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Public climate-change skepticism, energy preferences and political participation

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ABSTRACT

Many studies have shown a general decline of public concern about climate change or vice versa a rise in public climate-change skepticism, in particular in the U.S. and other Anglo-Saxon countries. There is a vivid debate on whether this is a global phenomenon, on which factors explain the decline, and on the broader societal implications of these trends in the context of the transformation toward a low-carbon society. We add to this literature by presenting the results of a recent general population survey in Germany in which we looked for systematic linkages between public climate-change skepticism on one hand, and energy preferences and political participation on the other. Germany is an interesting testbed as it is currently involved in a large-scale restructuring of its system of energy supply toward renewable energy sources (the “Energiewende”). Our results indicate that climate-change skepticism has not diffused widely in Germany, but that it correlates with less support of renewable energy sources. However, skepticism correlates negatively with political participation, and there is no strong political outlet for public climate-change skepticism in Germany. Alternative potential barriers for the successful implementation of the “Energiewende” are also discussed.

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1. Introduction

Public perceptions of climate change build the foundation for decisions on carbon-reduction policies. There is a strong interest in the social sciences in understanding the relationships between climate perceptions – in particular, public climate-change skepticism – and support for carbon-reduction policies. The correlation among public skepticism, energy preferences and political participation is a crucial field of analysis for any country that strives to transition toward a low-carbon society. We present results from a recent general social survey on public perceptions of climate change in Germany. With the concept of public climate-change skepticism we refer to a range of dimensions along which the broader public casts doubt on the mainstream risk assessment on anthropogenic climate change as expressed, e.g., by the reports of the IPCC. Someone can have serious doubts about the existence of climate change, about its causation by human factors or about potential negative impacts of anthropogenic climate change. More indirectly, someone can also seriously question that there is consensus among scientists. In this study we refer to these different dimensions to employ an inclusive concept of skepticism

rather than a single item factor. We assess the diffusion of public climate-change skepticism in Germany and seek for factors, which might affect the diffusion.

It is widely believed that a transition toward low-carbon lifestyles or the introduction of low-carbon policies are difficult to achieve in the face of wide-ranging public climate-change skepticism. To achieve a more systematic understanding of these potential linkages, we evaluate the correlations among public skepticism, the preference for different energy sources and political participation. We address a missing link in the current research on the transformation toward a low-carbon society. In this paper, we focus on answering the following questions: Compared with Anglo-Saxon countries, how widespread is public climate-change skepticism in Germany? Which socio-demographic and attitudinal factors are related to skepticism? How does skepticism relate to perceptions of different energy sources and energy preferences? And, finally, is skepticism related to political participation? The wider implications of the results are discussed in the concluding section.

2. Background: climate-change skepticism and beyond

Ratter et al. (2012) and Scruggs and Benegal (2012) recently pointed to a general decline in major industrialized countries in public concern about climate change over the past few years.

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Others have shown that public skepticism about climate change has become a mainstream phenomenon in the U.S. and to a lesser extent in other major industrialized countries (McCright and Dunlap, 2011a; Poortinga et al., 2011; Leiserowitz et al., 2011; Washington and Cook, 2011; Weber and Stern, 2011; Schmidt, 2010; Hamilton, 2010; Hoggan and Littlemore, 2009). To date, studies have focused on evaluating the diffusion of public skepticism and have sought to identify factors explaining when and why the public turns toward skepticism. Some authors link the growing skepticism to political campaigns (Dunlap and McCright, 2011), others to the economic crisis and high unemployment rates (Scruggs and Benegal, 2012). In addition, several studies have analyzed the dynamics and the effects of organized skepticism, i.e., lobbying efforts to discredit climate scientists and their research results (McCright and Dunlap, 2010; Inman, 2012). Also, knowledge about climate change among laypeople has not diffused or grown substantially over the past few decades, in spite of a tremendous knowledge accumulation in the scientific community (Reynolds et al., 2010). Most of these studies have a strong focus on the Anglo-Saxon part of the world, with only a few, and purely descriptive, comparisons with other (European) countries (Eurobarometer, 2011).

Therefore, only few studies analyzed whether climate change skepticism has grown in countries outside of the Anglo-Saxon cultural and political realm, and how a respective growth would influence voters' readiness to support carbon-reduction policies. The comparative analysis is important because factors explaining skepticism in Anglo-Saxon countries might be irrelevant or non-existent in other countries. In Germany, organized political campaigns to discredit climate scientists and to cast doubt on the science of climate change have been largely absent. Germany is a country in which pro-environmental attitudes are part of the cultural mainstream (e.g., Eurobarometer, 2009; Kuckartz, 2008), and since the 1990s, climate change has had strong affirmative repercussions in politics and the mass media (Weingart et al., 2000). One indicator of this is that all major political parties represented in the national parliament relate in some positive way to environmental and climate protection goals. The political parties are extremely unlikely to launch campaigns in favor of climate-change skepticism, and climate-change skeptics have no strong political outlet in the current political landscape of Germany.

In addition to the question of an expansion of climate-change skepticism, several studies have attempted to test the correlations between the inclination to adopt a skeptical stance on climate change and socio-demographic and attitudinal variables in often complex statistical models. Several authors have tested to what extent a person's level of education, level of income, political orientation and general attitudinal background correlates with being skeptical about climate change (McCright and Dunlap, 2011a; Poortinga et al., 2011; Whitmarsh, 2011). These studies show that climate-change skepticism is embedded in general cultural values and attitudes. In the tested models of these studies, low scores of general environmental concern correlate with skepticism. Other factors such as sex, education and age also correlate with different degrees of skepticism in most statistical models.

For the U.S., social scientists have predicted a growing divide between liberals and conservatives rather than the emergence of a social consensus (Hoffman, 2011a; McCright and Dunlap, 2011b). There, the probability of holding skeptical views on climate change is significantly higher among white male respondents who identify with the conservative party than among any other group. For the U.K., Poortinga et al. (2011) found a positive correlation between climate-change skepticism and low social status, old age and support for a conservative political party. However, they were not

able to show the "white male" effect in their study. These differences already demonstrate that in spite of some general factors, the specific composition of factors correlating with climate-change skepticism depend strongly on the political and cultural context in which the model is tested. We assume that countries which differ stronger from the U.S. and the U.K. in terms of culture and the political system will need other models, or other combinations of factors in these models, to understand the country specific dynamics of climate-change skepticism. These differences can be observed at various levels of society: they can be deeply rooted in the conception of the individual vis-à-vis the state (Eisenstadt, 2000), they can concern the complex institutional settings which structure economic and political life (Thelen, 2009), and more specifically the different regulatory styles and traditions with which environmental problems have been treated so far. The precautionary principle is, to give an example, firmly rooted in the German culture and also institutionalized in its political and legal approach to environmental protection, whereas this is less so in the US (Schreurs, 2003).

Cultural and institutional differences should become particularly visible if it comes to the correlation between skepticism and attitudes, racial background and socio-economic status. For example, public attitudes and political debates are not organized along racial divides in Germany so that "race" as a variable is typically not even addressed in public surveys. The German political spectrum is also much different from the polarized pattern of conservatives versus liberals in the U.S.: traditional conservative milieus have undergone cultural changes, and the five to six relevant political parties form various and changing coalitions, depending on the specific electoral situation in a given government at the national, state or communal level.

Other ongoing scientific debates focus on the questions how climate-change skepticism should be measured, how skepticism can be differentiated into several dimensions (Whitmarsh, 2011; Rahmstorf, 2004; Poortinga et al., 2011; McCright and Dunlap, 2011a) and how skepticism, denial and contrarianism relate to each other (see the debate in O'Neill and Boykoff, 2010; Kemp et al., 2010; Ryghaug et al., 2011). Several dimensions of skepticism are discussed in the literature, e.g. a person's doubts regarding the reality of climate change, the anthropogenic origin of climate change or the possibility of adverse effects on society. Not only the science of climate change, but also the scientists working in this field have come under close scrutiny, and they have been faced with a loss of trust in the integrity of their work (Nerlich, 2010; Leiserowitz et al., 2010).

But why is climate-change skepticism a significant object of social science research in the first place? Different forms of skepticism have been acknowledged as a major reason for the lack of support for government policies on climate change and for low public engagement in carbon-reducing activities (Ding et al., 2011; Whitmarsh et al., 2011). Widespread public skepticism about climate change can produce strong political and cultural barriers that hinder a government's domestic climate change policy agenda, especially in the case of carbon-reduction policies. It is generally assumed that a growing number of skeptics create an important political barrier against carbon-reduction policies or against a switch toward renewable energy sources. This is linked to the often untested assumption that skeptics are active participants in the political process, or that they have a strong political voice through which they can transport their opposition. We go beyond these studies in that we test the correlations among public skepticism of climate change, energy preferences and political participation. Energy preferences are important because in any major industrialized country seeking to reduce carbon emissions, energy policies will be a key tool that can be used to achieve this goal. Political participation is an indicator of influence and of the

ability of actors to raise a voice in debates on energy-related or carbon reduction policies. It is thus important to ask whether skeptics are active in the political decision-making process, or whether they can wield a veto-power through established political parties. Even if it can be shown for a specific country that climate-change skepticism is on the rise, this does not automatically imply an influence on the skeptics' support for certain policies, and whether this support of or veto against policies finds its ways through the political system.

For a number of reasons, Germany is an interesting country to study with respect to the relationships among skepticism, energy preference and political participation. First, Germany is currently undergoing a large-scale transformation of its energy sector by phasing out nuclear power, continuing a policy of reducing domestic CO₂ production, and reorganizing its electricity grid (Praetorius and von Stechow, 2009; Townshend et al., 2011). Second, it is a major industrialized but non-Anglo-Saxon country; it is both politically and culturally different from countries such as the U.S., the U.K., and Canada. It is thus interesting to ask whether public skepticism has spread among the population as it has in other countries and to analyze the potential implications of public skepticism for the German attempt to introduce the "Energie-wende" toward renewable energy.

3. Materials and methods

3.1. Data collection and data quality

Our study was based on a representative phone survey in Germany using the conventional random digital dial (RDD) method for recruiting. The sample included $N = 3000$ respondents, age 18 and older, living in households with landlines. Within households, the date of birth was used as a key for randomization. The survey was conducted from April 28 to June 28, 2011; the average interview time was 30 min. After correction for non-systematic dropout, a response rate of 23.2% was achieved. This response rate reflects the growing unwillingness to respond to phone surveys in general (Curtin et al., 2005; Keeter et al., 2006). Other phone surveys in this subject area have achieved lower or similar response rates, e.g., a response rate in Canada was 10% (Ackerlof et al., 2010) and response rates of 27% and 28% were obtained in the US (Malka et al., 2009); for a broader discussion and more examples of similar response rates for phone surveys, see Keeter et al. (2006).

Our database contains over- or under-representations of certain socio-demographic structures of the German population that are typical for phone surveys (e.g. Ackerlof et al., 2010; Malka et al., 2009): people aged over 60 years are slightly underrepresented (33.7% in our study versus 38.4% in the German population); women are slightly overrepresented (55.1% in our study versus 51.3% in the German population); and people with a tertiary education are overrepresented (20.5% versus 9.5%). We conducted every analysis below with weighted and unweighted datasets and obtained the same basic results and conclusions. In the following analysis, we use the weighted dataset. The data were weighted with regard to age, sex and education.

3.2. Item construction and factor analyses

The questionnaire for this study was composed of four sections that explored the respondents' knowledge of and attitudes toward the following: climate change (I), expected impacts of climate change (II), energy preferences (III) and socio-demographic variables (IV).

We used regression analyses, first to answer the question of how public skepticism in Germany is connected with socio-economic and attitudinal variables and, second, to analyze how

skepticism correlated with political participation. To analyze the connections between skepticism and energy preferences, we used a Spearman rank correlation coefficient. We used this nonparametric test because the distributions of the energy preferences across the German population are heavily skewed.

The relevant variables and factors were constructed as follows:

Public climate-change skepticism was measured using a multi-dimensional construct, including several types of doubt and uncertainty. Many studies use skepticism as a single item factor only, and there is a lively methodological debate how to apply a broader and more inclusive construct of skepticism than a simple measure of belief or disbelief in the existence of climate change (see the debate in O'Neill and Boykoff, 2010; Kemp et al., 2010; Rygghaug et al., 2011). McCright and Dunlap (2011a, b) combine variables, which measure beliefs about climate science with variables which measure beliefs about the scientific community and variables on the personal concern about climate change. Rahmstorf (2004) focuses on beliefs about climate science and distinguishes between trend skeptics (non-believers of the empirical evidence that climate change is occurring), attribution skeptics (non-believers of the causation of climate change by human activities) and impact skeptics (non-believers of negative impacts). Poortinga et al. (2011) combine these three types with a distinction between (firm) skeptical disbeliefs, differing degrees of uncertainty about some aspect of climate change, and attitudinal ambivalence, acknowledging that very often laypeople are not very convinced about what to believe, and how to feel about different aspects of climate change. Whitmarsh (2011) combines several attitudinal statements into one multidimensional skepticism scale, covering uncertainty about the existence of climate change with certain beliefs about how the media exaggerate and a general mistrust in the evidence of climate change.

We are specifically interested in the correlation between skepticism and carbon-reduction policies, and selected the dimensions, which we considered most relevant for this research perspective. The sheer disbelief in the existence of climate change is the most basic form of skepticism. According to Whitmarsh (2011), this form of outright rejection is not widespread, but it has severe implications for political action: No carbon-reduction policy can be legitimated by referring to climate change if it simply does not take place. We were therefore interested in the extent to which respondents agreed or disagreed to the phrase "Climate change is currently occurring" (trend skepticism). Among those who more or less agree on the existence of climate change, varying other forms of skepticism are imaginable, with different implications for the policy process and for questions of risk communication. If, for example, someone believes that climate change is currently occurring, but strongly doubts that human activities are causing it, this would also be a weak basis for accepting policies to mitigate climate change. Climate change could, in this understanding, be caused by natural variation and solar cycles. This might support adaptation strategies such as building dams against sea-level rise or improving insurance schemes to protect private property losses due to more violent storms etc., but it would be no foundation for the transition toward a low-carbon energy mix. As a second dimension of skepticism we therefore asked for agreement to the phrase "climate change is caused by humans" (attribution skepticism). Another dimension of skepticism relevant for our research perspective is the belief or disbelief in negative impacts of climate change, even if it should be caused by human activities. If positive impacts outweigh negative ones or impacts are expected to be neutral, the readiness to accept costly policy measures might be rather low, even if people feel uneasy about altering the earth's climate system. This dimension can refer to many different aspects of why respondents are not worried enough about impacts of climate change to support mitigation policies: They might expect

Table 1
Factor analysis results.

	Factor loadings	Reliability (Alpha) ^a
Skepticism factor		.79
Disagreement with “Climate change is currently occurring.” (trend skepticism)	.78	
Disagreement with “Climate change is caused by humans.” (attribution skepticism)	.74	
Disagreement with “Climate Change is a serious problem” (impact skepticism)	.83	
Disagreement with “There is a consensus in climate science that climate change is happening.” (consensus skepticism)	.78	
Environmental awareness factor		.60
If things continue on their present course, we will soon experience a major ecological catastrophe.	.72	
Humans are severely abusing the environment.	.72	
The balance of nature is strong enough to cope with the impacts of modern industrial nations (reverse coded).	.60	
The so-called “ecological crisis” facing humankind has been greatly exaggerated (reverse coded).	.57	
The earth is like a spaceship with limited room and resources.	.50	
Risk awareness factor		.72
Criminality	.73	
Economic development in Germany	.67	
Immigration	.64	
Personal health	.62	
Terrorism	.61	
Own economic situation	.60	

^a Subjects who answered “I fully disagree” to the item “There is currently climate change” were not asked any other question about climate change. In order to include these subjects in the analysis, they were re-coded as answering “I fully disagree” to all other items. As expected, this intervention led to a slightly better alpha value. However, the alpha value without the intervention was with 0.69 also satisfactory.

negative impacts only in the distant future or in spatially remote world regions, or they might hope for immediate positive impacts such as “better” weather, the expansion of arable land, or a shifting of climate zones which would allow for new economic activities. For this reason we tried to find a question which refers to a general belief in impacts of climate change, but leaves open the questions of where, when and how. We therefore asked for the extent of agreement to the phrase “climate change is a serious problem” (impact skepticism). Finally, a serious doubt in the consensus among climate scientists that climate change is happening might also postpone political action. If experts disagree, any such scientific risk assessment on climate change as provided by the IPCC might simply be wrong, and an investment into more research might be preferable to heavy investments into the transformation of a country’s energy system. Studies in the US and the UK context in particular have pointed out the discrepancy between the consensus shared by the vast majority of climate scientists (Doran and Zimmerman, 2009) and the widespread public perception that experts disagree about climate change. We wanted to know to what extent respondents agreed or disagreed to the phrase “There is a consensus in climate science that climate change is happening” (consensus skepticism). Skepticism about the scientific consensus is often linked to media constructions of climate change and to the journalistic norms of balanced reporting (Boykoff and Boykoff, 2004, 2007). Some studies therefore include questions on how much media reporting exaggerates the seriousness of global warming (McCright and Dunlap, 2011a, b; Whitmarsh, 2011). Such a question seems inappropriate in the German context, however. Climate change has long and widely been accepted in the German media as a rather certain and serious problem, and skeptics are less present in German media reporting than in the US (Grundmann, 2007; Grundmann and Scott, 2012). German journalists rather tend to omit uncertainties about findings from climate science, thus exaggerating their certainty (Maurer, 2011); and media coverage in Germany strongly focuses on anthropogenic causes of climate change (Arlt and Wolling, 2012). Maybe as a result, German climate scientists are quite pleased with mass media reporting about climate change (Schäfer et al., 2012). We therefore considered the dimension of perceived exaggeration of media reporting as less relevant in the German context.

We assume that we can address the most crucial links between public beliefs and perceptions on climate change and public support for carbon-reduction policies – like the policies which are needed in the context of the German Energiewende – with these four dimensions of public climate-change skepticism. We combined them into one construct to be used in the regression models. This multidimensional concept yields three advantages: (a) we can compare the diffusion of different dimensions of skepticism, (b) the answers of the participants in all four dimensions are treated as part of the factor rather than being analyzed separately, and (c) in each dimension, the entire answer scale is used to construct the factor instead of measuring skepticism with only the “extreme” values of the answer scales or with only dichotomous indicators. For the factor loadings of the different dimensions, see Table 1.

Attitudinal variables were introduced to this study in two ways. One was a measure of general environmental awareness. The other was a measure of risk awareness not specifically connected to the environment or climate change.

As a measure of *general environmental awareness*, we used a condensed version of the revised New Ecological Paradigm (NEP) scale, which has been widely used in the literature on environmental values. Responses were in the form of values from 1 = “fully agree” to 5 = “do not agree at all” (Dunlap et al., 2000; Dietz et al., 2007). In comparison with the original scale, this revised scale has a slightly lower but still acceptable alpha value according to the results of the factor analysis. A possible explanation for the lower reliability could be that the specific cultural connotations of individual items may differ between Germany and the US. However, Whitmarsh also points in her research to the observation that a number of people found several of the NEP items difficult to interpret (Whitmarsh, 2011, 2008).

To construct a *measure of general risk awareness*, we asked respondents how worried they were about eight predefined items, such as criminality, economic development and climate change (again with 1 = “fully agree” to 5 = “do not agree at all”). To include this measure in a linear regression analysis, we conducted a factor analysis with six of these items. For the factor analysis, we excluded “worry about climate change” to construct a factor not directly related to environmental or climate change issues. The item “worry about xenophobia” was excluded from our risk awareness

Table 2

Coding, mean and standard deviation for the study variables.

Variable	Code	Mean	SD
Age	18–93 (years)	51.62	17.11
Sex	0 (female) to 1 (male)	.49	.50
Parenthood	0 (no) to 1 (yes)	.71	.46
East/west Germany	0 (East) to 1 (West)	.82	.38
Home ownership	0 (no) to 1 (yes)	.60	.49
Full-/part-time employment	0 (no) to 1 (yes)	.54	.50
Monthly net income	0 (less than 1500 Euros) to 1 (1500 Euros and more)	.73	.45
Educational attainment	0 (less than university-entrance diploma (Abitur)) to 1 (university-entrance diploma (Abitur) and above, e.g. university degree)	.23	.42
City size	0 (less than 500.000 Citizens) to 1 (500.000 Citizens and more)	.15	.35
Level of information	1 (not at all) to 5 (very well)	3.45	.76
Environmental awareness factor (factor analysis)	(high factor = environmental consciousness)	0	1
Risk awareness factor (factor analysis)	(high factor = high awareness of risks)	0	1
Skepticism factor (factor analysis)	(high factor = climate-change skepticism)	0	1
Political participation (index of 6 items)	Index range from 6 (low) to 18 (high)	10.18	2.56
Rating of energy sources:			
Wind	–5 (very bad) to +5 (very good)	3.55	2.10
Solar	–5 (very bad) to +5 (very good)	4.11	1.56
Hydro	–5 (very bad) to +5 (very good)	3.54	1.86
Biomass	–5 (very bad) to +5 (very good)	0.42	3.16
Coal	–5 (very bad) to +5 (very good)	–0.93	2.96
Gas	–5 (very bad) to +5 (very good)	1.14	2.69
Oil	–5 (very bad) to +5 (very good)	–0.68	3.03
Nuclear	–5 (very bad) to +5 (very good)	–2.66	3.04

construct because of its unsatisfactory factor loading. The factor loadings and alpha values of the “risk awareness” construct are given in Table 1.

Energy preference is covered by the question about a person's rating of a particular source of energy. In the past, Germany's primary energy mix was based on fossil fuels (about 80%), nuclear energy and renewable energy sources. This implied heavy dependence on energy imports: crude oil needs to be imported by almost 100%, mineral oil, natural gas and coal by almost 80%, whereas lignite and renewable energy are available almost entirely through domestic sources. The “Energiewende” as a political goal means the complete phase-out of nuclear power, and a near complete switch from fossil fuels to renewable energies by the mid-century. In 2011, the share of renewable energy sources of the overall power generation in Germany has already been 20%, and has been rising since. Almost half of this share stems from wind energy, the rest is mainly provided by biomass, photovoltaic and hydropower (BMWi, 2013). There is an ongoing political debate on which new energy mix would be most appropriate in the German context. Each potential source of renewable energy has its caveats: onshore windpower is under debate because the windmills are often built in populated areas and disturb scenic impressions; offshore windpower is criticized because of marine ecological reasons and because it reinforces the centralized and oligopolistic structure of the energy market; biomass has been criticized for ecological reasons and its potential impacts on world food security; and photovoltaic has been very popular among homeowners who received subsidies for small installations on the roofs of their private homes, but overall, solar energy is seen to be more appropriate in countries further in the south of Europe. Nuclear energy has polarized the German public ever since the accident in Tschernobyl in 1986, in the aftermath of which the German environmental movement gradually evolved from a radical minority perspective to a mainstream phenomenon (Hatch, 1995). For all these reasons, it is important to analyze whether there are correlations between public climate skepticism and a person's energy preferences. In our study, we distinguished between wind, solar, hydro, biomass, coal, gas, oil and nuclear, and we asked respondents to give a rating between “very bad” (–5) and “very good” (+5) for each energy source. The wording was as

follows: “In general, how do you rate the following sources of energy generation? Please answer on a scale from –5 to +5, where –5 means that you rate this energy source as very bad and +5 means that you rate this energy source as very good. With the values in between you can differentiate your rating.”

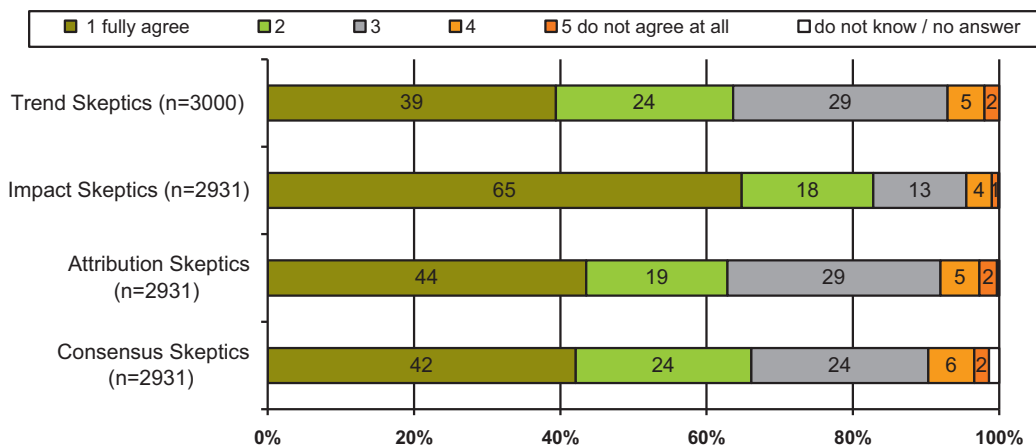
For the variable *political participation*, we constructed an index of six modes of energy-related political participation: membership in a grassroots initiative, donation to an NGO, membership in an NGO, participation in a protest march, collection of signatures for a petition, and signing a petition. For each of these items, respondents could choose among the following: “have participated” (coded 3), “have not participated, but could imagine doing so” (coded 2), and “would not participate” (coded 1). Accordingly, the additive index of these items was coded from 6 (low political participation) to 18 (high political participation). The factor analysis that we conducted for these six dimensions yielded an alpha of 0.76, with individual factor loadings ranging from 0.64 to 0.71. We interpreted these results as support for the appropriateness of the composition of the index. However, in the following analysis, we use the index instead of the factor analysis because an index is far more appropriate for our ordinal three-point scale. As the questions always refer to forms of political participation with regard to energy policy (and not just general forms of political participation), we assume to have a satisfactory indicator for our specific research perspective.

Knowledge about climate change or the level of information is often used in related studies, sometimes in combination with the source of information they use or with the level of confidence that people have in their knowledge on climate change (McCright and Dunlap, 2011a; Malka et al., 2009). We asked how well informed people felt about the issue of climate change in general, with a scale from “not at all” (1) to “very well” (5).

All variables and factors used for this study – such as standard socio-demographic variables – are listed in Table 2, including codings, means and standard deviations.

4. Public skepticism of climate change, energy preferences and political participation: results

To determine how widely public climate-change skepticism has spread in Germany, we adopted a broadened concept of



Graph 1. Skepticism dimensions in Germany.

climate-change skepticism covering the dimensions of trend, impact, attribution and consensus skepticism. The frequency distributions are summarized in Graph 1.

In all four dimensions, we see that climate skeptics are clearly a minority in Germany. If we combine “somewhat disagree” and “do not agree at all”, we find 7% skeptics along the dimension of trend skepticism, 5% along the impact dimension, 7% along the attribution dimension, and 8% along the consensus dimension. In Germany, skeptics form a relatively small group. Even if all types of skepticism are added together, only 19% of respondents indicated “do not agree at all/somewhat disagree” to one or more dimensions.

Comparisons with studies of public skepticism in other countries are difficult to make because surveys may vary in terms of the questions asked and the answer scales provided. Despite these difficulties, we found indicators that public skepticism in Germany was relatively low. Poortinga et al. (2011) ask for trend, attribution and impact skepticism by using two different items for each dimension. In order to be better able to compare our results with theirs, the comparison refers to the questions with a five-point-scale. Still, Poortinga et al. used slightly different formulations for measuring the different skepticism dimensions. Their formulations were as follows: trend skepticism: I am uncertain that climate change is really happening; attribution skepticism: Most scientists agree that humans are causing climate change; impact skepticism: The seriousness of climate change is exaggerated. For all these items they used – as in our study – a five-point scale from “strongly agree” to “strongly disagree”. They gave results in terms of pooled values for 1 + 2 and for 4 + 5. Our comparative values were re-grouped accordingly. We found that in the UK Trend Skeptics represented 28% of the general population, whereas the same group represented only 7% of the German population. Attribution Skeptics – those who doubt humans are causing climate change – represented only 7% of the German population, but 21% of the population in the UK. The greatest difference in group size was between Impact Skeptics in Germany (5%) and the UK (40%) (Poortinga et al., 2011).

McCright and Dunlap (2011a) used data from several surveys conducted by the Gallup institute, ranging from a five-point scale for trend skepticism, to a four-point scale for impact skepticism, to a three-point scale for consensus skepticism. They also employed a dichotomous answer option for attribution skepticism. Even if we combine the last 3 answer categories of our five-point-scale into one, we still have a much lower value of attribution skepticism for our German sample compared to the dichotomous answer in the US sample. We found smaller groups in terms of the represented population in Germany than in the US (Trend Skeptics, USA: 12% vs.

Germany: 2%; Attribution Skeptics, USA: 37% vs. Germany: 36%; Impact Skeptics, USA: 19% vs. Germany 1%; Consensus Skeptics, USA: 40% vs. Germany: 32%). The general direction of these results is also supported by other international comparisons of climate change beliefs and perceptions, with the general problem that they often focus on the “impact” dimension of skepticism. For example Brechin and Bhandari (2011) report similar results regarding the lower level of impact skepticism in Germany from a PEW Study in 2009. For this study, respondents were asked whether they perceived global warming a serious problem. Different from our study, the authors used a four-point-scale (very serious, somewhat serious, not too serious, not a problem). This might be one reason for slightly higher skepticism values for Germany in this study. If the categories “not too serious” and “not a problem” are grouped together as a measure of impact skepticism, 8% of the German population falls into this category, in contrast to 15% of both the Canadian and the British populations and 25% of the US population. This finding of a lower level of impact skepticism in Germany remains stable both in the earlier and in the follow-up study of 2010 (PEW, 2011). If we look at comparative data provided by the Eurobarometer (2011), impact skepticism in Germany is again lower than in the UK. The question “And how serious a problem do you think climate change is at this moment?” was answered by 10% of the German sample with “not a serious problem” versus 17% of the UK sample. A ten-point-scale was used and then regrouped into “not serious” (points 1–4), “fairly serious” (points 5–6) and “very serious” (points 7–10). The report of the Eurobarometer points to high numbers of impact skeptics in other European countries which in some cases are above the UK numbers. E.g., the share of respondents answering that climate change is “not a serious problem” is 21% in Estonia and 18% in Finland. The reasons for these high values are unclear; they indicate persisting research needs (Brechin and Bhandari, 2011: 882). At the other extreme, more Germans are convinced that climate change is a “very serious problem”: 67% of the German respondents said so, compared to only 51% of the UK respondents. The overall picture is thus that, compared with public skepticism in Anglo-Saxon countries, public skepticism in Germany has not spread widely across the population.

To answer our second question, we identified the socio-demographic structure and attitudinal factors related to skepticism with two linear regression models. In these models, we implemented the skepticism factor as the dependent variable (Table 3). The models estimated correlations between socio-demographic and attitudinal variables on one hand and the degree of skepticism on the other.

In contrast to the regression models in other studies (Poortinga et al., 2011; McCright and Dunlap, 2011a), socio-demographic and

Table 3

Linear regression model of climate-change skepticism (skepticism factor = dependent variable; values = standardized coefficient Beta).

	Socio-economic model	Socio-economic-attitudes model
Age	-.001	-.040
Sex	.073**	.008
Children	.018	.029
East/west Germany	-.071*	-.059*
Home ownership	.051	.046
Employment	-.034	-.010
Net income	.025	.005
Education	.034	.037
City size	-.053	-.038
Level of information	-.110**	-.054*
Environmental awareness		-.411**
Risk awareness		-.091**
F	7.03**	48.19**
Adjusted R ²	.025	.199
Base	2396	2283

Significant:

* $p < 0.01$.

** $p < 0.001$.

socio-economic variables – such as education, income, or employment – had relatively little explanatory power for the German population. Only 2.5% of the variation along the skepticism factors was explained by socio-demographic factors. This result is consistent with previous findings by Dietz et al. (2007), who showed that education and income on one hand and the support for climate change policies on the other hand were not correlated in Germany. Even if the link is weak in our study, climate-change skepticism tends to correlate with being male and living in East Germany. People who feel well informed are less likely to be skeptical about climate change. This result was in line with Whitmarsh's UK based study (2011), but differed from the finding of McCright and Dunlap (2011a) that skepticism correlated with a high confidence measure of self-reported understanding of climate change. Whitmarsh (2011: 697) uses her finding that self-reported knowledge about climate change and the level of education did not predict skepticism and uncertainty as an argument against the knowledge deficit explanation of public climate skepticism.

In our study, *attitudinal variables* explained 17.4% of the variance on the climate-change skepticism scale. The environmental awareness scale had the greatest explanatory power, followed by the risk awareness scale: Low environmental awareness and low general risk awareness were correlated with climate change skepticism. While it is not too surprising to see that low environmental awareness correlates strongly with skepticism, the negative correlation between risk awareness in other fields than the environment and skepticism deserves attention. This result implies that skeptics are in general less aware of societal risks, and worry less. Therefore our results add another facet to the results of previous studies (e.g. McCright and Dunlap, 2011a; Poortinga et al., 2011; Whitmarsh, 2011; Dietz et al., 2007; Hoffman, 2011b) that climate change skepticism seems to be connected to broader attitudinal variables which have no direct relation to environmental issues.

We still find a negative significant correlation of skepticism with the level of information on climate change in this second model, but it is weaker than in the first model. The variable East/West Germany remains significant, but the variable sex does not. Overall, we find the attitudinal variables to have the strongest explanatory power. Skepticism in Germany seems to be connected to a pre-existing set of environmental attitudes and risk perceptions.

To answer our third question – how does skepticism relate to perceptions of different energy sources and energy preferences? – we used a Spearman rank correlation coefficient.

The mean values for the evaluation of different energy sources given in Table 2 indicate that alternative/renewable energy sources are ranked relatively positively in Germany. Solar energy has the highest mean score (4.11), followed by wind (3.55) and hydro (3.54). At the other end of the spectrum, we find oil (–0.68), coal (–0.93) and nuclear energy (–2.66). The rank correlations between these ratings of energy sources and the skepticism factor are summarized in Table 4. Many of the correlations are highly significant, but rather small. The results indicate that with higher values on the skepticism factor, the positive evaluation of wind, solar and hydro decreases significantly, as does the negative evaluation of coal, oil and nuclear power. In conclusion, skepticism leads to less positive ratings of alternative energy sources and to less negative ratings of “traditional” energy sources. It is however interesting to see that climate skepticism is not correlated with a sweeping support of coal which would be the “easy way out” for a nuclear phase-out in Germany. As explained earlier, if someone does not believe in the existence of climate change, in its negative impacts or its human causation, the use of domestic lignite would be a win-win-strategy: it could help improve energy security and avoid domestic job losses. However, the “dirty” image of coal and oil seems to persist more or less independently of beliefs about the role of CO₂ for climate change.

Having found that climate skeptics were a relatively small group in Germany, that skepticism is correlated with pre-established attitudes, and that skepticism correlates with less support for renewable energy sources, our next step was to ask the following question: Is skepticism related to participation in the political process on energy-related questions?

Even a small group can wield strong influence depending on its position in the political process, its degree of political activism and its links to powerful elites. Small groups and even individuals can play a decisive role in the formation of public opinion (Weidner, 2002; Dietz et al., 2007; Fischer et al., 2011). To estimate the potential political influence of climate change skeptics in the German public and in the political sphere, we inquired about different forms of legal political participation relative to questions of energy policy. We used political participation as the dependent variable in a linear regression model (Table 5) to test the extent to which the “climate-change skepticism” factor influenced political participation. We also used this model to explore other socio-demographic factors as well as environmental awareness and risk awareness. The model showed that climate-change skepticism correlates with lower levels of political participation. In a descriptive sense, we found skeptics in Germany to be a rather silent minority whereas in the US, they can be depicted as a larger

Table 4

Spearman rank correlation coefficient between energy preferences and skepticism factor.

	Skepticism factor
Wind	-.161**
Solar	-.115**
Hydro	-.053*
Biomass	-.043
Gas	.004
Coal	.100**
Oil	.128**
Nuclear	.203**

Significant (two-tailed test):

* $p < 0.01$.

** $p < 0.001$.

Table 5

Linear regression of political participation (political participation index = dependent variable; values = standardized coefficient Beta).

	Political participation
Age	.003
Sex	−.106**
Children	−.012
East/west Germany	.047
Home ownership	.045
Employment	.050
Net income	.051
Education	.112**
City size	.010
Level of information	.171**
Environmental awareness	.219**
Risk awareness	−.069*
Skepticism factor	−.104**
F	35.160**
Adjusted R ²	0.166
Base	2236

Significant:

* $p < 0.01$.

** $p < 0.001$.

societal group with a strong political voice. One reason for this might be that climate change skeptics in Germany are somewhat fatalistic about the possibilities to alter the political course of action, if there is no strong political addressee with whom to identify. An alternative explanation would be that skeptics would not choose the type of political engagement, which we used to construct the index. We have to leave this question open, and will discuss the implications of our finding below.

Using this model, we also found that environmental concern raised political participation, as did a higher level of education, being female and having a high level of information. In this model, heightened risk awareness did not lead to higher levels of political participation. Although this finding may appear counterintuitive, the result is plausible because political participation itself can be perceived as a risk. People with high self-reported values for worrying in general may also fear standing out or being arrested during political protests.

5. Summary of findings and discussion

Our findings indicated that the majority of the German public is convinced that climate change exists and is a serious man-made problem. To date, public skepticism has not become a mainstream phenomenon in Germany. We assume to have stable results in spite of the skewed distribution of skepticism in Germany and the resulting low variance of the distribution between skeptics and non-skeptics. To achieve a high stability of the results in the descriptive analysis, we have interviewed 3000 respondents, which is more than the usual N for representative phone surveys in Germany. In our further analysis the effect of the low variance was minimized by including not just a one-item-factor of skepticism into the models but a multidimensional construct in which not only the extreme values were included, but values over the full five-point-scale. Finally, we have applied very strict levels of significance.

Skepticism might thus be a phenomenon of the Anglo-American cultural sphere rather than a worldwide trend. More studies are needed that analyze the diffusion of public climate-change skepticism and its correlations with energy preferences and political participation in a cross-national comparison to understand worldwide dynamics over time. Such studies should cover more countries and should measure skepticism in a multidimensional manner.

When we analyzed the socio-demographic, socio-economic and attitudinal distinctiveness of skepticism, the socio-demographic variables alone had only a small degree of explanatory power in the regression models. However, skepticism correlated with particular attitudes. The environmental awareness scale had the greatest explanatory power, followed by the risk awareness scale. Attitudes played an important role, with low environmental awareness and low risk awareness correlating with skepticism.

As Scruggs and Benegal (2012) have recently brought forward strong empirical support for an economic explanation in the sense that a significant correlation exists between labor market conditions and public concern about climate change, this deserves some critical reflection. Their study uses a longitudinal perspective and compares different economic phases, so we cannot discuss our own results in direct comparison. However, our findings that climate-change skepticism is less wide-spread in Germany than in some other countries do at least not counter Scruggs' and Benegal's line of reasoning, as the timing of the survey coincided with a general impression that the German economy came comparatively undisturbed through the world financial and economic crises, and that the labor market was relatively healthy. When our survey was conducted, the German unemployment rate had dropped to around 7 percent (from a maximum rate of almost 12 percent in 2005). At the individual level, neither the type of employment nor unemployment showed any significant effect on our skepticism factor. We will have to leave the question open to further research whether a direct influence of the overall economic situation on public climate-change skepticism is country-specific or rather general across cultures and electorates.

Public climate-change skepticism in Germany correlates with energy preferences. Skepticism is associated with less enthusiasm for renewable energy sources and a significantly less critical stance on nuclear energy. It is noteworthy that this correlation is not very strong, and it does not change the direction of the assessment: Even people who do not believe in climate change, its negative impacts, its human causation or in a scientific consensus are most likely to assess nuclear energy, coal and oil negatively, and to be in favor of renewable energy sources. This seems to indicate that independently of the CO₂ issue, the German public has a clear preference for "clean" over "dirty" energy sources.

Moreover, public skepticism of climate change correlates with lower political participation. This correlation might be a consequence of the perception that pro-environmentalism has become part of the German mainstream. German opinion polls show relatively strong support for climate policies and for the transition toward renewable and general ecological goals (e.g. Eurobarometer, 2009). Because environmental policies in general and carbon-reduction policies in particular are considered goals of all of the large political parties, there is no strong party basis for climate-change skepticism in the German political arena. Even though there have been individual authors writing now and then books and articles about alternative explanations for rising global temperatures (e.g., solar cycles), these publications have not influenced the broader political debate so far. Some publications receive a short-lived media attention, but on the whole, climate science is not broadly disputed in the German media (Grundmann and Scott, 2012). In particular, skeptical arguments are typically not used by leading politicians to back-up changes in political programs.

However, although Germany has a favorable political climate for transitioning to renewable energy sources, this favorable political climate should not lead to overly optimistic expectations of an easy transformation process with quick results. The perception of rising costs, citizens' resistance to local impacts, the complexities of energy consumption practices and a lack of

vision or positive framing of the “Energiewende” can lead to more modest expectations:

The public support for large infrastructural changes could be much lower in the future if such changes result in rising (energy) costs. First, private households in Germany are paying already one of the highest prices for electricity in Europe. Only the prices per kWh (kilowatt hour) in Denmark are higher than in Germany. Furthermore, private households in Germany experienced a 25 percent rise in energy costs (per kWh) between the first half of 2007 and the second half of 2011 (Statistisches Bundesamt, 2012: 5.9.2), and they anticipate a further rise connected to the transformation. It is plausible to assume that the *anticipation* of costs by consumers can present a strong barrier to political support for transformations in the energy sector, regardless of the diffusion and strength of pro-environmental awareness. In the first months of 2013, the rising costs have been a pivotal argument in the political debates on the speed and the direction of the policies aimed at implementing the “Energiewende”.

The second problem is linked to local resistance, e.g., against new above-ground power lines. Citizen objection to large-scale infrastructure construction in the vicinity of one's own neighborhood is known to be rather strong, a phenomenon that has been widely discussed under the label of NIMBY (“Not in My Back Yard”; Wolsink, 2000; Martin, 2010). The German transition toward a new energy mix based on renewable sources depends on massive changes and expansion of the electric power grid. Therefore, resistance to the transformation toward a low-carbon society will very likely be based on NIMBY problems much more than on public skepticism about climate change.

Third, the link between environmental awareness and pro-environmental behavior is known to be rather weak (Diekmann and Preisendörfer, 1998); this is also true for the link between concern about climate change as a serious man-made problem and the actual switch to a low-carbon life-style. Two perspectives are important as alternatives against a theoretical narrowing onto the triadic concept of *attitude, behavior and choice* – pejoratively dubbed the ABC-approach to climate change policy by Elizabeth Shove and colleagues (e.g. Shove, 2010). One perspective would be the embeddedness of social action not only in cultural meanings but also in institutional settings, systems of provision and socio-technical systems (Berkhout et al., 2004; Van Vliet et al., 2005). The second perspective would start from practices as the analytical frame of reference: practices are, compared to individual actions, conceptualized as complex ensembles of artifacts, meanings and know-how (Shove and Walker, 2007; Shove and Chappells, 2001). Both perspectives would offer a broader understanding of social transformations and the evolution of carbon-reduction policies than we were able to offer in the context of a general population survey.

Finally, if attitudes are important, as we hope to have confirmed once more with this study, the broad vision and the discourses accompanying the transformation will also have an influence on the feasibility and the dynamics of the “Energiewende”. In the current public debate about how Germany's energy future should look like, centralistic and decentralized visions compete for recognition and dominance. Large energy providers seek support for a vision with centralized features, building on offshore wind parks in the North Sea or solar parks in Spain which are connected to water reservoirs in Scandinavia. Many citizen initiatives, however, favor an almost opposing model of smart grids allowing for many local autonomous or semi-autonomous renewable energy generation schemes. Curran (2012) has shown how renewable energy narratives can shape and frame the room for maneuvering the transformation toward a low-carbon society. We expect very lively contestations about the particular shape of the German energy future in the next few years.

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