the next step is to test the hypotheses on effects of worries about climate change worries and energy security worries, respectively, on energy preferences. Table 1 presents the main effects from the multilevel regression models with energy source preferences as dependent variables, the climate change worries and energy security concerns, respectively, as main independent variables, and the previous energy mix to account for path-dependent support. For reasons of space, the coefficients for all other control variables appear in the full models reported in Table A4 in the Online Appendix. The main coefficients from these models capture the associations between worries about climate change and energy security and energy sources preferences and thus provide a test of Hypotheses 1 and 2. Finding systematic associations and patterns is a pre-condition for testing the existence of a trade-off.

The coefficients for the worries about climate change indicate support for Hypothesis 1 as higher worries about climate change are significantly associated with stronger support for renewable energies (hydroelectric power, biomass, wind energy, and solar energy). Moreover, higher climate worries decrease the support for fossil forms of energy such as coal and gas significantly. The strongest associations between climate change worries and energy preferences can be observed for wind, solar and nuclear power, the latter being negative.

The coefficients for the worries about energy security in Table 1 largely confirm Hypothesis 2. Respondents who are worried about energy security have a significantly lower support for hydroelectric power, wind, and solar energy. In contrast, the more worried people are about energy security, the stronger the support for fossil forms of energy (coal, gas) and for nuclear power. Support for biomass diverges here since both concerns are significantly associated with higher support for this energy source albeit the coefficients for biomass remain generally modest compared to all other energy sources. This is reflected by the relatively modest R^2 for biomass in Table 1 (and other models for this energy source reported in the Online Appendix). Accordingly, the results in Table 1 support Hypothesis 1 as well as Hypothesis 2 except for biomass. Support for traditional forms of energy is higher among respondents who are more concerned about energy security than climate change and its consequences. These respondents obviously perceive renewable energies such as wind and solar as compromising energy security and therefore support traditional energy sources. The opposite is true for respondents who are worried about climate change. They show a high support for renewable energies and a low support for fossil forms energy and nuclear power.

Apart from biomass, we see another striking pattern in Table 1 when

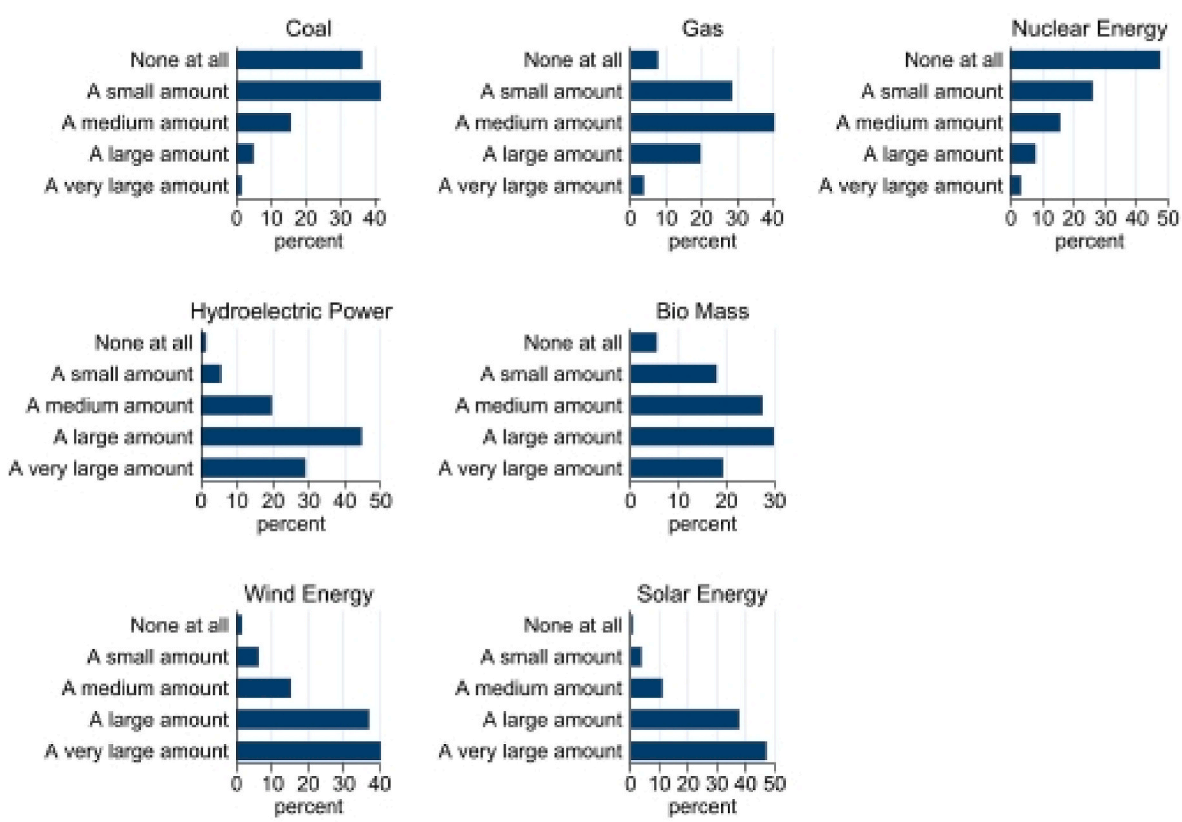

Fig. 1. Support for different sources of energy in 14 Western European countries.
Source: European Social Survey (2016). *Note:* the data are weighted with the design and population size weights.

Table 1
Effects of worries about climate change and energy security on energy source preferences.

	Coal	Gas	Nuclear Power	Hydroelectric Power	Biomass	Wind Energy	Solar Energy
Worried	−0.104***	−0.062***	−0.137***	0.035***	0.088***	0.131***	0.124***
climate change	(0.007)	(0.009)	(0.009)	(0.008)	(0.010)	(0.009)	(0.008)
Worried	0.135***	0.070***	0.096***	−0.054***	0.028*	−0.050***	−0.046***
energy security	(0.009)	(0.011)	(0.012)	(0.011)	(0.013)	(0.011)	(0.010)
Energy mix by 2000 as percentage of total energy production (Reference category: Share of oil)							
Share coal	−0.703	1.121	−0.349	−6.711***	−0.235	−2.839!	−5.014**
	(0.452)	(1.133)	(1.874)	(1.542)	(1.124)	(1.626)	(1.787)
Share gas	0.184	−0.123	1.849*	−2.210**	3.166***	−2.189**	−1.653*
	(0.204)	(0.505)	(0.833)	(0.685)	(0.502)	(0.722)	(0.794)
Share	−0.808***	0.502	2.415***	−2.873***	1.599***	−2.300***	−2.042**
nuclear power	(0.179)	(0.444)	(0.734)	(0.604)	(0.442)	(0.636)	(0.699)
Share hydro-	−1.739***	−0.608	−0.302	−1.600*	−0.262	−1.251	−2.359**
electric	(0.231)	(0.573)	(0.946)	(0.778)	(0.569)	(0.821)	(0.902)
Share	−1.827***	−3.629***	1.997!	−4.614***	2.574***	−1.554	−1.402
biomass	(0.292)	(0.731)	(1.207)	(0.993)	(0.725)	(1.047)	(1.151)
Share wind	−22.470***	8.224	−1.375	−25.559*	−2.062	−2.372	−10.159
& solar	(3.281)	(8.012)	(13.189)	(10.857)	(7.981)	(11.445)	(12.566)
Variance components							
Random intercept	0.001***	0.007***	0.021***	0.014***	0.007***	0.016***	0.020***
variance	(0.000)	(0.003)	(0.008)	(0.006)	(0.003)	(0.006)	(0.008)
Residual	0.609***	0.857***	0.952***	0.778***	1.166***	0.835***	0.676***
variance	(0.006)	(0.009)	(0.010)	(0.008)	(0.012)	(0.009)	(0.007)
N	17779	17812	17862	18081	17588	18157	18160
Snijders & Bosker R^2	0.160	0.058	0.169	0.101	0.068	0.123	0.111
Rho	0.001	0.009	0.022	0.018	0.006	0.019	0.028
-2LL	−20821.973	−23912.319	−24925.285	−23408.980	−26319.494	−24144.341	−22233.292
BIC	42025.591	48206.355	50232.396	47200.262	53020.213	48671.147	44849.056
df	36	36	36	36	36	36	36

Source: European Social Survey (2016). *Note:* entries are coefficients from multilevel linear regression models. Standard errors appear in parentheses; ! $p < 0.10$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Only main effects for worries and previous energy mix shown. Full models containing all control variables appear in Table A4 in the Online Appendix.

comparing the coefficients and their signs for each source. If the worries about climate change have a positive [negative] coefficient for a given energy source, then the coefficient of energy security worries on the same energy source becomes negative [positive], i.e. always the opposite. This is tentative support for the postulated existence of a trade-off as hypothesised in Hypothesis 3 between climate change worries and energy security worries in the support for six out of seven energy sources.

The coefficients reflecting the energy mixes of the countries by 2000 further demonstrate that there are some systematic patterns indicating path-dependency in the support for different energy sources. Most coefficients are significantly negative. This indicates that the stronger the reliance on a specific energy source in a country, the lower is public support for other energy sources vis-à-vis oil as reference category. Specifically, the negative coefficients for the share of coal and gas of total energy production on support for hydroelectric power, wind, and solar energy show that support for renewable energies is lower in countries that have previously relied heavily on coal and gas in their energy mix. In turn, those countries who have made no or only little use of fossil forms of energy in the past have higher support for renewable energies (e.g. Switzerland).

For nuclear power as part of the previous energy mix, there is a clear and significant path-dependency here as well. The strong and highly significant coefficient of 2.415 demonstrates that the more nuclear power was used in the past, the higher the current support for this energy source. Previous use of nuclear power also reduces the respondents' support for coal and the renewable energy source significantly. Another strong path-dependent support can be observed for biomass energy. Biomass as energy source enjoys significantly stronger support in those countries, where it had been a strong component of the energy mix before. Previous reliance on biomass also reduces the support for the two fossil forms of energy but also hydroelectric power significantly. The results for the macro variables capturing the energy mix illustrate that, beyond the two worries about climate change and energy supply, there is a considerable path-dependency in the energy preferences in Western Europe. The low rho values indicate that the models explain the cross-country variation in energy preferences quite well as there is a low residual variance on the macro-level. This is in line with arguments about path-dependency where previous energy policies have shaped support for the different energy sources at a later stage.

The analyses of the unconditional associations detected clear and significant relationships as well as a systematic pattern in the support for the seven energy sources. This is the precondition for testing the existence of a trade-off postulated in Hypothesis 3. I therefore turn to the crucial explanatory variable of the analysis, the effects of the energy trade-off measure. To re-iterate, the categorical variable for measuring the climate-energy security trade-off captures the four logical combinations of worries about climate and energy security plus a control group of indifferent respondents. The four combinations are [1] "not worried about either", [2] "worried about climate, not about energy security, [3] "worried about energy security, not about climate", and [4] "worried about both". The control group of indifferent captures those respondents who scored indifferent (=3) on either of the two variables or both [0]. This category serves as the reference category for the trade-off measure. The coefficients are reported in Table 2 and visualised in Fig. 2.

The are several clear patterns in the analysis using the trade-off measure in Table 2. First, respondents who are neither worried about climate change nor worried about energy security have a strong and significant preference for nuclear power and also favour coal to a lesser degree. This group has a significant negative view on renewable energies (biomass, wind, and solar) and no difference to the reference group for gas and hydroelectric energy. Second, and unsurprisingly, those respondents who are worried about climate change but not about energy security have a significantly lower support for coal, gas and nuclear power and a strong support for the two renewable energies (wind and solar energy). These respondents also have a weaker but still significant preference for hydroelectric power and biomass compared to the reference group of indifferent respondents. Third, respondents who are

Table 2
Effects of perceived trade-off climate change vs. energy security worries on energy source preferences.

	Coal	Gas	Nuclear Power	Hydroelectric Power	Biomass	Wind Energy	Solar Energy
Energy trade-off position (reference category: indifferent position on either or both items)							
Not worried	0.057***	−0.026	0.146***	0.007	−0.130***	−0.120***	−0.090***
about both	(0.017)	(0.020)	(0.021)	(0.019)	(0.023)	(0.019)	(0.017)
Worried about climate,	−0.152***	−0.138***	−0.144***	0.053**	0.063**	0.160***	0.164***
not energy	(0.016)	(0.019)	(0.020)	(0.018)	(0.022)	(0.018)	(0.017)
Worried about energy,	0.255***	−0.008	0.180**	−0.103*	−0.066	−0.146**	−0.167***
not climate	(0.045)	(0.052)	(0.055)	(0.049)	(0.062)	(0.051)	(0.045)
Worried	0.051*	−0.048!	−0.093***	0.016	0.129***	0.134***	0.126***
about both	(0.021)	(0.025)	(0.026)	(0.023)	(0.029)	(0.024)	(0.022)
Energy mix by 2000, % of total energy production compared to oil							
Share coal	−0.559	1.152	−0.268	−6.658***	−0.124	−2.820!	−4.950**
	(0.572)	(1.225)	(1.979)	(1.573)	(1.094)	(1.655)	(1.810)
Share gas	0.249	−0.130	1.864*	−2.183**	3.126***	−2.205**	−1.680*
	(0.256)	(0.545)	(0.879)	(0.699)	(0.489)	(0.735)	(0.804)
Share nuclear	−0.732**	0.506	2.455**	−2.855***	1.622***	−2.290***	−2.023**
power	(0.225)	(0.480)	(0.775)	(0.616)	(0.430)	(0.647)	(0.708)
Share hydro-	−1.727***	−0.578	−0.300	−1.540!	−0.224	−1.230	−2.329*
electric	(0.291)	(0.619)	(0.999)	(0.794)	(0.554)	(0.835)	(0.913)
Share	−1.914***	−3.628***	1.895	−4.493***	2.546***	−1.500	−1.424
biomass	(0.369)	(0.790)	(1.275)	(1.013)	(0.705)	(1.066)	(1.165)
Share wind & solar	−23.651***	8.179	−2.189	−24.334*	−1.349	−0.896	−8.906
	(4.095)	(8.648)	(13.920)	(11.071)	(7.767)	(11.642)	(12.720)
Variance components							
Random intercept	0.002***	0.009***	0.024***	0.015***	0.007***	0.017***	0.020***
variance	(0.001)	(0.004)	(0.009)	(0.006)	(0.003)	(0.007)	(0.008)
Residual variance	0.621***	0.860***	0.964***	0.782***	1.173***	0.842***	0.683***
	(0.007)	(0.009)	(0.010)	(0.008)	(0.012)	(0.009)	(0.007)
N	18163	18198	18256	18490	17943	18578	18588
Snijders & Bosker R^2	0.153	0.056	0.161	0.098	0.065	0.119	0.105
Rho	0.002	0.010	0.024	0.019	0.006	0.019	0.029
-2LL	−21453.979	−24468.828	−25589.465	−23990.734	−26902.357	−24781.551	−22856.170
BIC	43310.051	49339.828	51581.233	48384.292	54206.308	49966.121	46115.381
df	38	38	38	38	38	38	38

Source: European Social Survey (2016). *Note*: Standard errors appear in parentheses; ! $p < 0.10$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Entries are coefficients from multilevel linear regression models. Only main effects for trade-off variable for worries and previous energy mix shown. Full models containing all control variables appear in Online Appendix in Table A5.

worried about energy security but not climate change have the strongest support for coal and nuclear power among all four combinations of worries and show a significant opposition to renewable energies (hydroelectric power, wind and solar energy) compared to the reference group. For gas and biomass, there are no effects for this group.

Lastly, respondents who are worried about both climate and energy security support coal as traditional source of energy but also biomass, solar and wind energy as renewable sources of energy. This group does also – in contrast with the reluctant acceptance argument (Corner et al. (2011) – oppose nuclear energy significantly. Accordingly, the regression coefficients provide considerable empirical support for Hypothesis 3.

Plotting the results as marginal effects in Fig. 2 further illustrates the distinct patterns of support for the different sources dependent on their worries about climate change and energy supply. Especially for the groups ‘worried about energy security but not about climate’ and ‘worried about climate but not energy security’, we can observe distinct patterns of support for different energy sources. Fig. 2 shows that these groups have – except for gas – always opposite preferences for the energy sources under review. Fig. 2 further illustrates that the attitudinal gaps between the different groups are strongest for coal, nuclear power, wind, and solar energy. This indicates that the polarisation in energy preferences caused by varying worries about climate change or energy supply, respectively, is strongest for these energy sources. For gas and hydroelectric power, the gaps between the groups captured by the trade-off measure remain modest and often insignificant, which is also indicated by the relatively lower R^2 measures in Table 2. This signals a considerably weaker polarisation around these two energy sources in the climate vs. energy security debate.

To further illustrate how the different perceptions of climate change and energy security worries affect the support for energy sources, I used ordinal logistic specifications of the models above. These allow predicting the allocation of energy preferences across the trade-off measure (see Online Appendix, Tables B8-B14). Fig. 3 plots the predicted distribution of energy preferences for coal, nuclear energy, hydroelectric power, and wind energy over the trade-off measure (reference categories omitted). For reasons of space, similar graphs for the remaining three energy sources gas, biomass and solar energy appear in the Online Appendix, Figure B1.

The predicted percentages (i.e. the likelihood to fall into one of the five answer categories from ‘not at all’ to ‘very large amount’) across the trade-off categories underpin the findings from the linear specifications above. They also indicate that the worry about climate change is the slightly stronger predictor in the trade-off measure compared to the energy security worry for most but not all energy sources. For coal in the upper left-hand corner of Fig. 3, we observe a total rejection by 50 per cent in the category ‘worried about climate but not about energy’. In contrast, respondents worried about both have only a 35 percent likelihood to reject coal categorically and thus a more pragmatic attitude on coal. Around 65 per cent who are worried about both do not support abandoning coal completely, which comes close to support in the category ‘worried about energy only’.

For nuclear energy in the upper right-hand panel, we observe a total rejection of this energy source among people who are only worried about the climate (60 per cent), but almost a similar strong rejection among those worried about both (55 per cent). This speaks again against the ‘reluctant acceptance’ thesis. People who are not worried about either or only about energy security do not reject nuclear energy categorically and would at least allow for some use of it (around 60 per cent of those respondents fall into the categories ‘small amount’ to ‘very large

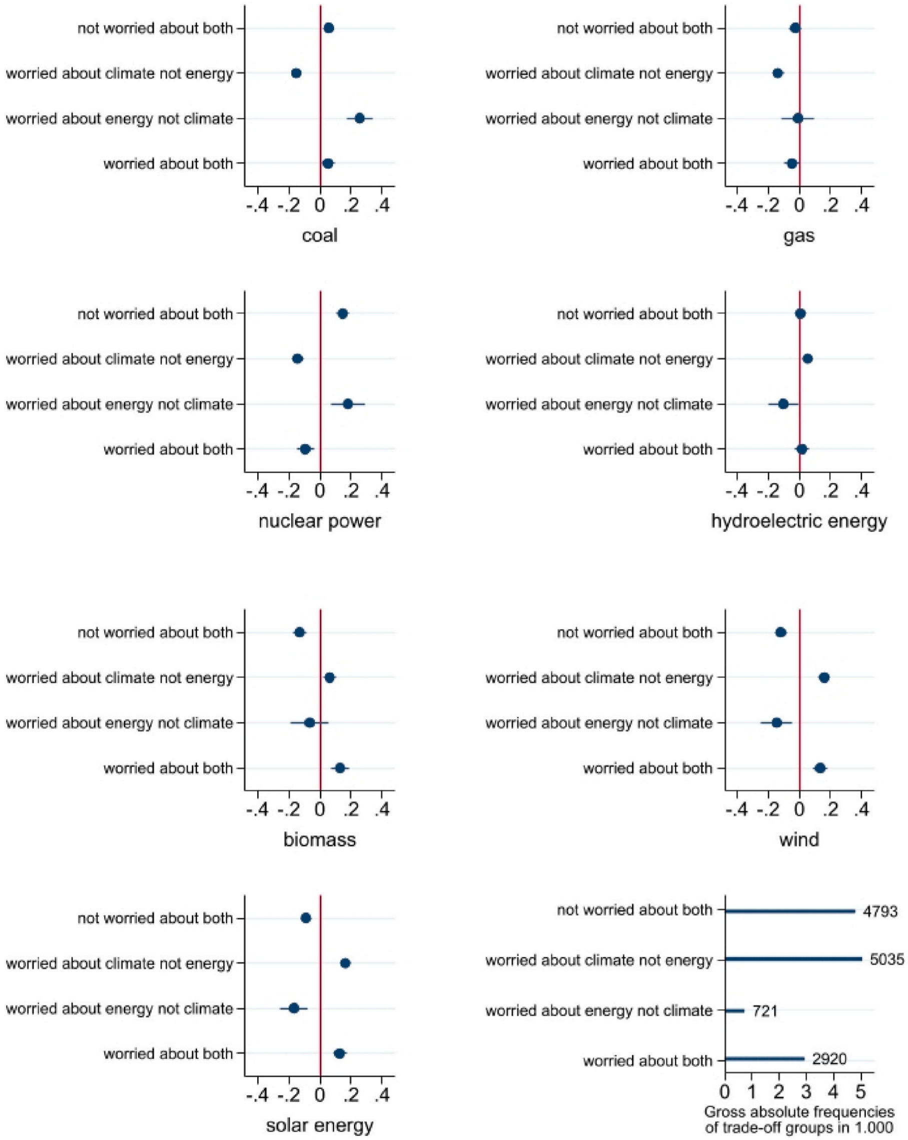

Fig. 2. Climate change and energy security trade-off perceptions and energy source preferences.
Source: Multilevel regression models from Table 2.
Note: Entries are marginal effects of predicted support for the seven energy sources across the four groups in the climate-security trade-off compared to the group of indifferent respondents. Differences to the red line on the x-axis reflect distance to control group. Gross absolute group sizes in lower right-hand panel calculated with weights with control group omitted. Numbers besides the bars indicate total N for each group.

amount'). We should keep in mind that nuclear power is the most unpopular energy source in our data, though.

The support for hydroelectric energy (lower left-hand panel in Fig. 3) is least driven by the energy vs climate trade-off. Most responses fall into the category 'a large amount' and the predicted probabilities differ only weakly over the trade-off measure. The scepticism towards hydroelectric power is slightly higher among those who are worried about energy security but not the climate compared to the three other groups. This matches the results from Tables 1 and 2 above where respondents were less polarised over hydroelectric power.

For wind energy, we see that unconditional support for this energy source is highest among people who are worried about both, followed by those worried about the climate but not energy (50 and 45 per cent fall into 'very large amount'). In contrast, we observe more sceptical views towards wind energy among those who are concerned about energy security or not concerned about either. Less than 30 per cent of the respondents in these two categories support a very large amount of wind energy for this otherwise most popular energy source. Solar energy has a very similar pattern (see Figure B1 in Online Appendix).

In sum, Fig. 3 indicates that the trade-off is mostly driven by the climate change worry, but it also makes a difference whether there is a worry about energy security especially for coal. The predicted probabilities indicate that the position on the trade-off measure particularly conditions the categorical rejection or outright support for a given energy source. For coal and nuclear power, the willingness to accept at least smaller amounts of these otherwise least popular energy sources is driven by both energy security concerns and climate worries. Here, we observe differences in the predicted support by up to twenty per cent between the categories of the trade-off measure.

4.2. Robustness checks

I ran the models presented above in Tables 1 and 2 with different specifications. This includes using restricted maximum likelihood estimations instead of the ordinary maximum likelihood estimations (McNeish and Stapleton, 2016), reduced models without attitudinal variables, ordinal logit models instead of mixed linear models, fixed effects instead of maximum likelihood models, using NUTS-regions instead of countries, and adding Eastern European countries to the sample. None of these specifications alter the conclusions drawn from the models presented in Tables 1 and 2, and Figs. 2 and 3. These models appear in the Online Appendix, Tables B1 to B7 and Tables B8 to B16.

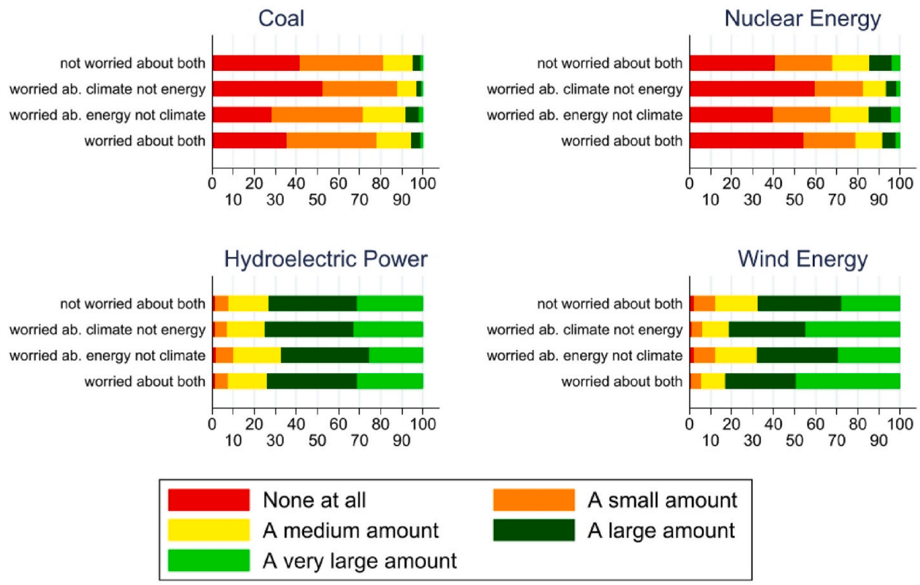

Fig. 3. Predicted distribution of energy source preferences across trade-off perceptions.
Source: Predictions from multilevel ordinal logit regression models reported in Model 3, Tables B8, B10, B11, and B13 in Online Appendix. *Note:* Entries show the predicted support in per cent for the seven energy sources across the four groups in the climate-security trade-off (reference categories omitted).

5. Conclusion and policy implications

As the intended decarbonisation of Western societies goes along with a fundamental reorganisation of energy supply, policymakers need to find a new energy mix to provide stable but also publicly acceptable energy supply in the future (Dermont et al., 2017; Drews and van den Bergh, 2016; Wüstenhagen et al., 2007). Accordingly, the future energy mix has become an intensive topic for discussion among scientists, policymakers, industry actors, and the public. Scholars of environmental politics have therefore called for further investigation of public opinion towards policy solutions to provide guidance for policymakers (Prakash and Bernauer, 2020).

This article added new empirical findings to this debate by analysing how concerns about climate change and energy security drive support for different sources of energy. Investigating different factors of support for energy sources is crucial because supporters and opponents of conventional and renewable energies have pointed to energy security and climate considerations when defending specific energy sources. Moreover, not only the public debate but also recent research has pointed to existent trade-offs between climate change mitigation and energy security concerns in the choice of the energy mix (Bang, 2010; Brown and Huntington, 2008; Gracceva and Zeniewski, 2014; Hache, 2018; Sinn, 2017). Some renewable energies, so the critique goes, do not provide reliable and stable energy supply, and would compromise economic competitiveness and security of supply through a higher risk of blackouts and increased dependence on foreign energy.

Using the European Social Survey (Round 8), this analysis first confirmed that support for seven different energy sources among citizens from 14 Western European countries is indeed conditional. The higher the worries about climate change, the higher the support for renewable forms of energy and the stronger the opposition to fossil forms of energy and nuclear power. In contrast, the higher the concerns about energy security, the stronger the support for coal, gas, and nuclear power. Being worried about energy security further drives the resistance against renewable energies (hydroelectric power, wind, and solar energy).

In a second step, I examined the effects of the perceived trade-off between climate and energy security on energy preferences by modelling the four logical attitudinal combinations in the debate. This analysis identified two contrasting combinations of attitudes. Those who are worried about climate change but not energy supply are the core supporters of renewable energies. In contrast, those who are not very worried about climate change but worry greatly about energy security support coal and nuclear power and oppose solar and wind energy. Crucially, those who are worried about both the climate and energy security strongly support wind energy, solar power, and biomass. In this group, we further find a relatively strong opposition to nuclear power that is stronger than the resistance to coal – something to be corroborated by future research. The empirical analyses further demonstrated that the attitudinal differences around energy sources are strongest for coal, nuclear energy, wind, and solar energy, whereas views are less polarised concerning biomass, gas, and hydroelectric power.

Needless to say, this study has various limitations that provide avenues for future research. First, the data were collected in 2016 and thus before Russia's attack on Ukraine and the resulting energy crisis throughout Europe. The war and its repercussions have likely changed the perception of several energy sources and this needs to be addressed by future research drawing on longitudinal data. For instance, some renewable energies have been regarded as less secure in terms of stable energy production but might now be regarded as more secure as energy can be produced domestically thereby decreasing the reliance on energy imports. This might make the picture even more complicated as citizens have changed their perceptions of the advantages and disadvantages of different energy sources and thus also on the perceived trade-offs over time.

This is an issue for further research comparing pre- and post-Ukraine War energy preferences. Valuable would also be longitudinal studies with a more general focus on how the energy trade-off has evolved given the increasing importance of climate change and energy security in recent years. This research should not only look on the 'classical' renewable energies, wind and solar, but also inspect the two energy sources that had intermediate positions in the analysis of the energy trade-offs, namely biomass and hydroelectric energy. Especially the latter might be increasingly considered as solution to improve energy security since it is possible to steer hydroelectric energy production domestically. On the other hand, hydroelectric energy production requires changes in landscapes and local ecosystems and is thus often the subject of ecological and social conflicts (see Tabi and Wüstenhagen, 2017). Tabi and Wüstenhagen (2017) further point out that attitudes towards hydroelectric energy have so far been understudied compared to newer forms of renewable energy (wind and solar), nuclear energy, and fossil forms of energy (coal and gas).

A second limitation of the study is its focus on Western Europe that has some implications for the results and their generalisability. Expanding the comparative study of energy preferences to Eastern Europe and other regions is another avenue for research, but requires a proper theorisation of East-West differences in energy preferences to account for differences rooted in history. Eastern Europe had in contrast to most Western European countries not seen the virulent conflicts about nuclear energy since the 1970s that could explain why the reluctant acceptance thesis on nuclear power could not be confirmed in this study. However, nuclear energy might be a more acceptable energy source to mitigate climate change in Eastern Europe, which future research could inspect.

A related aspect to be addressed by future research is whether Western Europeans are generally more willing to abandon fossil energies, whereas Eastern Europeans show more concerns about reducing their energy dependence on Russia even if this means adherence to domestic fossil fuel energies such as coal or shale gas. As mentioned before, these preferences might have changed or reinforced with Russia's attack on Ukraine. Future research should not only investigate to what extent citizens recognise the ability of some renewable energies to both substitute fossil energies domestically and reduce import dependence but also how much Western and Eastern Europe have converged or diverged in their energy preferences after the Russian attack on Ukraine as critical juncture.

Moreover, the trade-off between energy security concerns and climate change worries signals a considerable potential for polarisation among electorates in the future. If the division between those who are concerned about climate change and those who are primarily concerned about energy security (and affordability) becomes more and more manifest, strategic politicians will realise the respective electoral potential for their parties. Energy supply problems that are related to or ascribed to renewable energies might drive and increase resistance against these energies and this will be exploited by political parties, especially those with populist leanings (Lockwood, 2018). On the other hand, skilful policymakers could point to potential synergies between energy security and climate-friendly energy production for specific energy sources to counteract trade-off perceptions among the public. Politicians can in this regard apply distinct framing strategies to affect public support for energy sources.

Finally, the results pointed to path-dependent trajectories of support for specific energy sources as the previous energy mix around 2000 explained the support or opposition to specific energy sources by 2016. This helps us to understand why some otherwise similar countries have chosen different paths in their energy policies. Accordingly, the findings on specific energy sources need to be substantiated by further research covering the drivers of support for specific energy sources and country-specific differences after 2016. Future studies should therefore apply a longitudinal approach to investigate whether the patterns found in this analysis have changed or consolidated as consequence of the war and the growing recognition of the problems following from the dependence on Russian gas and oil in many countries.

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CRediT authorship contribution statement

Christoph Arndt: Conceptualization, Data curation, Investigation, Formal analysis, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2023.113471.

References

Aitchison, J., 1986. The Statistical Analysis of Compositional Data. Chapman & Hall, London.
Aklin, M., Urpelainen, J., 2013. Political competition, path dependence, and the strategy of sustainable energy transitions. Am. J. Polit. Sci. 57 (3), 643–658.
Bang, G., 2010. Energy security and climate change concerns: triggers for energy policy change in the United States? Energy Pol. 38 (4), 1645–1653.
Bell, D., Gray, T., Haggett, C., Swaffield, J., 2013. Re-visiting the 'social gap': public opinion and relations of power in the local politics of wind energy. Environ. Polit. 22, 115–135.
Bell, B.A., Morgan, G.B., Schoeneberger, J.A., Kromrey, J.D., Ferron, J.M., 2014. How low can you go? An investigation of the influence of sample size and model complexity on point and interval estimates in two-level linear models. Methodology: European Journal of Research Methods for the Behavioral and Social Sciences 10 (1), 1–11.
Blyth, M., 2001. The transformation of the Swedish model: economic ideas, distributional conflict, and institutional change. World Polit. 54 (1), 1–26.
Braun, D., Schäfer, C., 2021. Issues that mobilize Europe. The role of key policy issues for voter turnout in the 2019 European Parliament election. Eur. Union Polit. 23 (1), 120–140.
Brieger, S.A., 2019. Social identity and environmental concern: the importance of contextual effects. Environ. Behav. 51 (7), 828–855.
Brown, S.P.A., Huntington, H.G., 2008. Energy security and climate change protection: complementarity or tradeoff? Energy Pol. 36 (9), 3510–3513.
Bundestag, Deutscher, 2021. Unterrichtung durch den Bundesrechnungshof. Bericht nach § 99 der Bundeshaushaltsordnung zur Umsetzung der Energiewende im Hinblick auf die Versorgungssicherheit und Bezahlbarkeit bei Elektrizität. Deutscher Bundestag, Berlin. Drucksache 19/28689.
Chung, J.C., Kim, E.S., 2018. Public perception of energy transition in Korea: nuclear power, climate change, and party preference. Energy Pol. 116, 137–144.
Corner, A., Venables, D., Spence, A., Poortinga, W., Demski, C., Pidgeon, N., 2011. Nuclear power, climate change and energy security: exploring British public attitudes. Energy Pol. 39 (9), 4823–4833.
DECC, 2009. The UK Low Carbon Transition Plan: National Strategy for Climate and Energy. Department of Energy and Climate Change, London.
Demski, C., Poortinga, W., Pidgeon, N., 2014. Exploring public perceptions of energy security risks in the UK. Energy Pol. 66, 369–378.
Demski, C., Poortinga, W., Whitmarsh, L., Böhm, G., Fisher, S., Steg, L., Umit, R., Jokinen, P., Pohjolainen, P., 2018. National context is a key determinant of energy security concerns across Europe. Nat. Energy 3, 882–888.
Dermont, C., Ingold, K., Kammermann, L., Stadelmann-Steffen, I., 2017. Bringing the policy making perspective in: a political science approach to social acceptance. Energy Pol. 108, 359–368.
Drews, S., van den Bergh, J.C.J.M., 2016. What explains public support for climate policies? A review of empirical and experimental studies. Clim. Pol. 16 (7), 855–876.
Engels, A., Hüther, O., Schäfer, M., Held, H., 2013. Public climate-change skepticism, energy preferences and political participation. Global Environ. Change 23 (5), 1018–1027.
Ertör-Akyazı, P., Adaman, F., Özkaynak, B., Zenginobuz, Ü., 2012. Citizens' preferences on nuclear and renewable energy sources: evidence from Turkey. Energy Pol. 47, 309–320.
Eurobarometer, 2019. The 2019 Post-Electoral Survey. Have European Elections Entered A New Dimension? Eurobarometer Survey 91.5 of the European Parliament. A Public Opinion Monitoring Study. European Commission, Brussels.
European Commission, 2022. Complementary Climate Delegated Act, C(2022) 631/3. European Commission, Brussels,. https://ec.europa.eu/finance/docs/level-2-measures/taxonomy-regulation-delegated-act-2022-631_en.pdf.
European Social Survey Round 8 Data, 2016. Data File Edition 2.1. NSD - Norwegian Centre for Research Data, Norway – Data Archive and Distributor of ESS Data for ESS ERIC. https://doi.org/10.21338/NSD-ESS8-2016.
Fairbrother, M., Sevä, I.J., Kulin, J., 2019. Political trust and the relationship between climate change beliefs and support for fossil fuel taxes: evidence from a survey of 23 European countries. Global Environ. Change 59, 102003.
Fouquet, R., 2016. Path dependence in energy systems and economic development. Nat. Energy 1 (8), 1–5.

Fritz, M., Koch, M., 2019. Public support for sustainable welfare compared: links between attitudes towards climate and welfare policies. Sustainability 11 (15), 4146.
Gracceva, F., Zeniewski, P., 2014. A systemic approach to assessing energy security in a low-carbon EU energy system. Appl. Energy 123, 335–348.
Greenberg, M., 2009. Energy sources, public policy, and public preferences: analysis of US national and site-specific data. Energy Pol. 37 (8), 3242–3249.
Gupta, K., Nowlin, M.C., Ripberger, J.T., Jenkins-Smith, H.C., Silva, C.L., 2019. Tracking the nuclear 'mood' in the United States: introducing a long term measure of public opinion about nuclear energy using aggregate survey data. Energy Pol. 133, 110888.
Hache, E., 2018. Do renewable energies improve energy security in the long run? International Economics 156, 127–135.
Hazboun, S.O., Boudet, H.S., 2020. Public preferences in a shifting energy future: comparing public views of eight energy sources in north America's pacific northwest. Energies 13 (8), 1940.
Ho, S.S., Kristiansen, S., 2019. Environmental debates over nuclear energy: media, communication, and the public. Environmental Communication 13 (4), 431–439.
Hobman, E.V., Ashworth, P., 2013. Public support for energy sources and related technologies: the impact of simple information provision. Energy Pol. 63, 861–869.
Hox, J., 2002. Multilevel Analysis Techniques and Applications. Lawrence Erlbaum Associates Publishers, Mahwah, NJ.
IEA, 2022. World Energy Balances and Statistics. International Energy Agency, Paris. https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances.
Karasmanaki, E., Tsantopoulos, G., 2021. Public attitudes toward the major renewable energy types in the last 5 years: a scoping review of the literature. In: Kyriakopoulos, G.L. (Ed.), Low Carbon Energy Technologies in Sustainable Energy Systems. Academic Press, London, pp. 117–139, 2021.
Karlstrøm, H., Ryghaug, M., 2014. Public attitudes towards renewable energy technologies in Norway. The role of party preferences. Energy Pol. 67, 656–663.
Koto, P.S., Yiridoe, E.K., 2019. Expected willingness to pay for wind energy in Atlantic Canada. Energy Pol. 129, 80–88.
Lee, R.P., Gloaguen, S., 2015. Path-dependence, lock-in, and student perceptions of nuclear energy in France: implications from a pilot study. Energy Res. Social Sci. 8, 86–99.
Lockwood, M., 2018. Right-wing populism and the climate change agenda: exploring the linkages. Environ. Polit. 27 (4), 712–732.
McNeish, D.M., Stapleton, L.M., 2016. The effect of small sample size on two-level model estimates: a review and illustration. Educ. Psychol. Rev. 28 (2), 295–314.
Nisbet, M.C., Myers, T., 2007. The polls—trends: twenty years of public opinion about global warming. Publ. Opin. Q. 71 (3), 444–470.
Oesch, D., 2006. Redrawing the Class Map: Stratification and Institutions in Britain. Palgrave, Germany, Sweden and Switzerland.
Pierson, P., 2000. Increasing returns, path dependence, and the study of politics. Am. Polit. Sci. Rev. 94 (2), 251–267.
Plum, C., Olschewski, R., Jobin, M., Vliet, O. Van, 2019. Public preferences for the Swiss electricity system after the nuclear phase-out: a choice experiment. Energy Pol. 130, 181–196.
Prakash, A., Bernauer, T., 2020. Survey research in environmental politics: why it is important and what the challenges are. Environ. Polit. 29 (7), 1127–1134.
Rabe-Hesketh, S., Skrondal, A., 2012. Multilevel and Longitudinal Modeling Using Stata, third ed. Stata Press, College Station, TX.
Roddis, P., Carver, S., Dallimer, M., Ziv, G., 2019. Accounting for taste? Analysing diverging public support for energy sources in Great Britain. Energy Res. Social Sci. 56, 101226.
Schmid, N., Beaton, C., Kern, F., McCulloch, N., Sugathan, A., Urpelainen, J., 2021. Elite vs. mass politics of sustainability transitions. Environ. Innov. Soc. Transit. 41, 67–70.
Schmidt-Catran, A.W., Fairbrother, M., Andreß, H.J., 2019. Multilevel models for the analysis of comparative survey data: common problems and some solutions. Kölner Z. Soziol. Sozialpsychol. 71 (1), 99–128.
Sinn, H.W., 2014. Putin und der Zappelstrom, vol. 12. Wirtschaftswoche, p. 37, 17 March 2014.
Sinn, H.W., 2017. Buffering volatility: a study on the limits of Germany's energy revolution. Eur. Econ. Rev. 99, 130–150.
Stadelmann-Steffen, I., Eder, C., 2021. Public opinion in policy contexts. A comparative analysis of domestic energy policies and individual policy preferences in Europe. Int. Polit. Sci. Rev. 42 (1), 78–94.
Stegmueller, D., 2013. How many countries do you need for multilevel modelling? A comparison of Bayesian and frequentist approaches. Am. J. Polit. Sci. 57 (3), 748–761.
Stokes, L., 2016. Electoral backlash against climate policy: a natural experiment on retrospective voting and local resistance to public policy. Am. J. Polit. Sci. 60 (4), 958–974.
Tabi, A., Wüstenhagen, R., 2017. Keep it local and fish-friendly: Social acceptance of hydropower projects in Switzerland. Renew. Sustain. Energy Rev. 68 (1), 763–773.
Teräväinen, T., Lehtonen, M., Martiskainen, M., 2011. Climate change, energy security, and risk—debating nuclear new build in Finland, France and the UK. Energy Pol. 39 (6), 3434–3442.
Vieira, M.A., Dalgaard, K.G., 2013. The energy-security–climate-change nexus in Brazil. Environ. Polit. 22 (4), 610–626.
Visschers, V.H.M., Siegrist, M., 2014. Find the differences and the similarities: relating perceived benefits, perceived costs and protected values to acceptance of five energy technologies. J. Environ. Psychol. 40, 117–130.
Winzer, C., 2012. Conceptualizing energy security. Energy Pol. 46, 36–48.
World Economic Forum, 2006. The Energy Vision Update: the New Energy Security Paradigm. World Economic Forum, Geneve.
Wüstenhagen, R., Wolsink, M., Bürer, M.J., 2007. Social acceptance of renewable energy innovation: an introduction to the concept. Energy Pol. 35 (5), 2683–2691.
Ziegler, A., 2017. Political orientation, environmental values, and climate change beliefs and attitudes: an empirical cross country analysis. Energy Econ. 63, 144–153.