# Preparedness of Swiss Citizens for the Future Energy Debate: How Political Predispositions Influence Factual and Perceived Knowledge

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**Abstract**

A common understanding in public opinion studies is that we, the public, often turn to mental short-cuts to form an opinion on important policy issues: in particular, we reflexively adopt the positions of the political parties with which we identify. The use of political heuristics is prevalent especially when the topic is highly politicized or technical (i.e., cognitively demanding), such as is the case in climate and energy policy. However, recent research on climate beliefs has shown that not only opinions but even our supposedly *objective* knowledge about the topic correlates with our political ideology. Moreover, research shows that these innocent and natural mental short-cuts may lead us to *think* we know (subjective knowledge) more than we do. Much of existing research in sustainability transitions has focused on the effect of policy-related information or its framing on public support for a hypothetical policy that is designed to achieve climate and sustainability goals. In reality, however, the amount and type of "relevant" information people seek is not exogenous as it is assumed in many of these studies. Instead, as marketing research has shown in the context of people's product choice, our objective and subjective knowledge influence how much and what type of information we seek. This is why we argue that the potential effect of political heuristics on our knowledge-building is concerning whether or not our political parties espouse accurate information. In this paper, we investigate whether and under what conditions our perceived or factual knowledge might be influenced by our ideological predispositions. To this end, we rely on two original surveys asking Swiss citizens about energy technologies: deep geothermal energy (domestically nascent and not highly politicized) and hydro power (mature and politicized). Both technologies are currently being considered as clean energy to partially replace nuclear power. We find multiple paths through which political predispositions can affect citizens' knowledge. First, we show evidence that subjective and objective knowledge scores are not highly correlated. That is, respondents typically think they know more (or less) than they do. Second, to our surprise, we found a more prominent effect of political heuristics on knowledge in the case of DGE, a politically nascent and less politicized topic in Switzerland compared to HP. Finally, when we probed objective knowledge more deeply and analyzed each knowledge item, we found that respondents' answers to survey items that included "trigger" words (i.e., words that might elicit political feelings) exhibited political patterning.

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# 1 Introduction

Experts on decision making have shown that we, the public, often turn to mental short-cuts to form an opinion on important policy issues: in particular, we reflexively adopt the positions of the political parties with which we identify (e.g., Kahan, 2016). The use of political heuristics is prevalent especially when the topic is highly technical, politicized (contested among the public and political actors) such as is the case in climate and energy policy. This is because these topics are cognitively demanding for us to comprehend and evaluate (hence using any cues that facilitate our position-taking is tempting) and also because as Lupia (2013) points out, politicians and other stakeholders (senders of the policy information) have a strong incentive to reinterpret factual evidence in ways that can increase the their leverage. However, recent research on climate beliefs has shown that not only opinions but even our supposedly *objective* knowledge about the topic—i.e., *factual* beliefs that are either scientifically accurate or inaccurate—correlates with our political ideology (Hamilton, 2018). Moreover, research shows that these innocent and natural mental short-cuts may lead us to *think* we know (subjective knowledge) more than we do. Unfortunately, these short-cuts often result in biased, misinformed, or politically polarized decisions rather than decisions based on factual, objective knowledge (e.g., Camerer and Kunreuther, 1989; Kahan, 2016; Sunstein and Thaler, 2008; Rosling et al., 2018).

Much of existing research in sustainability transitions has focused on the effect of policy-related information or its framing on public support for a hypothetical policy that is designed to achieve climate and sustainability goals (e.g., Spence and Pidgeon, 2010; Bain et al., 2012; Bernauer et al., 2014). In reality, however, the amount and type of “relevant" information people seek is not exogenous as it is assumed in many of these studies. Instead, as marketing research has shown in the context of people’s product choice, our objective and subjective knowledge influence how much and what type of information we seek (Aertsens et al., 2011). Therefore, by extrapolating this information-selection mechanism to a policy arena, one might worry that our use of political heuristics will prevent us from learning about and acting on policy issues using scientific evidence especially in a world where we see identity politics on the rise. In fact, a wealth of research shows that we are largely under-informed or misinformed regarding important policy issues (Kuklinski et al., 2000; Lupia, 2013). In such a scenario, we woudl ultimately deprive ourselves of the opportunity to engage meaningfully in democratic institutions and reduce the input of sub-populations that hold different beliefs—an undesirable precondition for a democratic process of public policy-making. This is why we argue that the potential effect of political heuristics on our knowledge-building is concerning whether or not our

political parties espouse accurate information.

Currently, a lot of media and political coverage of energy policy around the world, particularly in the context of achieving national climate goals, appeals to political and emotional arguments that can potentially obscure facts to garner support for one side. Switzerland is not an exception.[1] In 2017, the Swiss population voted in favor of a sweeping energy transition—The Swiss Energy Strategy (ES2050)[2]—that requires the country to eventually replace all of its nuclear generating capacity. The results of this vote were largely along party lines with 92% of so-called leftist party supporters (SP, GLP, GPS) in favor of the policy while 49% of the right-leaning party supporters ("people's party" or SVP) opposed the measures (See Figure 1). Of the measures the Swiss government has proposed to meet the ES2050 objectives to replace the nuclear capacity eventually, two technologies are noteworthy: one is deep geothermal energy (DGE) and the other is hydropower (HP). They are both considered as clean technologies that can provide base load electricity as the country gradually phase out of nuclear-based power supply.[3] However, because Switzerland is a direct democracy, it is the public that must debate and decide whether to exploit this potential in Switzerland or not. As a fairly new technology, DGE has not been widely politicized in Switzerland, despite some controversial pilot projects that have resulted in press coverage (Stauffacher et al., 2015).[4] Hydropower (HP) is an old, extensively exploited resource that is well known to the population, though it can be seen as controversial and political due to its environmental consequences.[5]

In this paper, we investigate whether and under what conditions our self-assessed or factual knowledge might be influenced by our ideological predispositions. With the aforementioned history and the political undertones of the Swiss ES2050 in mind, our empirical analyses use two energy technology cases: DGE and HP in Switzerland. Both are currently being considered as clean energy to partially replace nuclear power. Moreover, DGE is a domestically nascent and not highly politicized topic, while HP is a mature and highly politicized topic in the country. Our empirical anlyses rely on data from two original surveys launched by the authors and the analysis using OLS and Logit regressions.

[1] An example of this type of advertising includes the flyer from loi-energie-non.ch of a woman taking a shower to show that the Energy Transition would be more expensive and result in people needing to take cold showers to save money. The image can be seen here: https://www.flyer-ueberall.ch/fileadmin/user_upload/dateien/lpc_flyer/284/loi-sur-energie-non-flyer-fr__optimized.pdf

[2] http://www.bfe.admin.ch/energiestrategie2050/index.html?lang=en

[3] Recent estimates suggest that up to 4000 GWh per year of DGE could be exploited (or roughly 17.4% of the current nuclear capacity) and that current production of hydropower could be increased by 10% (Bauer et al., 2017).

[4] Two pilot projects were canceled when exploratory drilling caused seismic events in the cities of St. Gallen and Basel (Ejderyan et al., 2019).

[5] Sierro (2018) for example, provides an in-depth case analysis of a symbolic hydropower project in Switzerland, the one in Lago Bianco. The analysis is an excellent illustration of the competing stakes (and hence a high level of politicization) around Swiss hydro projects.

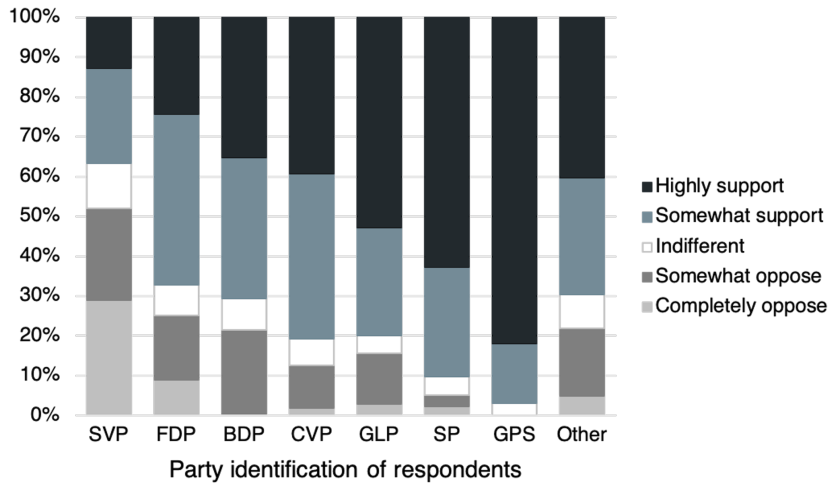



**Figure 1.** Support for the Swiss Energy Strategy 2050 by party ID, based on a representative survey conducted by Kachi & master's students right before the federal referendum to adopt the measures associated with the Strategy (May 2017) ($N = 1314$).

We find multiple paths through which political predispositions can affect citizens' knowledge. First, we find that objective and self-assessed knowledge measure different things. Namely, self-assessed knowledge tends to correlate with how much people are interested and familiar with the technology rather that how much they actually know (objective knowledge). Our data show that people's risk/benefit perceptions are also strongly correlated with their knowledge. However, the two types of knowledge are associated with risk/benefit views differently and the direction of the association found for one technology does not apply to the other technology in question. For instance, peopel's overall knowledge is better predicted by level of the awareness of risks than benefits in the case of DGE, while benefits predict one's knowledge on HP better. Risk and benefit perceptions are also strongly associated with self-assessed knowledge; and yet, whether being more aware of risks/benefits leads to higher or lower self-assessed knowledge depends on the technology in question. All together, these findings do not only pose methodological challenges to survey researchers (e.g., using a single-item subjective measure cannot proxy a multi-item objective measure), but also to the design of policy communication in this highly technical domain. It became clear from our findings that different clean energy technologies cannot necessarily be communicated using the same framework if we are to draw voters' attention properly to important but missing information about the technology. Moreover, if, for example, self-assessed knowledge has a greater influence on how voters can be motivated to seek relevant information, we must also keep in mind that those who actually lack information may not be the ones who seek more information and that people might not seek the information that is actually missing in their knowledge stock. This is because our self-assessed and actual knowledge are only meagerly correlated.

This paper proceeds as follows. In Section 2, we review the relevant literature that highlights the link between knowledge and heuristics. We describe our empirical strategies for answering the research questions using within and between technology studies of DGE (Study 1) and HP (Study 2) in Section 3. In Sections 4-6, we discuss our survey on DGE—our within technology study (Study 1). And, in Sections 7-9, we discuss our survey on HP (Study 2)—our between technology contrast to the results of DGE. Finally, we discuss the results in Section 10 and draw policy conclusions in Section 11.

## 2 The Knowledge-Heuristics Link from a Science Communication Perspective

There are many existing theories about the role and importance of knowledge[6] in public discourse and policy communication. Coming from a diverse set of research areas—psychology; science and risk communication; behavioural economics; and political and social science—these theories offer a range of insights on how the public acquires knowledge and how to measure knowledge.

Psychology, political science, and economics provide an extensive analysis on the ways in which people—the public and "experts" alike—process information and acquire knowledge (or misinformation). Very often people assess and adopt new information using heuristics and mental shortcuts. Whether people use heuristics consciously or unconsciously to simplify complex information, heuristics and mental shortcuts can—and typically do—bias people's assessment of new information and consequently, their decision-making (Camerer and Kunreuther, 1989; Sunstein and Thaler, 2008; Rosling et al., 2018). The political polarization of information and confirmation bias are two particularly worrisome results of these heuristic methods. Researchers find that politically motivated reasoning is one of the heuristics responsible for the political polarization of facts; that is, people rationalize, accept, or dismiss new information based on political identity (Kahan, 2016). For example, survey questions about factual knowledge can trigger partisan confidence rather than scientific interpretations (e.g., questions about anthropogenic climate change) (Hamilton, 2018). Similarly, confirmation bias results from people seeking, selecting, remembering, and believing information that confirms their intuition, previous beliefs, or preferences (Nickerson, 1998). Furthermore, people often hold these beliefs confidently and fail to question them, believing they know more than they actually do (Stoutenborough and Veditz, 2016; Nickerson, 1998). Taken together, these heuristics pose a major barrier against communicating new information and correcting misinformation (Kahan, 2016; Nickerson,

[6] We define knowledge as the measured level of factual learned information. We follow Lupia's (2013) definition: "the subset of beliefs that can be labeled as having positive truth-value because of their correspondence with reality."

1998).

We typically think about these mental short-cuts or heuristics acting on our “knowledge" of facts; however, marketing research discusses three distinct types of knowledge about products—experiential, subjective, and objective knowledge (e.g., Brucks, 1985)—all of which are subject to bias, political or otherwise. More recently Aertsens et al. (2011) applied this theory to people’s product (organic vegetable) choice to show the different working of the survey respondents’ objective and subjective knowledge. Moving closer to our topic in question, Hamilton (2018) finds that levels of both subjective and objective knowledge on climate change are partitioned by partisan identity and that knowledge survey questions probing politically controversial concepts (i.e., “identity-linked questions") measure belief rather than actual knowledge. Still, Hamilton (2018) and Stoutenborough and Veditz (2016) find that subjective and objective knowledge are positively correlated. In other policy contexts, people rank their subjective knowledge higher than what their objective knowledge indicates; even in cases where the topic is unfamiliar to people, they may overestimate their knowledge. As a result, for example, using the case of the Affordable Care Act in the U.S., Barcellos et al. (e.g., 2014) even shows that misinformation was wider-spread particularly among those who would be affected more by the policy. Taken together, these results increase our interest in understanding potential effect of political heuristics on our knowledge-building.

In a world where we see identity politics on the rise, we ask whether we use our political identities to make decisions on all technical topics such as energy and environment or simply those that are highly politicized. That is, in cases where one’s party may not have a clear or established stance on a topic, do we see more informed and less biased choices? To investigate these questions, we launched two original surveys asking Swiss citizens about energy technologies: deep geothermal energy (domestically nascent and not highly politicized) and hydropower (mature and politicized). We consider multiple paths through which political predispositions could affect citizens’ knowledge. Using these two surveys we are able to comment on “within" and “between" technology results for the following research questions:

- On average, are respondents’ subjective knowledge on energy topics correlated with their objective knowledge?
- What variables help explain subjective and objective knowledge? And, in particular, is political identity correlated with these types of knowledge?
- Are there differences between an old and widely-known technology and a new, relatively-unknown technology in terms of knowledge and political heuristics?

# 3 Empirical Strategy

## 3.1 The Technology Discourse Environment: DGE & HP

To conduct in-depth analyses of the existence and the degree of association between individuals' political predispositions and knowledge, we consider the cases of DGE and HP. DGE is a new, not highly politicized technology while HP is rather politicized and a well-known technology in Switzerland. We present these analyses as **Study 1** (DGE, less politicized) and **Study 2** (HP, more politicized). In this section, we explain the background of these two cases and our empirical strategies for answering our research questions using the two cases.

### 3.1.1 The Case of DGE in Switzerland (Study 1)

In line with the ES2050, we consider DGE as a potential energy production technology. Currently, the public discourse on DGE is limited and not highly politicized. The DGE case offers an ideal setting for several reasons. First, the Swiss government is currently considering deep geothermal as one of the future carbon-free, base-load energy sources to fulfill the goals under the ES2050. Estimates suggest that up to 4000 GWh per year of DGE could be exploited. This potential could contribute up to 17% toward replacing the current nuclear base load power (Bauer et al., 2017). Therefore, DGE is a current and relevant policy issue, and yet discussions on DGE in the context of Switzerland's energy transition are at their nascent stages. While geothermal technology is already being used to generate *heat* for district heating in Switzerland and for shallow, heat-pump applications, *deep* geothermal is yet to be adopted and implemented for *electricity* production. Compared to hydropower, the use of DGE in electricity production represents a relevant but much less politicized technology case. Still, Swiss citizens have had a minimum amount of exposure to DGE through piloted plants for electricity production in Basel and St.Gallen[7]. Both projects were halted because of induced seismic activity. These seismic events exposed some, but not all, of the population directly (and indirectly through media coverage) to DGE. This allows us to collect *credible* objective and subjective knowledge responses in which sufficient variation in the responses can also be expected.

### 3.1.2 The Case of HP in Switzerland (Study 2)

Hydropower offers a relevant counter example to DGE for a few reasons. First, HP has a long history in Switzerland, and Swiss dams and reservoirs have become iconic tourist attractions. Thus, Swiss

[7] Both areas are within the German-speaking part of Switzerland, where our survey participants were recruited.

citizens are all familiar with the technology. Furthermore, hydropower plants furnish cantons with considerable incomes from “Wasserzins" or taxes on water-use for hydropower production. Yet the history and current situation for HP are more complex—HP is associated not only with national pride, technical prowess, and tax income but also with environmental and ecological degradation (Barry et al., 2015). Consequently, current proposals to expand HP production to achieve the goals set under ES2050 are quite controversial and political. The proposals to expand hydropower both heighten existing dams and build new dams to capture melting glacial flows. HP resources are almost fully exploited, currently producing approximately 60% of all domestic energy, so such proposals could add a maximum of 10% of additional energy (Bauer et al., 2017). Taken together, these circumstantial details about hydropower in Switzerland have resulted in both supporters and opponents. The history and current politics around HP make it an interesting comparison for DGE.

### 3.1.3 Within and Between Technology Research Approach

Using the two above cases, we investigate the effects of political heuristics on knowledge *within* each technology and *between* the two technologies. For the *within* analyses in Studies 1 and 2, we ask the following research questions: *On average, are respondents' subjective knowledge correlated with their objective knowledge? What variables help explain subjective and objective knowledge?* And, in particular, *is political identity correlated with the two types of knowledge?* We are particularly interested in the case of DGE (Study 1) to see whether for a yet-to-be politically debated topic respondents' knowledge could already be influenced by their political identity.

For the *between* analysis, we contrast DGE and HP to assess the following question: *Are the associations between respondents' knowledge and ideology driven by the level of politicization of the technology?* Research on climate opinion has already shown that even one's knowledge (factual understanding) is correlated with his or her political leaning (Hamilton, 2018). However, it is also the case that climate issues are extremely politicized (Van der Linden et al., 2017), and therefore this result may not be so surprising. We would like to understand whether the use of political heuristics is something aggravated by political context or simply a reflex of political ideology itself. Using only a pair of contraasting cases, we are aware that these results will only offer suggestive evidence for this hypothesis; however, we believe these results are important for future empirical studies on energy policy communication.

### 3.1.4 Our Surveys

This paper draws on the results from two separate surveys: Studies 1 and 2. Though not identical, these surveys had parallel structures and survey items (explained in the next sections), which enables us to compare them, cautiously. We are cautious because some of the variables were defined differently and because the sampled populations differed.[8] The respondents in Study 2 were Swiss *residents* not *citizens*, while in Study 1 the respondents were citizens. Furthermore, participants in Study 2 were recruited based on fewer quota categories.[9] Although our study on the *more* politicized topic (HP in Study 2) is based on a "less Swiss citizen-like" sample compared to Study 1, the potential bias in the Study 2 sample would attenuate our results against our hypotheses. That is, residents may be less familiar and engaged in the Swiss politics, therefore, the effect that we can see with resident respondents is arguably less politicized than those seen with citizen respondents who are able to vote and participate in political life.

# 4 Study 1: Materials and Methods

## 4.1 Survey Data Collection and Sample Characteristics

In order to measure citizens' knowledge and political ideology, along with other control factors, including demographics, we conducted an original survey. The survey was implemented between May 24th and June 6th 2018 in the German-speaking region of Switzerland, which accounts for the largest share both geographically and by the size of population (63%) (Swiss Federal Statistics Office, 2017).[10] Participants were recruited via one of the most trusted panel services in Switzerland, Intervista.[11] To ensure a sample that approximates the population demographic distribution, we recruited participants of voting age, using quotas of age, sex, education level,[12] political party preference,[13] and economic

[8] The survey for Study 2 also included a part regarding DGE. However, the data are less representative of Swiss "citizens" of voting age, compared to the data we obtained specifically for Study 1, and the quota sampling categories were less demanding compared to that of Study 1. For this reason, we do not include our empirical results using Study 2's DGE data in the main text. For transparency, however, we have run a parallel analyses using the DGE component of the Study 2 data and included the results in Appendix. The key results remains robust. See Appendix D for more details.

[9] The Study 1 survey used age, sex, education, geographical distribution and party preference as quota categories. The Study 2 survey used only age and sex as quota categories.

[10] See Appendix A for a map summarizing Swiss regions by language

[11] See https://www.intervista.ch/ for more information on the survey firm.

[12] For quota sampling, two broad categories were used: (1) low/medium education (all the categories up to high school) accounting for 62% of the population, and (2) high education (High school and equivalent, as well as universities and advanced professional degrees.) of 38%.

[13] For party preferences, four broad categories were used: People's parties ("Bürgerliche Parteien": SVP, FDP, BDP) accounting for the 49% share of the population, Center parties ("Mitteparteien": GLP, CVP) of 17%, Leftist parties ("Linke Parteien": GPS, SP) of 26%, Other or no party of 8%.

region.[14]

Among the 351 complete responses, 26 cases were dropped due to the too short ($<$5 mins) or too long ($>$60 mins) survey duration. These decisions are to reduce any bias in the objective knowledge variable: respondents randomly clicking answers or respondents conducting outside research during the survey, respectively. Due to 12 non responses for the income question, we ultimately had 313 complete responses with an average time of 15 minutes for 43 items. Table 1 summarizes

**Table 1.** Overview of the Quota Sampling Variables (Study 1)

| | People's party (SVP,FDP,BDP) | Center party (CVP,GLP) | Leftist party (SP,Grüne) | Other/None | Total |
|---|---|---|---|---|---|
| Age | 47.51 | 51.19 | 47.80 | 50.83 | 48.44 |
| | (15.80) | (18.10) | (16.22) | (15.79) | (16.34) |
| Female | 0.46 | 0.51 | 0.56 | 0.50 | 0.50 |
| | (0.50) | (0.50) | (0.50) | (0.51) | (0.50) |
| Education Level | 2.61 | 2.61 | 2.83 | 2.28 | 2.65 |
| | (0.92) | (0.84) | (1.00) | (0.46) | (0.91) |
| $N$ | 158 | 57 | 80 | 18 | 313 |

Note: means are reported. Standard errors in parentheses. Education is a 4-point scale item: (1) up to mandatory schooling (2) vocational training/apprenticeship (3) high school and equivalent, and (4) university and advanced professional degree.

key quota sampling variables, age, sex and political party preference. Our sample is 48.4 years old on average (ranging from 18 to 90), consists of 49.5% female and 50.5% male and has the average educational attainment of 2.6 (of a 4-category scale), which corresponds to vocational level training. Approximately 54% of the sample has low-medium education level, and 46% of the sample has high education. Finally, about 50% of the sample identify themselves with people's parties,[15] about 20% with center parties, and about 30% with leftist parties. The participants mirror the Swiss voting population well, except on education level, which is slightly higher on average in our sample compared to the overall Swiss population.

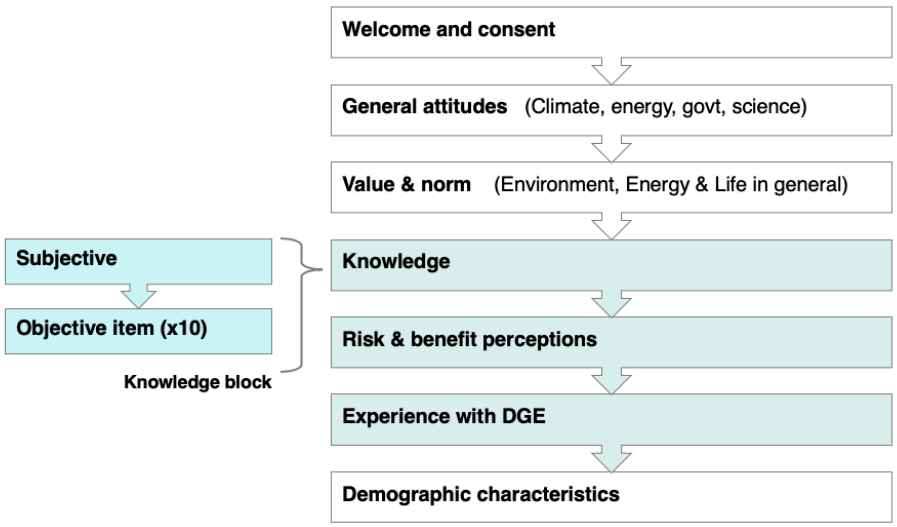
Figure 2 provides an overview of the survey flow. Once respondents agree to participate in the survey, they answer questions on general attitudes toward climate and energy issues. This section also includes items that measure trust in the government, science, and policy-making procedures. These questions are followed by items that measure respondents' value and norm perceptions regarding the environment, energy, and life in general.

Next, we pose various knowledge questions. First, we ask respondents to assess their

[14] The so-called WEMF regions of Switzerland are (1) French part accounting for about 25% of the population, (2) Alps and pre-alps of 22%, (3) Eastern plateau of 28%, (4) Western plateau of 21%, and (5) Italian part of 4%, among which (2)-(4) are relevant for our sampling area.

[15] What are often categorized as conservative parties in the Swiss politics context.

**Figure 2.** Summary of the Survey Flow




subjective knowledge i.e., how knowledgeable they feel they are regarding DGE. After, we measure their objective knowledge level with 10 factual knowledge items about DGE that we developed in cooperation with experts from the Paul Scherrer Institute (PSI)[16]. Six of the knowledge items are true-false questions and four are multiple choice. We carefully chose and tested these 10 items such that both general technological aspects of DGE and Swiss-specific knowledge would be studied. To include a range of difficulty, we ranked the entire pool of potential questions—based on the responses to these questions during a pilot study—and included a balanced set from easy to difficult. We continue the survey with a short section on risk and benefit perceptions and experience (i.e., whether the respondents experienced, or heard of, the seismic events from the two pilot DGE projects). The survey ends with a series of demographic questions.

## 5 Study 1: Variable Descriptions

In our analyses, we consider both subjective and objective knowledge as our dependent variable predicted by covariates such as political ideology; risk and benefit perceptions; general attitudes; and demographic variables. In this section, we describe how these variables are measured and summarize them with important statistics in Table 2.

[16] Later, the validity of the knowledge questions were confirmed also by a staff at the geothermal division of the Swiss Federal Office of Energy.

## 5.1 Knowledge Variables

To understand the nuances between different types of knowledge, we measure it in two ways: subjective self-assessed knowledge (`subjective knowledge`) and a measured level of objective knowledge (`objective knowledge score`). The subjective knowledge score is an ascending scale (1) “Not knowledgeable at all" to (5) “Very knowledgeable" in response to “How knowledgeable do you think you are about deep geothermal energy in Switzerland?" The objective knowledge variable is a composite score summing the correct responses to 10 objective knowledge items: 4 multiple-choice and 6 true/false questions. The 10 objective knowledge items and the proportion of correct responses for each of them will be discussed in the results section (Section 6, Table 3).

## 5.2 Explanatory Variables

**Table 2.** Descriptive Statistics of Variables Included in the Regression Models

| Variable | Mean | S.D. | Min | Max |
|---|---|---|---|---|
| *Dependent Variables* | | | | |
| Objective Knowledge Score | 7.32 | 1.28 | 3 | 10 |
| Subjective Knowledge | 2.37 | 0.98 | 1 | 5 |
| *Explanatory Variables* | | | | |
| Political Leaning (Left/Mid/Right) | 2.05 | 0.85 | 1 | 3 |
| Trust in Government | 0.015 | 0.996 | -2.542 | 1.629 |
| Trust in Science | 0.004 | 1.002 | -3.243 | 1.775 |
| Interest in Energy Topics | 3.27 | 0.72 | 1 | 4 |
| Risk Perception | 0.67 | 0.12 | 0.3 | 1 |
| Benefit Perception | 0.73 | 0.14 | 0.3 | 1 |
| *Demographic Controls* | | | | |
| Female | 0.50 | 0.50 | 0 | 1 |
| Age | 48.44 | 16.34 | 18 | 90 |
| Income | 3.55 | 1.93 | 1 | 9 |
| Education Level | 2.65 | 0.91 | 1 | 4 |
| $N = 313$ | | | | |

We are also interested in what individual characteristics and perceptions help explain subjective and objective knowledge. In our explanatory variables, we include political ideology and trust; interest in energy and climate topics; risk and benefit perceptions; and demographic characteristics.

As a measure of political ideology, we use `political leaning`, which captures where respondents situate themselves along a left-right scale with three levels (left, middle, right) as our single ideology score. [17] In relationship to political affiliation, we also ask about respondents trust in in-

[17] An individual’s party ID in the Swiss politics context is extremely difficult to place on any single dimension. Therefore, for

stitutions: `trust in government` and `trust in science`. Trust in institutions is known to be linked to people's policy or technology support as well as policy/technology risk perceptions (e.g., Bronfman et al., 2012; Blumer et al., 2018). In general, trust in institutions is understood as the willingness to believe in those who have the responsibility for proposing and managing a policy. In the case of DGE, too, a previous study shows the relevance of trust in the government and science (Stauffacher et al., 2015). We extrapolate the logic and assert that trust in the government and science may influence how knowledgeable one believes he/she is from what information the government and scientific research has issued in the public domain. In other words, another heuristic may be at play: those who trust government might be more likely to (try to) delegate energy-related decisions to the government (Hibbing and Theiss-Morse, 2002). The two trust variables are both composite measures, each of which is aggregated from 4 or 3 survey items (5-point Likert scale), respectively, via confirmatory factor analysis (CFA).[18]

We also consider how interested respondents are in energy topics. Following Lupia (2013), we posit that interest drives attention to the topic, and it is an important factor in determining how much relevant information one seeks to build his/her objective knowledge. Subjective knowledge—one's own feeling that he/she is knowledgeable about the topic—may also be driven simply by his/her interest in the topic. The variable `interest in energy topics` is a single-item variable measured on a scale of (1) "Don't agree at all" to (4) "Fully agree" to the statement, "I find energy topics interesting."

For the composite variables `risk perception` and `benefit perception`, respondents are asked how likely they perceive each of the following 4 risks and benefits:

| **Risks** | **Benefits** |
|---|---|
| earthquake | decrease in $CO_2$ emissions |
| borehole explosion | stable power generation |
| water pollution | decreased energy dependence |
| high costs | affordable energy |

The aggregate scores, `risk perception` and `benefit perception`, are simple averages of the responses (from (1) "unlikely" to (5) "likely") to each of the above risk and benefit elements, which are then rescaled to $0 - 1$. Note that all the risk and benefit items mentioned in our survey are scientifically proven to be possible. Our risk and benefit measures indicate how likely respondents perceive the technology to be risky or beneficial overall, *not* how accurately they perceive risks and benefits according to experts views.

regression purposes, we opted for the self-stated left-right measure.

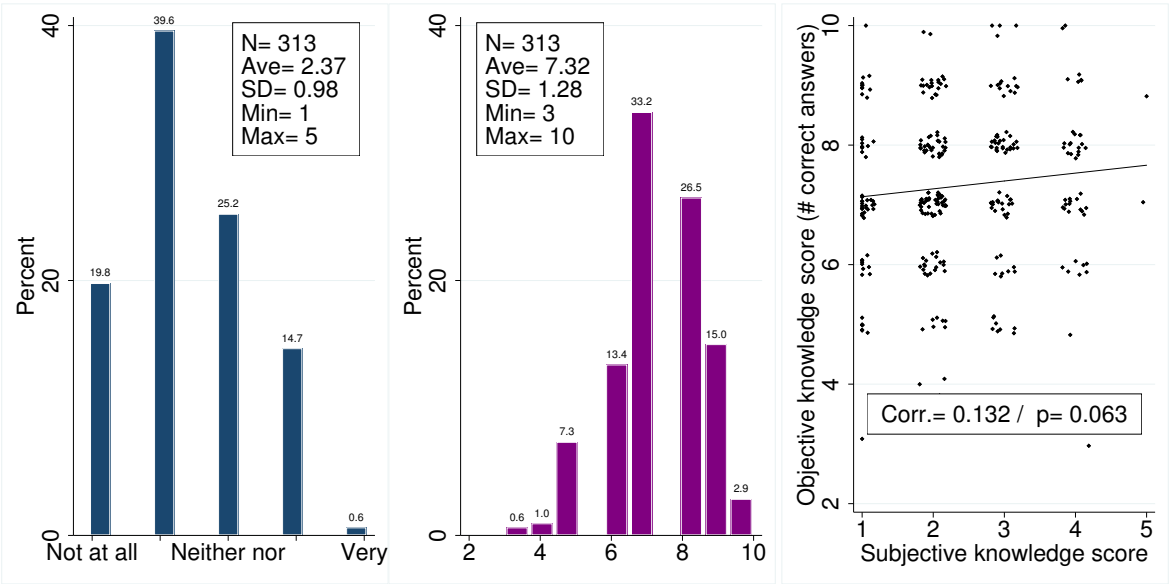
[18] Confirmatory factor analysis (CFA) is a statistical tool determine whether the relationship we suspect among our survey items and their underlying theoretical constructs (e.g., trust) indeed exist (Schreiber et al., 2006).

Finally, we have demographic information. The variable `Female` is dichotomous with 0 being male and 1 female, and `age` is the raw integer response. We measure `income` with 9 ranges of monthly earnings, with the lowest range being "< 4,000" and the highest "> 18,000" (all in Swiss francs).[19] The `education level` is meausre by 4 categories: (1) mandatory, (2) vocational, (3) high school & equivalent, and (4) university+.[20]

# 6 Study 1: Results

## 6.1 Low Correlation between Subjective & Objective Knowledge of DGE

The average German-speaking Swiss citizen believes he/she is relatively "not knowledgeable" about DGE (mean 2.37 out of 4) (Figure 3a), giving the distribution of self-assessed subjective knowledge a right-skew. However, as can be seen in the middle panel (Figure 3b), the average participant could answer about 7 out of 10 questions correctly, with the typical degree of dispersion being 1.3. This objective knowledge score is much higher than we would expect given the respondents' average self-reported subjective knowledge. Indeed, subjective and objective knowledge are not highly correlated (Figure 3c).




**(a)** Self-Assessed Knowledge **(b)** Objective Knowledge **(c)** Correlation

**Figure 3.** Distributions of Knowledge Measures

[19] The exact 9 income ranges are; < 4000, 4001-6000, 6001-8000, 8001-10000, 10001-12000, 12001-14000,14001-16000,16001-18000, and > 18000.

[20] The original education attainment measure includes 1=No degrees (kein Schulabschluss), 2=Obligatorische Schule (Mandatory schooling), 3-7= Vocational education (3= Haushaltslehrjahr, Handelsschule; 4=Anlehre; 5=Diplommittelschule, Fachmittelschule, Verkehrsschule 6=Berufslehre 7=Vollzeitberufsschule, each of which is for a distinct purpose and hence difficult to rank-order); 8=High school and equivalentaturit (Maturität, Berufsmaturität, Lehrerseminar); and 9=Universities and advanced professional degrees (Universität, ETH, FH, PH, höhere Berufsausbildung).

Furthermore, detailed analyses by objective knowledge item reveal a more nuanced picture of current DGE knowledge in Switzerland. Table 3 reports the proportion of correct responses for each item from the most correctly answered to the least. It is notable that the three least correctly answered items include what we are calling “trigger words": “nuclear", “toxins", and “renewable". One might suspect that these items may be interpreted by the respondents with a political lens that are triggered by these politically contested concepts.

**Table 3.** Summary of objective knowledge by item: from the most to the least correctly answered item with simplified item descriptions

| Objective knowledge items | Share correct (0–1) | S.D. |
|---|---|---|
| How to extract geothermal energy in general. (8) | .97 | .18 |
| From what geothermal energy originates. (7) | .96 | .19 |
| If Switzerland has already used (shallow) geothermal for heat pumps. (1) | .92 | .27 |
| Which natural disasters can be linked to DGE in general. (10) | .87 | .34 |
| If there were (cancelled) DGE projects in Switzerland in the past. (6) | .84 | .37 |
| In what DGE can be converted to. (9) | .73 | .45 |
| Whether Switzerland is already generating energy by DGE. (4) | .65 | .48 |
| If full exploitation of DGE capacity could replace nuclear power plants. (2) | .57 | .50 |
| Whether resulting water from DGE can contain toxins. (3) | .50 | .50 |
| Whether DGE is considered a renewable source. (5) | .31 | .46 |

Note: $N$=313. Numbers in parentheses are the order of appearance. “Share correct" is the share of respondents who answered the item correctly, ranging 0–1. “S.D" is the standard deviation.

These observations about the two uncorrelated knowledge measures lead us to the regression analyses that we present in the following section. Hamilton (2018) have shown, in the context of climate change, that self-assessed knowledge is driven by political ideology and gender, implying that subjective knowledge measures resemble personal perception or opinion measures more than actual knowledge. Therefore, taking the subjective and objective score as the dependent variable, respectively, we attempt to unfold what individual characteristics and perceptions can predict each type of knowledge, and whether one’s political ideology is associated with either of the knowledge scores.

## 6.2 Regression Analysis

### 6.2.1 Subjective Knowledge on DGE

We use Equation (1) in an OLS regression to determine the factors that predict subjective knowledge.

$$\begin{aligned}\text{subjknow}_i = \alpha + \beta_{\text{ob}}\text{objknow}_i + \beta_{\text{m}}\text{polmid}_i + \beta_{\text{r}}\text{polright}_i \\ + \beta_{\text{intmid}}\text{objknow}_i \times \text{polmid}_i + \beta_{\text{intright}}\text{objknow}_i \times \text{polright}_i + \mathbf{X_i^m}\boldsymbol{\gamma} + \varepsilon_i,\end{aligned} \tag{1}$$

where $\text{subjknow}_i$ is the self-assessed level of knowledge the respondent believes they have about DGE in Switzerland, $\text{objknow}_i$ is a composite objective knowledge score (0-10)[21]. We next include the political leaning variable (left, middle, right). An interaction term between political leaning and objective knowledge, $\text{objknow}_i \times \text{polmid/right}_i$ ("Left" is the reference category), is also included to test the hypothesis that objective knowledge may correspond to different subjective knowledge assessments depending on his/her political ideology.

The vector $\mathbf{X}_i^m$ contains all the other covariates and demographic characteristics. As explained in Section 5 (*Study 1: Variable Description*), our covariates include `trust in government`, `trust in science`, `interest in energy topics`, `risk perception`, and `benefit perception`. Four demographic items—`female` (male = 0; female = 1), `age`, `income`, and `education level`—are included. In addition, we include a `canton` (Swiss state) indicator to control for any common political economic characteristics that might differ across cantons. Finally, $\varepsilon_i$ is an idiosyncratic, respondent-specific error that captures the variation not explained by the included variables.

Table 4, column (1), presents the results from the OLS regression specification, Equation 1. We cluster standard errors by canton because the responses from participants living in the same canton may not be independent. As the bivariate plot (Figure 3) indicates, and the regression results also confirm, objective and subjective knowledge are correlated, but the magnitude is modest. Subjective knowledge is also positively correlated with interest in energy topics and age.[22] That is, the older one is or the more interest one has, the more highly they rank their subjective knowledge. Risk and benefit perception are also correlated with subjective knowledge but in opposite directions. A *lower* level of self-assessed knowledge is correlated with the average respondent's perception that overall risks are more likely, while a *higher* level of self-assessed knowledge is correlated with a perception that

[21] The theoretical range of this variable is 0-10. As can be seen in the descriptive statistics (Table 2), nobody scored less than 3. Therefore, the empirical range is 3-10.

[22] We also noticed that statistical significance (at the "conventional" confidence level around 90-95%) on age and trust in government decreases when we included the canton control, suggesting that the average age and the level of trust exhibit systematic patterns across cantons.

**Table 4.** Study 1: Regression Results

| | 1<br>Subj Know | 2<br>Obj Know | 3<br>Nuclear | 4<br>Toxins |
|---|---|---|---|---|
| Objective Knowledge Score | 0.160** | | | |
| | (0.068) | | | |
| Subjective Knowledge | | 0.166* | 0.210* | 0.079 |
| | | (0.093) | (0.115) | (0.088) |
| Middle | 1.684** | 0.108 | 0.776** | 0.156 |
| | (0.721) | (0.268) | (0.351) | (0.408) |
| Right | 0.638 | 0.066 | 0.388* | 0.174 |
| | (0.621) | (0.077) | (0.215) | (0.284) |
| Middle × Objective Knowledge Score | -0.184* | | | |
| | (0.089) | | | |
| Right × Objective Knowledge Score | -0.062 | | | |
| | (0.081) | | | |
| Trust in Government | -0.114* | -0.135 | 0.270* | -0.089 |
| | (0.057) | (0.088) | (0.143) | (0.109) |
| Trust in Science | 0.006 | -0.006 | -0.187 | -0.110 |
| | (0.063) | (0.093) | (0.120) | (0.100) |
| Interest in Energy Topics | 0.188** | 0.088 | 0.092 | 0.089 |
| | (0.077) | (0.131) | (0.252) | (0.187) |
| Risk Perception | -0.883** | 2.980*** | 1.907*** | 4.838*** |
| | (0.421) | (0.628) | (0.719) | (1.022) |
| Benefit Perception | 0.868** | -0.087 | -4.832*** | -1.003 |
| | (0.414) | (0.584) | (1.043) | (0.724) |
| Female | -0.260 | 0.116 | -0.184 | 0.109 |
| | (0.158) | (0.144) | (0.200) | (0.205) |
| Age | 0.008** | -0.001 | -0.008 | -0.010** |
| | (0.003) | (0.005) | (0.006) | (0.005) |
| Age-SQ | -0.000 | 0.000 | 0.000 | -0.001 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Income | -0.037 | 0.027 | 0.018 | -0.077 |
| | (0.023) | (0.037) | (0.052) | (0.051) |
| Education Level | 0.102 | 0.026 | 0.034 | 0.160 |
| | (0.065) | (0.110) | (0.168) | (0.200) |
| Constant | -0.277 | 4.583*** | 1.663** | -2.674** |
| | (0.837) | (0.629) | (0.773) | (1.186) |
| Canton Control | YES | YES | NO | NO |
| $N$ | 313 | 313 | 313 | 313 |
| $R^2$ | 0.215 | 0.173 | | |
| Pseudo $R^2$ | | | 0.0962 | 0.0833 |

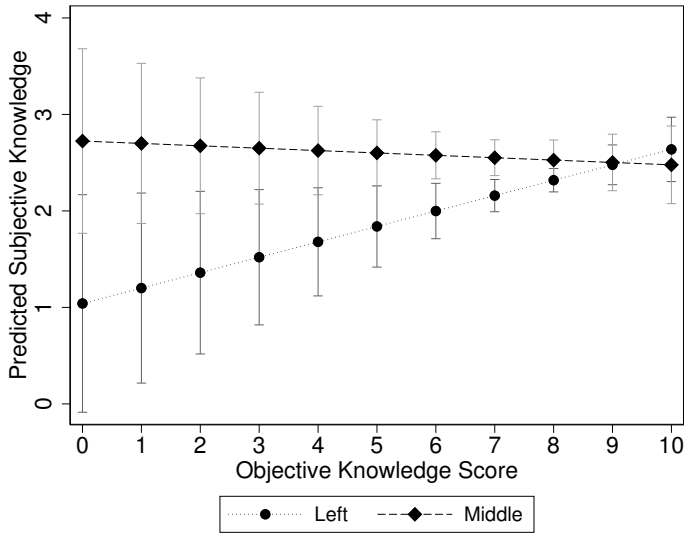
Note: The base level variable for the factor of Political Leaning is “Left;" therefore, the Middle and Right coefficients should be interpreted as relative changes from that base group. Standard errors clustered by canton. *p<0.1, ** p<0.05, ***p<0.01

overall benefits are more likely. In theory, an individual’s perception of risks (or benefits) should not influence how much one believes he/she knows. With this in mind, one plausible explanation for the link between risks/benefits and subjective knowledge comes from an analysis of nuclear energy: When people perceive uncontrollable risks or risks with an unknown magnitude and consequence, they feel less confident and have greater fear (Slovic, 1987).

Finally, political leaning, measured on a left-middle-right scale and treated as a categorical variable, reveals an interesting pattern. For estimation, “Left" is set as the baseline category. Gener-

ally, those respondents who identify with the moderate political stance claim a higher self-assessed knowledge level compared to those who claim to be Left, while those who claim to be Right are not significantly different from those who are Left.[23] What is more interesting, perhaps, is that the correlation between subjective and objective knowledge may not be a quantity that we can discuss without taking into account one's political ideology. As summarized in the interaction terms, Middle$\times$Objective Knowledge Score, and in Figure 4, the positive correlation between the two types of knowledge is stronger among Left. (Although the slope does not significantly differ from Middle and Left, the slope among Right follows a similar pattern as Left.) In fact, among Middle, the predicted marginal association between subjective and objective scores has a negative sign, suggesting that self-assessed knowledge of people on the two extreme political ideology categories reflects their factual knowledge level better than that of those in Middle.

**Figure 4.** Predicted Subjective-Objective Correlations among the Political Left and Middle




Note: (1) All the other covariates are set at the mean. (2) For simplicity, Right—whose pattern is not statistically significantly different either from Left or Middle—is omitted from this graph. The predicted trajectory for Right lies in between that of Middle and Left, and the pattern resembles that of Left, sloping up. See Appendix B for a graph with all 3 political leaning categories.

## 6.3 Objective Knowledge

We next consider the following specification to predict objective knowledge (Equation (2)):

$$\text{objknow}_i = \alpha + \beta_{\text{sub}}\text{subjknow}_i + \beta_{\text{m}}\text{polmid}_i + \beta_{\text{r}}\text{polright}_i + \mathbf{X_i^m}\boldsymbol{\gamma} + \varepsilon_i, \tag{2}$$

[23] A further analysis confirms that the difference between Middle and Right is not statistically significant at the 90% confidence level ($F = 2.29, p = 0.13$).

where the dependent variable `objknow` is a composite objective knowledge score (0-10) and $\mathbf{X}_i^m$ is the same covariate vector as before. This regression does not include an interaction term for a lack of theoretical and logical motivation. We display the results from this model in Table 4, column (2).

A higher level of risk perception is associated with a higher level of objective knowledge. This result is “assuring" in this specific case, as all the risk items included in the survey (to which participants indicated how likely they thought each risk was) are factually accurate risks with non-zero probabilities. Therefore, a higher level of risk perception should be positively correlated with objective knowledge. At the same time, this is an interesting contrast to respondents’ risk perception being negatively associated with subjective knowledge. That is, the less risky a respondent perceived DGE, the more they thought they knew about it. Again, suggesting that comfort or an absence of concern increases confidence. This time, however, benefit perceptions seems not linked to the level of one’s objective knowledge. One plausible explanation for this pattern is the media coverage of DGE in Switzerland. Though Stauffacher et al. (2015) find that the two main Swiss newspapers *Neue Zürcher Zeitung* and *Tages-Anzeiger* have covered both the risks of DGE and the potential of DGE for the energy transition goals, their analysis also revealed that more articles focused on the risks of the technology due to the two seismic incidents associated with the past pilots in St. Gallen and Basel, two cities in Switzerland. Thus, what distinguishes the (factually) knowledgeable to the unknowledgeable is his/her understanding of risks linked to the technology. Perhaps most surprising of these results is that interest does not appear to predict objective knowledge whereas with subjective knowledge as a dependant variable, interest is significant. In other words, if a respondent is interested in these topics, one thinks he/she knows more, yet this interest may *not* translate to actual objective knowledge.

### 6.4 Objective Knowledge Trigger Words in DGE

So far, political ideology does not seem to predict one’s objective knowledge level regarding DGE. Is this because DGE is not yet a heavily politicized topic in Switzerland compared to other power production technologies such as hydro or nuclear? Before going into this analysis across varying levels of topic politicization, we will take a closer look at some of the DGE objective knowledge items alone (Table 4, column 3-4).

We focused on the two objective knowledge items that presented the most variance in correct answers and those that contained potential “trigger" words. That is, words that are not directly related to DGE and have been (or can be) associated with other, in this case, political or environmental debates. One such example in our knowledge items is “nuclear" (column 3), and the other is “toxins"

(column 4).[24] The “nuclear" item asks if full exploitation of DGE capacity could replace the current power production by nuclear power plants. (The correct answer is no.) The “toxin" item asks if resulting water from DGE production could contain toxins. (The correct answer is yes.) We estimated the model with a logistic (logit) model with a binary dependent variable—whether the respondents answered the item correctly (1) or not (0).

We find some suggestive evidence for our hypothesis that these questions triggered the use of political identity heuristics. That is, the respondent reacted to a familiar word according to his/her own political beliefs. In column (3) of Table 4, we can see that relative to their “Left" or “Right" counterparts, respondents identifying as politically moderate answered the question more accurately. The political Right answered this item more accurately than the Left, and yet far more inaccurately than the political Moderate. In other words, people who self-identify as Left answered this item incorrectly significantly more often compared to Middle and Right, stating that DGE has the potential to replace current nuclear power production.[25] On the other hand, we do not see any evidence of respondents using a heuristic in answering the item including the word “toxin" (column (4) of Table 4).

# 7 Study 2: Materials and Methods

## 7.1 Survey Data Collection and Sample Characteristics

Next, we assess whether stronger political heuristics effects can be detected when we focus on a relatively old, familiar energy technology that has been the subject of highly politicized debates. By comparing the results from similar regressions *between* DGE and HP, we investigate the potential effect of the topic politicization level on the extent to which responses to knowledge questions are affected by one’s political ideology. To this end, we used data from the authors’ own previous survey conducted in 2017. The survey from Study 1 and this survey had many commonalities, making it possible for us to conduct this between-technology comparison.

The online survey was in the field between December 13 and 20, 2017 in the German-speaking regions of Switzerland. Through a survey panel service, Respondi[26], we recruited Swiss residents using quotas on age and gender. Fewer quota categories were used compared to Study 1, nevertheless, the sample approximates the age, gender, and education characteristics of the Swiss

[24] We also considered looking into an item that included “Renewable" as a trigger word, but we decided to omit it as the definition is sometimes contested.

[25] Nuclear power currently account for as much as 40% of the total electricity production in Switzerland.

[26] https://www.respondi.com/EN/

population (see Table 5).[27] The sample include a higher proportion of political left compared to the known population distribution as well as to the Study 1 distribution. The fact that the participants are Swiss *residents*, not *citizens*, and that fewer quota categories were used makes this sample less ideal than that of Study 1. We use this data set nevertheless as the best available data that come from a survey that has a very similar structure to Study 1 and, most importantly, contains subjective and objective knowledge items of the same structure as Study 1. Overall, this provides us with a unique opportunity to conduct such between-technology analyses of this specific kind.

This survey had three distinct segments, one of which (that involves HP) we use in this study. We start with the sample of 334 respondents who answered the relevant survey flow on hydropower. Of these 334, 95 observations were dropped. An observation was dropped if the following two criteria were met: the participant (i) completed the entire survey in under 5 minutes and (ii) clicked-to-complete, i.e., choosing the same answer for every question (14 obs) or (iii) did not choose to include income/education information (83 obs). The final number of observations we work with is 237. The average time for these participants to complete the survey was 19.9 minutes. The survey flow mirrored that of Study 1, making the relevant modifications according to technology (see Figure 2). The relevant ways in which the two surveys differed are in the way that we measured some of the control variables, as discussed in Section 8.

**Table 5.** Overview of the Quota Sampling Variables (Study 2)

| | People's party (SVP,FDP,BDP) | Center party (CVP,GLP) | Leftist party (SP,Grüne) | Other/None | Total |
|---|---|---|---|---|---|
| Age | 47.96 (15.16) | 44.81 (16.00) | 47.05 (14.55) | 43.89 (14.98) | 46.05 (15.02) |
| Female | 0.42 (0.50) | 0.43 (0.51) | 0.44 (0.50) | 0.62 (0.49) | 0.49 (0.50) |
| Education Level | 2.60 (0.87) | 2.52 (0.98) | 2.60 (0.91) | 2.47 (0.82) | 2.55 (0.87) |
| $N$ | 72 | 21 | 63 | 81 | 237 |

Note: means are reported. Standard errors in parentheses. Education is a 4-point scale item: (1) up to mandatory schooling (2) vocational training/apprenticeship (3) high school and equivalent, and (4) university and advanced professional degree.

[27] Five age categories were defined per gender. Once a quota was filled, additional respondents belonging to the category were screened out.

# 8 Study 2: Variable Descriptions

Table 6 summarizes key variables included in the analyses. We consider both subjective and objective knowledge as dependent variables predicted by the same set of covariates considered in Study 1: political ideology; risk and benefit perceptions; interest in energy topics, trust, and demographic characteristics. (See Table 6.)

**Table 6.** Descriptive Statistics of Variables Included in the Regression Models

| Variable | Mean | S.D. | Min | Max |
|---|---|---|---|---|
| *Dependent Variables* | | | | |
| Objective Knowledge Score | 5.41 | 1.43 | 1 | 9 |
| Subjective Knowledge | 5.03 | 1.98 | 1 | 10 |
| *Explanatory Variables* | | | | |
| Political Leaning (Left/mid/Right) | 2.09 | 0.79 | 1 | 3 |
| Trust in Government | 0.09 | 1.02 | -2.20 | 2.20 |
| Trust in Science | 5.04 | 1.25 | 1 | 7 |
| Interest in Energy Topics | 4.78 | 1.42 | 1 | 7 |
| Risk Proxy | 4.95 | 1.38 | 1 | 7 |
| Benefit Proxy | 0.05 | 0.87 | -3.42 | 1.46 |
| *Demographic Controls* | | | | |
| Female | 0.49 | 0.50 | 0 | 1 |
| Age | 46.05 | 15.02 | 18 | 75 |
| Income | 3.06 | 1.92 | 1 | 9 |
| Education Level | 2.55 | 0.87 | 1 | 4 |
| $N = 237$ | | | | |

## 8.1 Knowledge Variables

As in Study 1, we measure knowledge in two ways: subjective self-assessed knowledge (`subjective knowledge`) and a measured level of objective knowledge (`objective knowledge score`). The subjective knowledge measures are an ascending scale (1) “Not knowledgeable at all" to (10) “Very knowledgeable" in response to the question, “How knowledgeable do you consider yourself about hydropower?" The objective knowledge variable is a composite score summing the correct responses to 10 objective knowledge questions: 4 multiple choice questions and 6 true/false questions (Table 7). The form of the battery of knowledge questions is the same as in Study 1: 6 true-false questions and 4 multiple-choice questions. Though the content of the questions is different, corresponding to the technology, we mirror the level of difficulty and the number of Swiss-related to general questions using the results of a pre-test (N=76). The 10 objective knowledge items and the proportion of correct

responses for each of them will be discussed in the results section (Section 9, Table 7).

### 8.2 Explanatory Variables

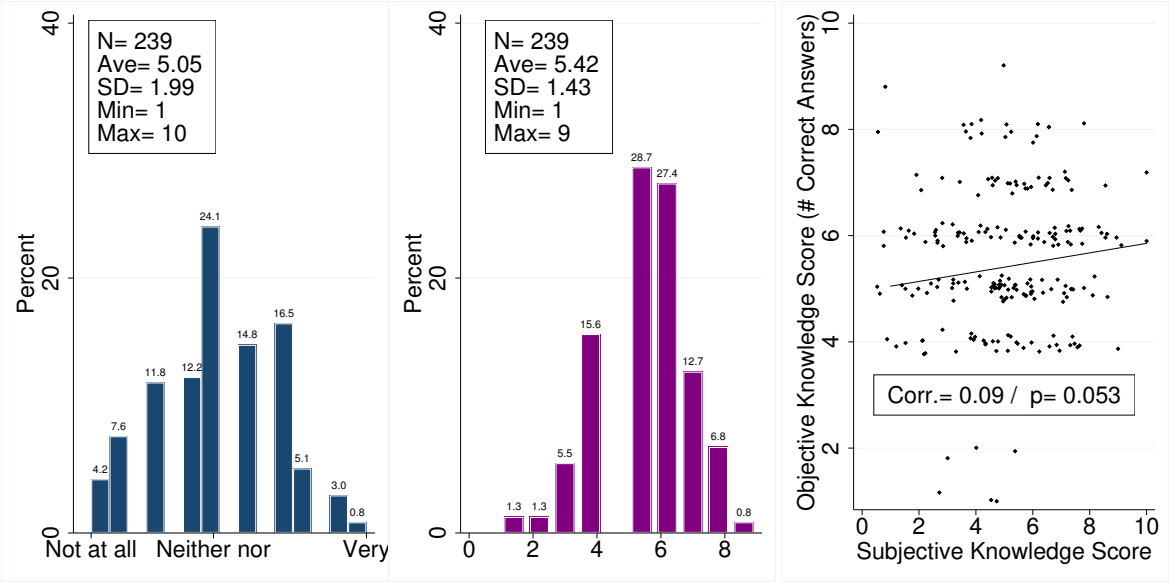
In Study 2, we consider the same set of variables as the predictors of the two types of knowledge. While we construct the dependent variables in the same way as in Study 1, we measure some of the explanatory variables differently. While in Study 1 we have a series of risk and benefit related items, in Study 2, we assess respondents' views of the risks and benefits of hydropower using semantic association items. That is, based on whether the respondents think risk- or benefit-related words are closely associated with the technology. For risk, the word the respondents weigh is "safe". For benefits, the words the respondents weigh are the following: "worthwhile", "necessary", "important", and "inexpensive". The composite benefit perception variable was constructed by confirmatory factor analysis (CFA). To measure the our respondents' trust in the government, three seven-point scale items were aggregated using CFA: (1) "My vote has an influence on Swiss politics." (2) "I trust the Swiss parliament." (3) "I trust Doris Leuthard" (the former Head of the Swiss Federal Office of Energy). We measure trust in science using a single seven-point scale item ((1) Rather Disagree to (7) Completely Agree): "I trust science and its research results." We end the survey with items on demographic characteristics, which are measured the same way as in Study 1.

## 9 Study 2: Results

### 9.1 Low Correlation between Subjective & Objective Knowledge of HP

The average respondent neither believes he/she is knowledgeable nor uninformed about HP, with an average subjective knowledge score of 5 out of 10. The distribution is broad with a slight left skew indicating that more respondents believe they know a fair amount about HP (Figure A3a). The distribution of objective knowledge is more visibly skewed left, indicating that a majority of respondents possess more factual knowledge about HP than the mean, 5.42 (Figure A3b). Nevertheless, the correlation between subjective and objective knowledge on hydropower is quite low at 0.09. The relationship is marginally significant (p=0.053) (see Figure A3c). This result suggests that how much respondents think they know is not related strongly to how much they do know.

When we pay attention to each knowledge item, however, we see additional interesting results. Table 7 reports each knowledge item, the proportion of correct responses (0-1), and the standard deviations. Overall, it appears that respondents perform better on knowledge questions that




**(a)** Self-Assessed Knowledge **(b)** Objective Knowledge **(c)** Correlation

**Figure 5.** Distributions of Knowledge Measures

relate directly to Switzerland, with the exception of knowing that hydropower accounts for 60% of domestic demand. The questions relating to the "basics" of hydropower (e.g., sources of hydropower, components of hydropower plants, and the efficiency of hydropower relative to other sources of energy) pose greater challenges for the respondents. Similar to Study 1, we test the political heuristic hypothesis below in the following section.

**Table 7.** Summary of objective knowledge by item: from the most to the least correctly answered item with simplified item descriptions

| Objective knowledge items | Share correct (0–1) | S.D. |
|---|---|---|
| The amount of energy that HP plants produce changes with seasons. (1) | .87 | .34 |
| Pumped storage HP plants in CH can store energy like a battery. (4) | .77 | .42 |
| Why HP is considered renewable. (7) | .77 | .42 |
| There is enough unused capacity in CH to expand HP by 50%. (6) | .64 | .48 |
| There are over 600 HP plants in CH. (2) | .60 | .49 |
| The components that HP plants must all have. (8) | .47 | .50 |
| Sources of HP. (9) | .39 | .49 |
| Enviro damages caused by HP. (5) | .35 | .48 |
| HP elec production satisfies approx 60% of total elec demand in CH. (3) | .31 | .46 |
| Comparison of HP efficiency with other types of energy. (10) | .25 | .43 |

Note: $N$=239. Numbers in parentheses are the order of appearance. "Share correct" is the share of correct responses ranging 0 – 1. "S.D" is the standard deviation.

## 9.2 Regression Analyses

We run four main regressions, as in Study 1. First, with subjective knowledge as the dependent variable, we use Equation 1 as in Study 1. We use Equation 2 to determine the variables that explain objective knowledge—for the objective score variable we use OLS, whereas for the individual items with "trigger words", we use logit. The regressions differ from those in Study 1 only in how some of the covariates are measured according to differences in the surveys. As in Study 1, we again test three different objective knowledge dependent variables: an aggregate objective knowledge score and two specific knowledge items that contain trigger words. There are two items that contain such trigger words: one discusses *environmental damages* and the other the relative production *efficiency* of HP compared to other typical technologies. The "damage" item serves as a clear trigger-word items because any Swiss hydro projects have been contested by environmental NGOs for their potential negative environmental impacts, and along with the economic risks and benefits, the environmental issue has been one of the main topics in public debates. The "efficiency" item serves as a trigger-word item for a different reason. This item asks the respondents to compare the electricity production efficiency of HP with other production technologies, including *nuclear power*. As we illustrated earlier, in Switzerland, nuclear power has been a major energy source (40% of the current power production) and also in the center of public debates in the context of phase-out policies (e.g., Rinscheid and Wüstenhagen, 2018).

Table 8 summarizes the results from these regressions. We find that after controlling for some explanatory variables such as age, gender, income, and education, that subjective knowledge is not predicted by objective knowledge (Table 8, column (1)). Rather, we see that subjective knowledge is correlated with respondents' opinion about the riskiness of the technology and their interest in energy topics. These results support those found regarding DGE.

Objective knowledge (Table 8, column (2)), however, can be modestly predicted by subjective knowledge. This relationship emerges based on the differences in control variables between Equation 1 and Equation 2, and most likely based on the strong correlation between subjective knowledge and some other covariates (i.e., interest and risk perception). In contrast to DGE, we see that objective knowledge is highly correlated with respondents' consideration of the benefits of hydropower. In other words, in the case of HP, one's factual knowledge level is better predicted by his/her perception about benefits rather than risks. Unlike the case of DGE, education is correlated with knowledge. This offers some suggestive evidence that more education in Switzerland is linked to more exposure to, and hence a better understanding of, HP. We assume that the history of DGE is too thin for one's education

**Table 8.** Study 2: Regression Results

| | 1<br>Subj Know | 2<br>Obj Know | 3<br>Damages | 4<br>Efficiency |
|---|---|---|---|---|
| Objective Knowledge Score | 0.119 | | | |
| | (0.176) | | | |
| Subjective Knowledge | | 0.096** | 0.093 | 0.042 |
| | | (0.047) | (0.122) | (0.086) |
| Middle | 0.520 | -0.424 | -0.497 | -0.521* |
| | (1.304) | (0.272) | (0.537) | (0.314) |
| Right | 0.273 | -0.293 | -0.370 | -0.891*** |
| | (1.068) | (0.231) | (0.464) | (0.282) |
| Middle × Objective Knowledge Score | -0.011 | | | |
| | (0.217) | | | |
| Right × Objective Knowledge Score | 0.068 | | | |
| | (0.177) | | | |
| Trust in Government | 0.169 | 0.090 | 0.050 | -0.070 |
| | (0.103) | (0.116) | (0.141) | (0.119) |
| Trust in Science | -0.027 | -0.085 | -0.097 | -0.112 |
| | (0.110) | (0.065) | (0.096) | (0.127) |
| Interest in Energy Topics | 0.615*** | -0.103* | -0.160 | -0.035 |
| | (0.080) | (0.053) | (0.112) | (0.083) |
| Risk Proxy | 0.212** | 0.056 | -0.158 | -0.030 |
| | (0.101) | (0.094) | (0.135) | (0.150) |
| Benefit Proxy | -0.185 | 0.313*** | -0.309 | 0.072 |
| | (0.115) | (0.098) | (0.240) | (0.187) |
| Female | -0.453 | -0.105 | 0.483* | -0.004 |
| | (0.354) | (0.183) | (0.259) | (0.237) |
| Age | -0.016 | -0.048 | 0.038 | -0.062 |
| | (0.065) | (0.033) | (0.050) | (0.048) |
| Age-SQ | 0.000 | 0.000 | -0.001 | 0.001** |
| | (0.001) | (0.000) | (0.001) | (0.000) |
| Income | -0.008 | -0.029 | 0.100 | -0.140** |
| | (0.055) | (0.059) | (0.098) | (0.064) |
| Education Level | 0.145 | 0.240** | 0.226* | 0.216 |
| | (0.175) | (0.100) | (0.129) | (0.223) |
| Constant | -0.196 | 6.544*** | 0.179 | 0.342 |
| | (1.950) | (0.888) | (1.123) | (1.514) |
| Canton Control | YES | YES | NO | NO |
| $N$ | 237 | 237 | 237 | 237 |
| $R^2$ | 0.39 | 0.21 | | |
| Pseudo $R^2$ | | | 0.12 | 0.07 |

Note: The base level variable for the factor of Political Leaning is “Left;" therefore, the Middle and Right coefficients should be interpreted as relative changes from that base group. Standard errors clustered by canton. *p<0.1, ** p<0.05, ***p<0.01

level to matter.

When considering the two objective knowledge survey items that contained trigger words/concepts (columns (3)-(4)), we see evidence for political heuristics being used in the case of the “efficiency" question. The survey item regarding the relative efficiency of HP energy production compared with other energy sources contained the words “nuclear", “solar", “wind", “coal", and “natural gas". The question asked, “Hydropower plants are less efficient at converting energy than which of the following energy sources (choose one)?" The correct answer is “none of the above," meaning that HP is more

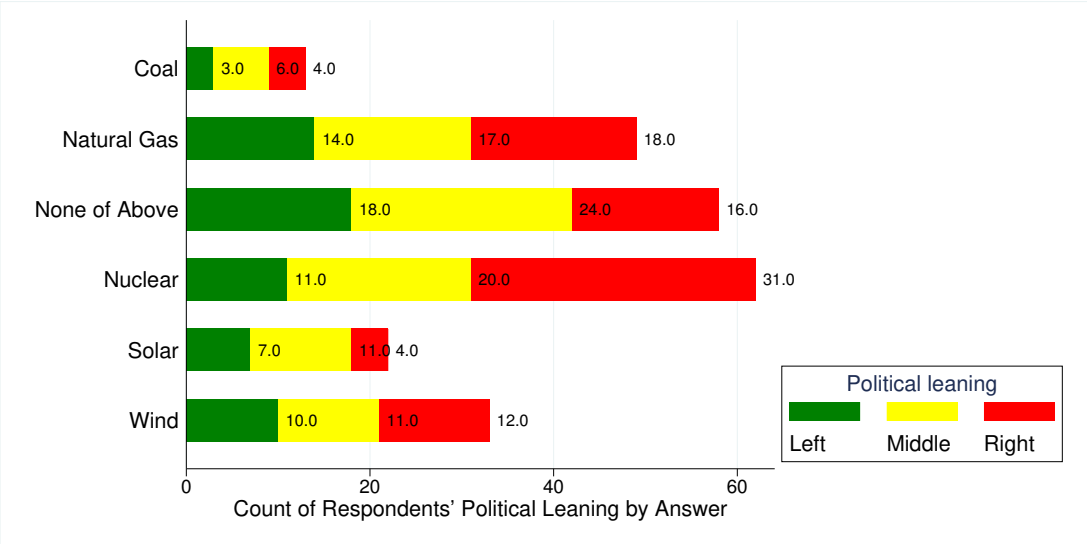



**Figure 6.** Answer to the multiple choice question: "Hydropower plants are less efficient at converting energy than which of the following energy sources (choose one)?" The correct answer is "None of Above."

efficient than any of the other provided answer categories. However, it seems that, depending on one's political affiliation, one may have a quick political reaction about the relative "goodness" of HP compared with these technologies. We see that respondents identifying as Middle and Right leaning were much less likely to answer that question correctly relative to their Left-leaning counterparts. We also see that respondents with higher incomes in Switzerland are less likely to answer this question correctly. That is, they tend to see HP as a less efficient energy production technology than it actually is.

Splitting the answers out by political leaning (Figure 6), we can see that respondents on the Right were more likely to believe incorrectly that natural gas and nuclear power are more efficient than hydropower. In Switzerland, both nuclear and natural gas are highly politicized energy sources. Nuclear power is politicized, as in many countries, because of its low-probability high-consequence accidents and its waste disposal challenges. Natural gas is controversial because using it requires greater dependencies on other countries via imports and due to its $CO_2$ emissions. However, opponents of these two energy sources are typically associated with the Left.

## 10 Discussion

In order to understand how different types of knowledge about energy technologies may be influenced by political ideology and affiliation, we used the results from two surveys on the Swiss population. From these results we considered both "within" and "between" technology results.

Regarding our first research question,"On average, are respondents' subjective knowledge on energy topics correlated with their objective knowledge?", we found that subjective and objective knowledge are correlated, but only weakly. This finding is extremely important for both substantive and methodological reasons.

First, substantively, we see that respondents are not necessarily able to assess their own knowledge in relation to what experts (scientists or policy proposers) perceive as a set of good factual understanding about the topic. To the extent that people use their self-assessment to gauge how much information they need to make an informed decision (e.g., policy and technology support), a low correlation between subjective and objective knowledge suggests people may not appropriately seek information—both in terms of the amount and the type of related information. The link between one's knowledge stock and their information-seeking behavior, therefore, seems a fruitful area of future empirical research in order to design effective policy or technology communication.

Second, surveys often use self-assessed knowledge to proxy for knowledge. This is likely due to how simply one can measure subjective knowledge (by a single item) compared to objective knowledge (which requires a battery of many items). We find in both survey results that this assumption may be very misleading. Our results show that self-assessed and objective knowledge measures are indeed measuring two different types of knowledge. We found that our self-assessed knowledge measure was more strongly correlated with interest than objective knowledge, though both types of knowledge were strongly associated (though in different directions) with risk and benefit perceptions. This result offers us evidence that the subjective knowledge measure is capturing confidence in or support for a technology rather than an assessment of one's factual knowledge. One plausible explanation comes from an analysis of nuclear energy: When people perceive uncontrollable or risks with an unknown magnitude and consequence they feel less confident and have greater fear (Slovic, 1987).

Regarding our second research question, "What variables help explain subjective and objective knowledge? And, in particular, is political identity correlated with these types of knowledge?", we found—as previously noted—that objective and subjective knowledge were both largely driven by interest and risk/benefit perceptions. However, these variables influenced the types of knowledge differently. Notably, interest was strongly correlated with subjective but not objective knowledge. In other words, respondents' interest in energy topics corresponded with confidence or perceived familiarity with DGE and HP rather than substantive knowledge. Our findings on the link between knowledge and risk/benefit perceptions also shed light on a potential blind spot in the current energy and climate policy research. First of all, respondents' objective knowledge—what we actually know—

seems to reflect the level of *risk* awareness in the case of DGE, while respondents' knowledge on the other technology reflects the level of *benefit* awareness. Based on existing studies about energy policy narratives in Switzerland (e.g., Stauffacher et al., 2015), we suspect that the media contents largely influences people's focus either on potential risks or benefits to the extent that this focus shapes their factual knowledge. Second, when we turn to self-assessed knowledge, risk perception is a strong predictor regardless of the technology in question, except the direction of the association is opposite between the two technologies. As noted, this result is likely related to respondents familiarity with or confidence in the technology. Finally, and perhaps most importantly, we found that political identity influenced both subjective and objective knowledge.

How political identity influenced the different types of knowledge was tightly linked to our third research question, "Are there differences between an old and widely-known technology and a new, relatively-unknown technology in terms of knowledge and political heuristics?" Political identity influenced subjective knowledge for DGE, a relatively unknown technology. This is interesting because we had suspected the more politicized (like with climate change (e.g., Van der Linden et al., 2017; Hamilton, 2018)), the more likely political identity would play a role. Therefore, if any, we expected a larger influence of politics in the case of HP. However, it appears the political heuristic was used to resolve a potential uncertainty, rather than to comply with a clear political preference. Another surprising finding that emerged from our detailed analysis is that, among the three categories of political leaning, more than those who self-identified as political middle, the political left and right had subjective and objective knowledge scores that were more congruent (Figure 4 and A2). In fact, our data shows that the subjective and objective scores are even negatively correlated among the political middle.

Political identity influenced objective knowledge of the two technologies similarly. In aggregate measures of objective knowledge, political identity did not appear to influence respondents' objective knowledge. However, when we considered objective knowledge items individually—and, in particular, items that contained "trigger" words—we found patterned political responses. When the questions included comparisons to other technologies (i.e., nuclear), there were statistically significant differences in the responses along political leaning. The questions containing trigger words were also more difficult for respondents, again supporting our theory that political heuristics are being used to guess when uncertain rather than to conform politically.

## 11 Conclusion

We, the public, cannot be experts in every field on which we are expected to vote (Lupia, 2016). As noted by Lupia and McCubbins (1998), we have limited time, resources, and interest to devote to any given task. To make it more challenging, many policy domains in which voters are asked to evaluate information are increasingly technical. Naturally, we must rely on quick assessments and mental shortcuts to make decisions or to determine who to trust. Our results show that political heuristics influence both subjective and objective knowledge of energy technologies. Similar findings have been reported with climate opinions and knowledge (e.g., Van der Linden et al., 2017; Hamilton, 2018). These studies imply that the link between misinformation or selection of self-confirming information can be driven by politically motivated reasoning, i.e., an implicit effort by citizens to hold opinions and knowledge that are consistent with their partisanship. However, our results indicate that political heuristics appear to be used to cope with a gap in knowledge rather than to conform politically. Had political heuristics been used purely to tow a political line, we would have expected to see more evidence in the case of a HP, given the highly politicized nature of HP versus DGE in Swiss society.

From a domestic policy-making and policy-communication point of view, how much and what people actually know about relevant energy technologies and policies are important pieces of information, especially when trying to communicate policy proposals. Governments are under pressure to seek feasible (i.e., acceptable for the public and industries) decarbonization measures, and hence substantial effort is being made to assess policy and technology acceptance. On a scientific level, this has led to much research on technology's social acceptance, asking what are the determinants for the public's positive opinions about technologies and policies in question. In these studies, often the current stock of individuals' knowledge is assumed away, or summarized in a single-item, self-stated knowledge at best. We show that self-assessed knowledge is not a good substitute for objective knowledge, as they are not highly correlated.

In this study, we focused on what different determinants can shape these two measures of knowledge, but naturally, this leads us to several important future empirical questions. When experts (scientists and policy proposers) try to draw citizens' attention to and communicate information about energy technologies and policies, how do people's existing stocks of subjective and objective knowledge affect their willingness to engage with new information? To us, this seems like the next urgent questions to be answered. In particular, how do people assess their informational needs? And, what motivates people to seek more information or to accept new information? Is there an opportunity

to get people to reassess their knowledge and thereby prompt information seeking?

We have shown here that interest does not imply a high level of factual knowledge but rather a higher level of subjective knowledge. To the extent that people assess their own informational needs, this disconnect suggests that we cannot depend on people to seek relevant information based on interest or perceived knowledge alone. Our findings suggest that we need to pay attention to how risks and benefits associated with the technology have been communicated with the public and how that exposure might influence people's knowledge and information seeking. Therefore, in order to design policy interventions that encourage people to seek information needed for them to make informed decisions, we will have to understand the factors that do prompt people to seek information—whether accurate or innaccurate—and under what conditions we can motivate information seeking behavior.

# Appendix A Map Summarizing the Geographical Distribution of German-Speaking Swiss Residents

Switzerland has 4 official languages and each has it's own geographical center. German accounts for the largest share (63%). In the top two darkest-shaded areas of Figure A1, more than 75% of people use German as the main language.

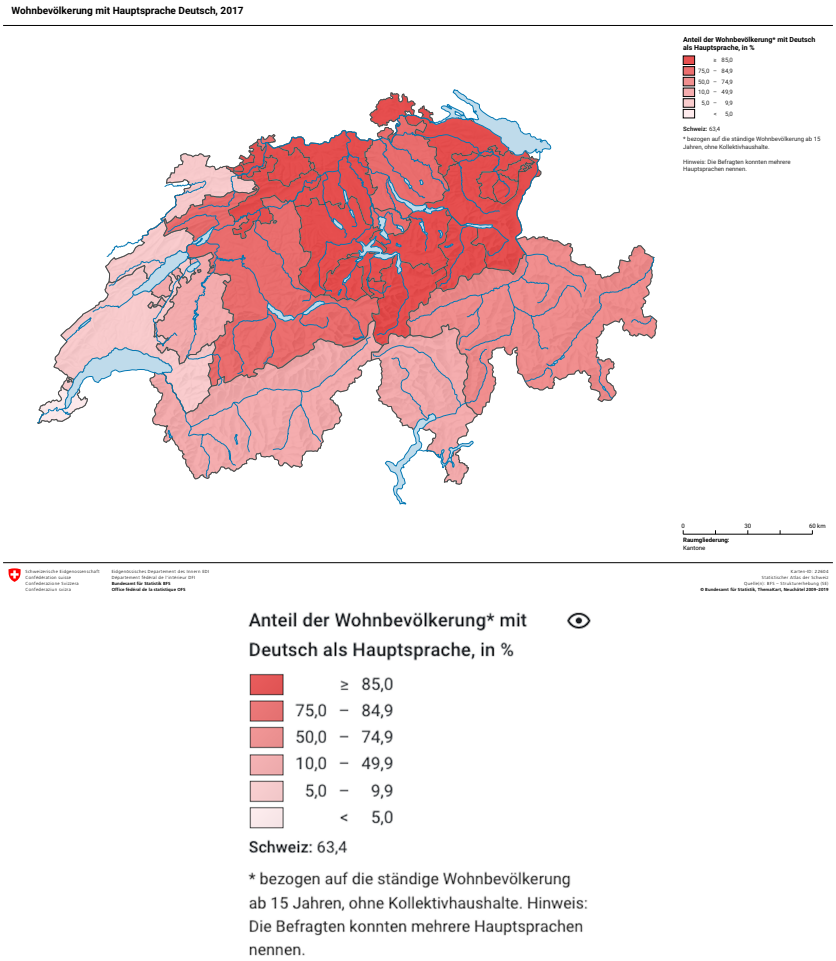



**Figure A1.** Share of Swiss Residents Who Use German as the Main Language

*Note: Source: https://www.bfs.admin.ch/bfs/en/home/statistics/regional-statistics/maps/interactive-maps.assetdetail.7227084.html. Translation of the legend: Share of the residents* with German as the main language. Switzerland (total): 63.4%. *"Resident" is based on the permanent resident population of the age 15+, without collective households. Note: Respondents could name several major languages.*

## Appendix B Predicted Subjective-Objective Correlations by the Political Leaning Score

The following graph (Figure A2) reports identical computation to Figure 4, but now with the political leaning category of Right, in addition to Left and Middle.

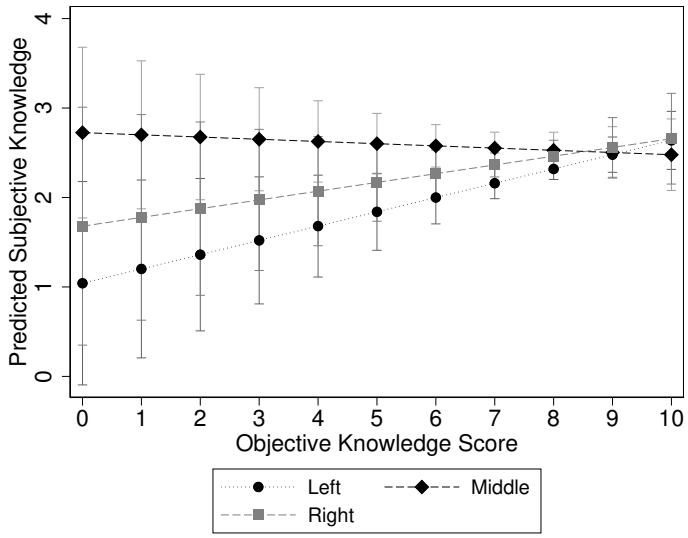



**Figure A2.** Predicted Subjective-Objective Correlations by Political Leaning

## Appendix C Further Regression Results for Study 1 (DGE)

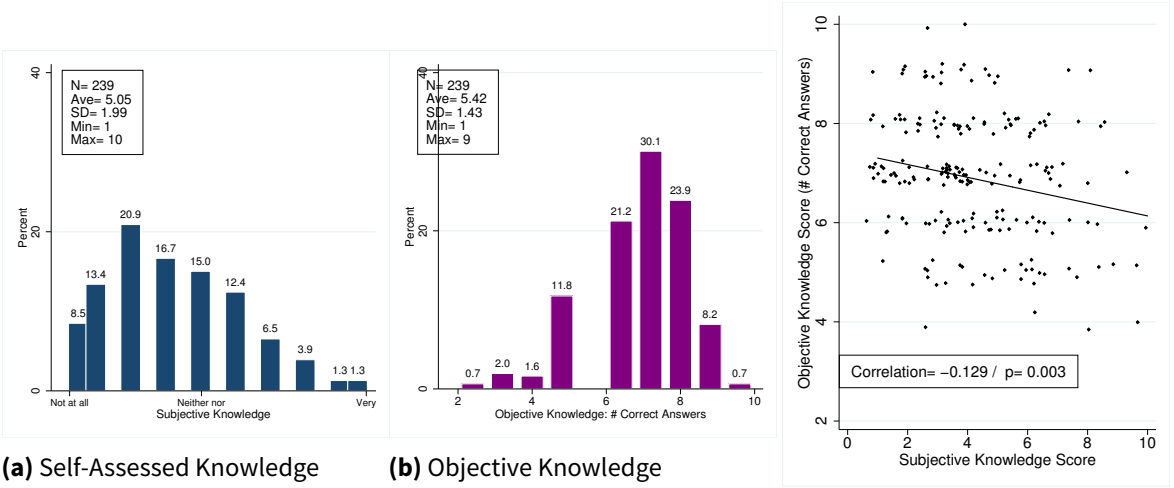
Table 9 reports the results from 3 additional regressions of subjective knowledge about DGE. Column 3 is identical to the main result in Table 4, Column 1. Column 2 and 4 include original 4 risk and benefit items (respectively) without aggregation, in order to check which risk and benefit item might be driving the main results. Column 1 and 2 also includes one of Schwarz's value orientation scores (bio-spheric value orientation) as an explanatory variables. The value measure is not statistically significant.

As a psychology literature finds that value orientations have significant association with one's pro-environmental behavior (e.g. De Groot and Steg, 2010). Although we think that the notion of knowledge is not entirely parallel to individuals' pro-environmental behavior, we have decided to run these exploratory tests. We measured a series of value and social norm variables taken from the literature (Schwarz et al., 2007): `value for environment` (composite of 4 items), `value for energy security` (composite of 5 items), Schwartz `biospheric value` (composite of 4 items), Schwartz `altruism` (composite of 4 items), Schwartz `ego` (composite of 4 items), `social norm` (composite of 4 items). Each item was measured with a 5-point Likert scale. Though each measure has been validated in other studies, we confirmed the combination of survey items for each composite variable using CFA.

Based on the same logic, Table 10 presents additional regressions including itemized risk/benefit variables as well as a value orientation variable. Finally, one of the trigger words in the DGE survey, toxin (i.e., water contamination), meant nearly the same issue as one of the risk components—water pollution. To check how much of the risk effect in our main analyses is driven by this single risk component, Table 11 presents the regression results for trigger word items with itemized risk and benefit variables.

## Appendix D Parallel Analyses of Another DGE Survey mentioned in Section 3

The survey for Study 2 also included a part regarding DGE. However, the data are less representative of Swiss “citizens" of voting age, compared to the data we obtained specifically for Study 1, and the quota sampling categories were less demanding compared to that of Study 1. For this reason, we do not include our empirical results using Study 2’s DGE data in the main text. For transparency, however, we have run a parallel analyses using the DGE component of the Study 2 data and included the results here. The key results remains robust. Figure A3 and Table 12 report the analysis that are parallel to our main results from Study 1 reported in the main text.




**(a)** Self-Assessed Knowledge **(b)** Objective Knowledge **(c)** Correlation

**Figure A3.** Distributions of Knowledge Measures using the Study 2 Survey

**Table 9.** Additional Regression Results for Subjective Knowledge about DGE

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Objective Knowledge Score | 0.148* | 0.123 | 0.160* | 0.124 |
| | (0.066) | (0.062) | (0.068) | (0.068) |
| Risk Perception | -0.786 | | -0.883* | |
| | (0.422) | | (0.421) | |
| Earthquake | | -0.034 | | -0.036 |
| | | (0.054) | | (0.061) |
| Borehole Explode | | 0.011 | | 0.014 |
| | | (0.049) | | (0.062) |
| Water Pollution | | -0.006 | | -0.002 |
| | | (0.059) | | (0.067) |
| High Costs | | -0.139* | | -0.171* |
| | | (0.062) | | (0.067) |
| Benefit Perception | 0.886 | | 0.868* | |
| | (0.429) | | (0.414) | |
| Decrease CO2 Em | | -0.122* | | -0.141 |
| | | (0.055) | | (0.070) |
| Stable Power Gen | | 0.195** | | 0.197* |
| | | (0.065) | | (0.073) |
| Decrease En Dependency | | -0.012 | | -0.010 |
| | | (0.062) | | (0.065) |
| Affordable | | 0.069 | | 0.062 |
| | | (0.047) | | (0.052) |
| Trust in Government | -0.124* | -0.117* | -0.114 | -0.107 |
| | (0.048) | (0.047) | (0.057) | (0.058) |
| Trust in Science | 0.011 | 0.013 | 0.006 | 0.014 |
| | (0.057) | (0.056) | (0.063) | (0.068) |
| Interest in Energy Topics | 0.219** | 0.239** | 0.188* | 0.205** |
| | (0.074) | (0.065) | (0.077) | (0.070) |
| Middle | 1.477 | 1.404* | 1.684* | 1.482* |
| | (0.744) | (0.655) | (0.721) | (0.698) |
| Right | 0.543 | 0.353 | 0.638 | 0.381 |
| | (0.572) | (0.617) | (0.621) | (0.694) |
| Female | -0.227 | -0.258 | -0.260 | -0.284 |
| | (0.141) | (0.139) | (0.158) | (0.149) |
| Age | 0.010** | 0.011*** | 0.008* | 0.009** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Age-SQ | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Income | -0.034 | -0.027 | -0.037 | -0.033 |
| | (0.019) | (0.020) | (0.023) | (0.023) |
| Education Level | 0.105 | 0.115* | 0.102 | 0.108 |
| | (0.058) | (0.054) | (0.065) | (0.060) |
| Middle $\times$ Objective Knowledge Score | -0.169 | -0.152 | -0.184 | -0.145 |
| | (0.089) | (0.076) | (0.089) | (0.086) |
| Right $\times$ Objective Knowledge Score | -0.055 | -0.032 | -0.062 | -0.030 |
| | (0.075) | (0.082) | (0.081) | (0.092) |
| Schwarz Biospheric Value | -0.055 | -0.064 | | |
| | (0.060) | (0.054) | | |
| Constant | -0.205 | 0.185 | -0.277 | 0.363 |
| | (0.812) | (0.743) | (0.837) | (0.794) |
| Canton Control | YES | YES | YES | YES |
| $N$ | 313 | 313 | 313 | 313 |
| $R^2$ | 0.1837 | 0.2172 | 0.2147 | 0.2521 |

Note: The base level variable for the factor of Political Leaning is “Left." Standard errors clustered by canton. *p<0.1, ** p<0.05, ***p<0.01.

**Table 10.** Additional Regression Results for Objective Knowledge about DGE

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Subjective Knowledge | 0.160 | 0.139 | 0.166 | 0.142 |
| | (0.085) | (0.084) | (0.093) | (0.094) |
| Risk Perception | 2.925*** | | 2.980*** | |
| | (0.614) | | (0.628) | |
| Earthquake * | | 0.249*** | | 0.262*** |
| | | (0.052) | | (0.055) |
| Borehole Explode | | 0.078 | | 0.098 |
| | | (0.051) | | (0.061) |
| Water Pollution | | 0.180** | | 0.175** |
| | | (0.050) | | (0.045) |
| High Costs | | 0.046 | | 0.027 |
| | | (0.072) | | (0.058) |
| Benefit Perception | -0.118 | | -0.087 | |
| | (0.541) | | (0.584) | |
| Decrease CO2 Em | | -0.067 | | -0.041 |
| | | (0.083) | | (0.081) |
| Stable Power Gen | | -0.058 | | -0.020 |
| | | (0.092) | | (0.107) |
| Decrease En Dependency | | -0.071 | | -0.120 |
| | | (0.094) | | (0.110) |
| Affordable | | 0.128* | | 0.117 |
| | | (0.045) | | (0.058) |
| Trust in Government | -0.127 | -0.136 | -0.135 | -0.143 |
| | (0.090) | (0.084) | (0.088) | (0.084) |
| Trust in Science | 0.007 | 0.022 | -0.006 | 0.009 |
| | (0.086) | (0.088) | (0.093) | (0.094) |
| Interest in Energy Topics | 0.031 | 0.024 | 0.088 | 0.076 |
| | (0.112) | (0.108) | (0.131) | (0.129) |
| Middle | 0.191 | 0.177 | 0.108 | 0.115 |
| | (0.240) | (0.245) | (0.268) | (0.275) |
| Right | 0.113 | 0.059 | 0.066 | 0.021 |
| | (0.092) | (0.094) | (0.077) | (0.087) |
| Female | 0.049 | 0.057 | 0.116 | 0.147 |
| | (0.128) | (0.140) | (0.144) | (0.152) |
| Age | -0.004 | -0.004 | -0.001 | -0.001 |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Age-SQ | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Income | 0.010 | 0.017 | 0.027 | 0.029 |
| | (0.032) | (0.033) | (0.037) | (0.038) |
| Education Level | 0.019 | 0.011 | 0.026 | 0.024 |
| | (0.096) | (0.095) | (0.110) | (0.110) |
| Schwarz Biospheric Value | 0.094 | 0.107 | | |
| | (0.084) | (0.087) | | |
| Constant | 4.927*** | 5.375*** | 4.583*** | 5.003*** |
| | (0.571) | (0.647) | (0.629) | (0.691) |
| Canton Control | YES | YES | YES | YES |
| $N$ | 313 | 313 | 313 | 313 |
| $R^2$ | 0.1177 | 0.1379 | 0.1726 | 0.1919 |

Note: The base level variable for the factor of Political Leaning is “Left." Standard errors clustered by canton. *p<0.1, ** p<0.05, ***p<0.01.

**Table 11.** Additional Regression Results for Objective Knowledge Items with Trigger Words (DGE)

| | Nuclear | Nuclear | Toxins | Toxins | Toxins |
|---|---|---|---|---|---|
| main | | | | | |
| Subjective Knowledge | 0.210 | 0.263* | 0.079 | 0.052 | 0.047 |
| | (0.115) | (0.120) | (0.088) | (0.085) | (0.079) |
| Risk Perception | 1.907** | | 4.838*** | | |
| | (0.719) | | (1.022) | | |
| Earthquake | | 0.034 | | 0.123 | 0.027 |
| | | (0.114) | | (0.081) | (0.076) |
| Borehole Explode | | -0.186 | | 0.301 | 0.103 |
| | | (0.143) | | (0.154) | (0.156) |
| Water Pollution | | 0.289 | | | 0.733*** |
| | | (0.157) | | | (0.081) |
| High Costs | | 0.352* | | 0.113 | 0.011 |
| | | (0.139) | | (0.139) | (0.165) |
| Benefit Perception | -4.832*** | | -1.003 | | |
| | (1.043) | | (0.724) | | |
| Decrease CO2 Em | | -0.045 | | -0.122 | -0.071 |
| | | (0.113) | | (0.153) | (0.174) |
| Stable Power Gen | | -0.655*** | | 0.060 | 0.073 |
| | | (0.151) | | (0.156) | (0.179) |
| Decrease En Dependency | | -0.458** | | 0.002 | -0.003 |
| | | (0.159) | | (0.173) | (0.184) |
| Affordable | | 0.247 | | -0.161 | -0.223 |
| | | (0.149) | | (0.129) | (0.152) |
| Trust in Government | 0.270 | 0.224 | -0.089 | -0.108 | -0.085 |
| | (0.143) | (0.130) | (0.109) | (0.123) | (0.124) |
| Trust in Science | -0.187 | -0.205 | -0.110 | -0.108 | -0.117 |
| | (0.120) | (0.107) | (0.100) | (0.108) | (0.126) |
| Interest in Energy Topics | 0.092 | 0.025 | 0.089 | 0.125 | 0.111 |
| | (0.252) | (0.270) | (0.187) | (0.189) | (0.207) |
| Middle | 0.776* | 0.657 | 0.156 | 0.215 | 0.300 |
| | (0.351) | (0.360) | (0.408) | (0.422) | (0.384) |
| Right | 0.388 | 0.325 | 0.174 | 0.178 | 0.277 |
| | (0.215) | (0.202) | (0.284) | (0.274) | (0.326) |
| Female | -0.184 | -0.164 | 0.109 | 0.110 | 0.152 |
| | (0.200) | (0.207) | (0.205) | (0.184) | (0.241) |
| Age | -0.008 | -0.010 | -0.010* | -0.011* | -0.007 |
| | (0.006) | (0.007) | (0.005) | (0.005) | (0.006) |
| Age-SQ | 0.000 | 0.000 | -0.001 | -0.001 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Income | 0.018 | 0.016 | -0.077 | -0.095 | -0.076 |
| | (0.052) | (0.054) | (0.051) | (0.050) | (0.054) |
| Education Level | 0.034 | 0.023 | 0.160 | 0.147 | 0.185 |
| | (0.168) | (0.179) | (0.200) | (0.191) | (0.206) |
| Constant | 1.663* | 1.348 | -2.674* | -1.043 | -2.384 |
| | (0.773) | (0.825) | (1.186) | (1.267) | (1.537) |
| Canton Control | NO | NO | NO | NO | NO |
| Observations | 313 | 313 | 313 | 313 | 313 |
| Pseudo R2 | 0.0962 | 0.1394 | 0.0833 | 0.0554 | 0.1219 |

Note: The base level variable for the factor of Political Leaning is “Left." Standard errors clustered by canton. *p<0.1, ** p<0.05, ***p<0.01.

**Table 12.** Regression Results for DGE Based on teh Study 2 Survey Data

| | Subj Know | Obj Know | Nuclear | Toxins |
|---|---|---|---|---|
| Objective Knowledge Score | -0.253 | | | |
| | (0.293) | | | |
| Subjective Knowledge | | -0.128* | -0.182 | -0.057 |
| | | (0.061) | (0.138) | (0.079) |
| Risk Proxy | 0.266* | -0.159 | 0.041 | 0.079 |
| | (0.104) | (0.085) | (0.062) | (0.129) |
| Benefit Proxy | -0.477* | 0.252* | -0.797*** | -0.694*** |
| | (0.196) | (0.094) | (0.125) | (0.140) |
| Trust in Government | 0.125 | 0.016 | -0.335** | -0.057 |
| | (0.236) | (0.041) | (0.107) | (0.195) |
| Trust in Science | 0.168 | 0.033 | 0.127 | -0.017 |
| | (0.140) | (0.072) | (0.165) | (0.116) |
| Interest in Energy Topics | 0.352** | 0.017 | 0.147 | 0.087 |
| | (0.099) | (0.085) | (0.134) | (0.106) |
| Middle | 0.841 | -0.053 | -0.175 | 0.026 |
| | (2.887) | (0.238) | (0.501) | (0.322) |
| Right | 0.229 | -0.024 | -0.200 | 0.122 |
| | (1.904) | (0.267) | (0.615) | (0.372) |
| Female | -0.401 | 0.106 | -0.348 | -0.316 |
| | (0.257) | (0.198) | (0.202) | (0.199) |
| Age | 0.016 | 0.039 | 0.009 | 0.017 |
| | (0.092) | (0.078) | (0.046) | (0.045) |
| Age-SQ | -0.000 | -0.000 | 0.000 | -0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Income | 0.102 | 0.036 | -0.057 | -0.142 |
| | (0.068) | (0.059) | (0.094) | (0.082) |
| Education Level | 0.339* | 0.127 | -0.181 | 0.323 |
| | (0.149) | (0.087) | (0.169) | (0.270) |
| Middle $\times$ Objective Knowledge Score | -0.090 | | | |
| | (0.412) | | | |
| Right $\times$ Objective Knowledge Score | -0.009 | | | |
| | (0.267) | | | |
| Constant | 0.841 | 6.203** | -0.087 | -0.264 |
| | (3.926) | (1.881) | (1.027) | (1.616) |
| Canton Control | YES | YES | YES | NO |
| $N$ | 211 | 211 | 211 | 211 |
| $R^2$ | 0.2751 | 0.2090 | | |
| Pseudo $R^2$ | | | 0.1159 | 0.0781 |

Note: The base level variable for the factor of Political Leaning is “Left;" therefore, the Middle and Right coefficients should be interpreted as relative changes from that base group. Standard errors clustered by canton. *p<0.1, ** p<0.05, ***p<0.01

Note: The base level variable for the factor of Political Leaning is “Left." Standard errors clustered by canton. *p<0.1, ** p<0.05, ***p<0.01.

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