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Impact of new social movements on attitudes towards nuclear energy

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Author(s):	Anouk Luypaert (UA), Florian Abraham (UNEXE), Fien Bergen (UA), Gaston Meskens (SCK CEN), Susan Molyneux-Hodgson (UNEXE), Peter Thijssen (UA), Catrinel Turcanu (SCK CEN)

For the Lead Beneficiary	Reviewed by Work Package Leader	Approved by Coordinator
Peter Thijssen	**Gaston Meskens**	**Daniela Diaconu**
X Peter Thijssen		

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EC Project Officer:	Michal Tratkowski
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Coordinator contact:	+40 744 701 476, daniela.diaconu@nuclear.ro
Administrative contact:	+40 744 701 476, daniela.diaconu@nuclear.ro
Online contacts (website):	https://ecosens-project.eu

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1 Introduction

1.1 ECOSENS project information

The ECOSENS project (Economic and Social Considerations for the Future of Nuclear Energy in Society) aims to create a neutral space where specialists in social sciences and humanities (including economics, sociology, social psychology, Science and Technology Studies, among others) and in nuclear energy research and policy meet, exchange views, and collaborate with civil society and other stakeholders to assess the future of nuclear energy in society in terms of public attitudes, sustainability of the entire lifecycle, and emerging investment models. Within Work Package 1, with its goal of a collaborative assessment of (imagined) energy worlds, Task 1.2 has two aims. First, to provide insight into the motivations behind and experiences with public participation in protest and advocacy movements focused on energy, sustainability, and climate change, with a particular emphasis on nuclear energy. Second, to explore the motivations and rationales of ecomodernism, both as a concept and as a movement.

1.2 Aim and structure of the document

The document combines the results of three separate studies. The first two are related to the first aim and uses surveys to examine the attitudes of protesters at anti-nuclear protests and climate change protests; First, an original survey was carried out at an environmental protest in London, UK, in 2023. Second, we use existing survey data collected at anti-nuclear protests in 2011-2012 in Germany, Belgium, Switzerland, and the UK. The third short study relates to the second aim of this task, which is to highlight the concept of 'ecomodernism' and the way it inspires a relatively recent 'movement' critical towards traditional (anti-nuclear) environmental activism. Typical of ecomodernism is the (often radical) pro-nuclear position, in contrast to traditional environmentalism. Given the recent phenomenon and the fact that no data exists yet that would allow understanding of how this recent vision could shape public opinion, we restrict ourselves in this report to a short literature study.

The structure of the document is as follows:

Section 2 of the document sets the scene by giving an overview of the relevant literature. In a first subsection, we highlight the literature on protest and attitudes towards nuclear energy and climate change, and the relationship between those attitudes, and describe the contexts of the countries under scope. The second subsection introduces the concept of ecomodernism and its relation to perceptions of nuclear energy as a phenomenon worth to consider in the future.

Focussing on anti-nuclear protests, consequently, **Section 3** describes the methodology for each case study, comprising the survey methods and the variables used in the survey analyses.

Section 4 describes the results for each case study separately, and **Section** 5 concludes with some final remarks regarding the key findings and the anticipated next steps in integrating the national case studies into the ECOSENS project implementation and publications.

Finally, **Section** 6 lists references and **Section 7** contains the appendixes.

2 Literature overview

2.1 Anti-nuclear protest

Anti-nuclear movements and opposition can significantly shape energy policies (Flam & Honda, 2021; Kitschelt, 1986; Parks, 2021; Sovacool et al., 2022; Wolfgang C. Müller & Paul W. Thurner, 2017). Historically, large-scale protests and social movements have influenced governments' decisions on energy strategies, from creating a stalemate in nuclear policy in the United States (Kitschelt, 1986) to Germany's and Belgium's phased nuclear power exit in response to public opposition (Wolfgang C. Müller & Paul W. Thurner, 2017). Against this backdrop, investigating the profiles of protesters – who they are, what motivates them, and what their grievances and demands are – is vital for fostering meaningful dialogue, as it allows advocates and authorities alike to address misconceptions and explore avenues for compromise or collaboration. Moreover, a democratic context - one that encourages public debate, inclusive decision-making, and stakeholder engagement - can help channel protest actions into constructive policy discussions.

While there is much recent research on climate change protesters (Bain & Bongiorno, 2020; Boucher et al., 2021; de Moor et al., 2020; Parks, 2021; Wahlström et al., 2013), research on recent anti-nuclear protest in Western Europe is scarce. One of the reasons for a lack of research on the topic may be that in recent years, there has been no, or at least very little, protest against nuclear energy in Western Europe. At the nuclear summit in Brussels in March 2024, there was a small group of international protesters against nuclear energy, but, interestingly, a group of international protesters in favor of it as well. This might in itself already indicate a shift in public attitude. A lack of protest could be due to a lack of reasons for protest. First, there have been no recent accidents, which in the past have caused rising anti-nuclear sentiment among and mobilization of the public (Joppke, 1993; Koopmans & Duyvendak, 1995; Kristiansen et al., 2016; Müller et al., 2017; Szulecki et al., 2022). Second, the Fukushima accident in 2011 gave rise to many protests in Western Europe and increased debate around nuclear energy, contributing to nuclear phase-outs in some countries (Dempsey & Ewing, 2011; Kristiansen et al., 2016). However, recently, the sentiment seems to be shifting again towards including nuclear. First, the increasing worry about climate change may not necessarily lead to positive sentiment, but may convince some that it is "a necessary evil" (McCalman & Connelly, 2019; Pidgeon et al., 2008). Additionally, the energy crisis and the Russian invasion of Ukraine in 2022 put energy security back on the agenda and made nuclear power an important source to consider (European Union, 2023; the Russsian threat already influenced certain countries in the 2010s, see Müller et al., 2017). Finally, developments in artificial intelligence and the accompanying need for large amounts of energy have made large tech companies invest in nuclear development (Duffy, 2024). In this context, the nuclear energy debate is likely to become highly relevant again.

It has often been observed that people who are concerned about climate change tend to oppose nuclear energy (Arndt, 2023; Durdovic et al., 2024; Spence et al., 2010). This belief likely arises from the idea that nuclear power harms the environment, a key concern among climate activists. However, according to recent research from Bohdanowicz and colleagues (2023), this link is not universal. They argue that while in many Western countries, such as Germany, the environmental movements of the 1970s framed nuclear energy as harmful to the environment, in Poland, a lack of such movements, due to their Soviet past, caused a less strong negative connotation between nuclear power and the environment. As a result, Poles who worry about climate change are not as strongly opposed to nuclear energy as their German

counterparts, who have come to link the environmental harm of nuclear power with climate change. Moreover, to some extent, the environmental social movements of the 1970s and the parties that evolved from those movements are currently issue owners, amongst others, of *both* the climate change issue and the (anti-)nuclear issue. This suggests that, in Western Europe, the collective frames used by climate change activists may overlap with those used by anti-nuclear protesters.

2.1.1 Sociodemographic profiles of protesters

Prior research suggests different protest issues attract individuals with different sociodemographic characteristics (Verhulst, 2011), referring to variation in terms of gender, education, age, and political values (Van Aelst & Walgrave, 2001; van Stekelenburg & Klandermans, 2013; Verhulst, 2011). For now, empirical data on the socio-demographic characteristics of anti-nuclear protesters is scarce. The research on opposition to energy infrastructure projects (in general, not limited to nuclear energy) of Memmot et al. (2021) suggests that certain demographic factors, such as age and gender, shape protest participation. They found that most protesters were more likely to be male and younger but did not find a significant impact between participation and education and political ideology. However, they examined protests against all kinds of energy infrastructure, including, for example, wind power. By aggregating all their data, certain patterns specific to different kinds of energy sources may be lost.

Climate change and nuclear energy are both so-called new, post-materialistic, and universal issues. Based on Verhult's typology (2011), one would, therefore, expect protesters to have similar profiles: young, female, leftist, and highly educated. Indeed, a variety of research has shown that many climate protesters are highly educated and leftist, and usually female rather than male (Boucher et al., 2021; de Moor et al., 2020; Wouters et al., 2022). As such, one may expect that the anti-nuclear protesters in our data will share these characteristics.

2.1.2 Collective action frames

Framing is a vital tool of social movements. Through framing processes, these movements create a shared meaning or interpretation of events, which helps mobilize protesters and may also influence the general public opinion (Benford & Snow, 2000; Johnston & Noakes, 2005; Klandermans, 2003; Parks, 2021; Snow et al., 2018). To better understand social movement dynamics, research has therefore examined the frames used by social movements. Many used the typology developed by Snow and Benford (1988), which distinguishes three key frames in social movements:

- **Diagnostic frames** identify a problem and attribute blame.
- **Prognostic frames** propose solutions or strategies to address the identified issue.
- **Motivational frames** provide a rationale for action, encouraging collective participation.

While some research examined the framing processes of climate movements (see, e.g., Wahlström et al., 2013), research how nuclear energy movements use frames is lacking.Our second research question, therefore, examines framing strategies: Do anti-nuclear protesters use similar collective action frames as climate activists? Given that anti-nuclear sentiment has historically been shaped by and is associated with environmental activism (Sonnberger et al., 2021), anti-nuclear activists may adopt framing strategies similar to those of climate activists. For instance, both movements may use diagnostic frames that emphasize environmental risks, prognostic frames that advocate for renewable energy alternatives, and motivational frames that stress the urgency of political action.

2.1.3 Country contexts

Nuclear energy policies and public opinion vary significantly across European nations, reflecting diverse historical, political, and environmental considerations. We shortly discuss the nuclear energy landscape in our four cases, Belgium, Germany, Switzerland, and the UK.

Nuclear energy plays an important role in the Belgian energy mix. In 2022, 46% of the electricity generation came from nuclear energy sources (World Nuclear Association, n.d.), through 7 nuclear reactors. However, in 2003 already, Belgium passed a law mandating the phase-out of its existing nuclear reactors by 2015, and, at the same time, banning the construction of new ones. This phase-out remained a contentious issue, subject to ongoing political and economic debates, putting its execution on the back burner with the next governments. Finally, in 2020, the government confirmed its intention to implement a (partial) nuclear phase-out under a so-called Plan A, which involved relying on gas as a primary energy source to replace nuclear power. If this plan failed and the Belgian energy supply became threatened due to the phase-out, there was a plan B that included the extension of two existing nuclear reactors. In October 2021, debates around energy security and costs intensified, with critics questioning the feasibility of phasing out nuclear energy amidst rising energy prices. The situation took a dramatic turn when Russia invaded Ukraine, intensifying the energy crisis and a reassessment of the nuclear phase-out timeline. By February 2022, the government decided to delay the phase-out by adopting Plan B, which involved extending the operation of two nuclear reactors. This marks a significant shift in Belgium's nuclear energy policy, especially given the election winner, N-VA, a proponent of nuclear energy. The new government formed in 2025, led by N-VA, strives for nuclear energy to be an important part of the Belgian energy mix (*Weg met de kernuitstap*, 2025).

Germany's approach to nuclear energy has been cautious. Similar to Belgium, the country decided to phase out nuclear power following the Fukushima incident, with the final reactors scheduled for closure by 2022. This policy, known as the "Energiewende," emphasizes a transition towards renewable energy sources. Public opinion in Germany has generally favored this move, driven by safety concerns and a strong environmental movement advocating for sustainable alternatives (Selje, 2022).

Switzerland, similarly, has relied on nuclear power for a significant share of its electricity. In the aftermath of Fukushima, Swiss authorities decided to gradually decommission existing nuclear plants and imposed a ban on constructing new ones (Kristiansen et al., 2016). Nonetheless, recent geopolitical events and energy security challenges have prompted new debate around this decision. In August 2024, the Swiss government announced plans to lift the ban on building new nuclear power stations, acknowledging the potential necessity of nuclear energy for a stable future supply ("Switzerland to Scrap Ban on Building Nuclear Power Stations," 2024; Turuban, 2024). Public sentiment reflects this shift, with a 2024 survey indicating that 49% of respondents support the continued use of nuclear energy, while 38% oppose it. "Of those respondents to the latest poll saying they support the use of nuclear, 87% said sufficient power generation remains the main argument, while 47% give the achievement of Switzerland's climate goals as the reason." (*Polls Find Strong Support for Nuclear in UK and Switzerland*, n.d.)

Finally, in the United Kingdom, nuclear energy has been a key component of the energy portfolio, accounting for approximately 15% of electricity generation (World Nuclear Association, 2024). The UK government has demonstrated renewed commitment to nuclear power, commissioning new reactors and extending the operational life of existing ones to enhance energy security and meet decarbonization targets (World Nuclear Association, 2024). Public opinion has shown increasing, albeit somewhat

reluctant, support for nuclear energy, influenced by climate change and concerns over energy independence (Corner et al., 2011; Poortinga et al., 2013). Notably, a recent YouGov poll indicated that 65% of respondents believe nuclear power should play a role in the country's climate policy (Matthew Smith, 2021).

2.2 Ecomodernism as concept and social movement – a short discourse analysis

2.2.1 What is ecomodernism?

Ecomodernism is a contemporary environmental philosophy that posits the compatibility of environmental sustainability with technological progress and economic development. In contrast to strands of environmentalism rooted in degrowth, conservationism, or primitivism, ecomodernism emphasizes the potential of human ingenuity, scientific advancement, and modernization to reduce humanity's ecological footprint while promoting global prosperity.

Ecomodernism supporters argue that technological development can *protect* nature (instead of potentially endangering it) and improve human wellbeing through eco-economic decoupling, i.e., by separating economic growth from environmental impacts. Ecomodernism embraces substituting natural ecological services with energy, technology, and synthetic solutions as long as they help reduce impact on environment (Wikipedia 2025).

2.2.2 Conceptual Foundations

At its core, ecomodernism leans on the notion of decoupling, wherein economic growth and human well-being are increasingly 'separated' from environmental degradation (Wackernagel et al., 2002; UNEP, 2011). Decoupling, 'separating' man and nature, is a key word for ecomodernists. The more we decouple our activities from nature, the better off we are, and nature is. Decoupling is mainly done by concentrating our activities - in agriculture, in energy production and in the way we organise housing and service buildings – thereby making more 'space' for nature. (Visscher, Bodelier et al., 2017). In other words, ecomodernists argue that through the deployment of advanced technologies societies can mitigate environmental harm while continuing to advance materially.

Key features of the ecomodernist philosophy include (Asafu-Adjaye et al., 2015, Glaeser, 2011; Foley et al., 2011; Brand, 2009):

- **Technological optimism**: A belief in the capacity of innovation, especially in clean energy (e.g., nuclear power, carbon capture, renewables), to address ecological challenges;
- **Dense urbanization**: Compact cities are seen as engines of sustainability, reducing per capita energy consumption and land use;
- **Intensive agriculture**: Increasing yields on existing farmland is favoured over extensive cultivation, thereby sparing land for rewilding and biodiversity;
- **Human stewardship**: Humans are viewed not as intrinsic threats to nature, but as capable managers of planetary systems.

2.2.3 Historical Development

While the formal articulation of ecomodernism coalesced in the early 21st century, its antecedents lie in earlier intellectual traditions, including ecological modernization theory (Mol & Sonnenfeld, 2000), technological utopianism, and systems ecology. One can say the point of departure of ecomodernist thought was the publication of the controversial essay *The Death of Environmentalism* in 2004. In that text, the authors Michael Shellenberger and Ted Nordhaus presented themselves as 'the grandchildren of the environmental movement', thankful for everything that movement realized up till then. They specifically referred to environmental problems such as acid rain, ozone and the protection of wildlife parks, but questioned the capacity of the movement when it comes to tackling more complex global problems such as climate change, the 'most serious ecological crisis in the world' (Visscher, Bodelier et al., 2017). They called the 'traditional' solution the historical environmental movement tends to present – a total reform of the economic system inspired by lowered ambitions and degrowth – ineffective and impossible to realise, also taking into account the urgency of the climate change problem. Shellenberger and Nordhaus argued that the environmental movement only came up with nagging statements, dramatic solutions and proposals that did not trigger the imagination of the masses and also still had little effect produced. "… W*e have become convinced*," Shellenberger and Nordhaus concluded, "*… that the environmental movement with all its unexamined assumptions, outdated concepts and exhausted strategies must be buried so that something new can blossom*." (Shellenberger and Nordhaus 2004).

One can understand the essay stirred a wave of outrage. It became frontpage news in The New York Times and The Economist and has inspired academic and more popular critique since then. The New York Times said that *"When environmentalists are writing tracts like 'The Death of Environmentalism', you know the movement is in deep trouble. That essay by two young environmentalists has been whirling around the Internet since last fall, provoking a civil war among tree-huggers for its assertion that 'modern environmentalism, with all of its unexamined assumptions, outdated concepts and exhausted strategies, must die so that something new can live.' Sad to say, the authors, Michael Shellenberger and Ted Nordhaus, are right."* (Kristof 2005). Interesting to note is that the term 'ecomodernism' was not yet used in the essay. In a follow-up move, the term entered public discourse with the release of *An Ecomodernist Manifesto* in 2015, authored by a group of scholars and policy analysts affiliated with the Breakthrough Institute, including (again) Ted Nordhaus and Michael Shellenberger (Asafu-Adjaye et al., 2015).

The Ecomodernist Manifesto was presented as a 'manifesto to use humanity's extraordinary powers in service of creating a good Anthropocene': *"... We offer this statement in the belief that both human prosperity and an ecologically vibrant planet are not only possible, but also inseparable. By committing to the real processes, already underway, that have begun to decouple human well-being from environmental destruction, we believe that such a future might be achieved. As such, we embrace an optimistic view toward human capacities and the future. ..."*

Notable intellectual influences of the ideas developed in the manifesto include Vaclav Smil's analyses of energy transitions (Smil, 2010), Stewart Brand's advocacy for environmental pragmatism (Brand, 2009), and Bruno Latour's meditations on the Anthropocene and the politics of nature (Latour, 2014). The manifesto proposes a paradigmatic shift from conventional environmentalism, asserting that modernization is not the enemy of nature but a vehicle for its preservation. It advocates for a 'good Anthropocene', in which deliberate technological intervention can stabilize the Earth's climate and

preserve biodiversity. With the use of the term 'manifesto', one can suspect the authors saw themselves as representatives of a new 'social movement', or at least as a movement that would need to take shape around the problem stated.

2.2.4 *Critiques*

Despite its optimistic orientation, ecomodernism has not escaped critique. Scholars from political ecology and critical theory argue that it tends to downplay structural inequalities and the sociopolitical dimensions of environmental harm (Blühdorn & Welsh, 2007). Others question its reliance on high-risk technologies, such as nuclear power and geoengineering, which may carry unforeseen ecological or geopolitical consequences (Stilgoe, Owen, & Macnaghten, 2013).

Moreover, ecomodernism's anthropocentric ethos and typical 'Western view' on the issues has drawn criticism from deep ecologists and indigenous scholars, who contend that it instrumentalizes nature and marginalizes non-Western epistemologies (Whyte, 2017). Also the simplistic vision of the 'separation' of humanity and nature (thereby making abstraction of the 'nature' of the human itself) received critique. Remarkably, the most prominent critique came from an intellectual whose ideas inspired the Manifesto in the first place. Bruno Latour stated that *"... the modernity celebrated in 'An Ecomodernist Manifesto' is a myth ..."* as it leans solely on what he called a 'great technical fix': *"... And this is where we encounter this strange animal, rather this monster, 'ecomodernism' [...]. To me, it sounds much like the news that an electronic cigarette is going to save a chain smoker from addiction. A great technical fix which will allow the addicted to behave just as before, except now he or she will go on with the benefit of high tech product and the happy support of his or her physician, mother and significant other. In other words, 'ecomodernism' seems to me another version of 'having one's cake and eating it too'. ...*" (Latour 2015).

All in all, one can say ecomodernism represents an alternative significant reconfiguration of environmental thought in the 21st century. It offers a vision of ecological modernity grounded in innovation, human agency, and a managed Anthropocene. Whether it proves to be a viable path towards sustainability – or a techno-utopian detour or blind alley – remains a matter of intense scholarly and political debate.

2.2.5 Ecomodernism and nuclear energy

It may be no surprise that ecomodernism supporters see nuclear energy as an energy source with a significant potential to combat climate change. Ecomodernists raise an (often radical) pro-nuclear voice, also in the Ecomodernist Manifesto: "… *Meaningful climate mitigation is fundamentally a technological challenge* ...", it is stated, and "… *nuclear fission today represents the only present-day zero-carbon technology with the demonstrated ability to meet most, if not all, of the energy demands of a modern economy. However, a variety of social, economic, and institutional challenges make deployment of present-day nuclear technologies at scales necessary to achieve significant climate mitigation unlikely* …".

In his book *Nuclear 2.0: Why A Green Future Needs Nuclear Power*, the author Mark Lynas is even more explicit, stating that "… *Everything you thought you knew about nuclear power is wrong* …" and that "… *asking renewables to deliver all the world's power is dangerously delusional* …". The first quote may also refer to himself, given he was an early anti-nuclear environmental activist who later

changed his mind. He sees a continuation of economic growth as inevitable, as "… *there is no possibility of using less energy […] when the developing world is fast extricating itself from poverty* …". And in a somewhat sarcastic poetic tone, he criticizes early anti-nuclear activists for being partly responsible for climate change: "… *The anti-nuclear movement of the 1970s and 80s succeeded only in making the world more dependent on fossil fuels […] its history is not lit by sunshine, but shrouded in coal smoke* …". (Lynas 2014)

Ecomodernists use the traditional – mostly technical – pro-nuclear arguments and often call sceptics or people with opposing opinions 'irrational' (Visscher, Bodelier et al., 2017, 58): the number of casualties (including those of accidents) is minimal as compared to the case of fossil fuels (with yearly thousands of deaths from mining and transport in the coal industry); nuclear waste can be managed safely and the proliferation risk can be controlled technically and politically. In addition, it is said, nuclear energy can help to reduce the number of existing nuclear weapons by turning the fissile material from the warheads into nuclear fuel for power plants. Many ecomodernists apparently also have a preference for the Thorium fuel cycle option, and may promote specific future types of reactors such as the Thorium-fueled molten salt reactor.

A clear example of a technical and even technocratic reasoning is the following quote on the disposal of radioactive waste: "*… Overall, the amount of long-lived waste is small, and there is no problem storing it safely for very long periods. It is brought to a location that we know has been stable for millions of years and is likely to be stable for millions of years to come. The material is sealed off from the environment, including groundwater. And there, 'in splendid isolation', the problem gradually resolves itself through radioactive decay* (Visscher, Bodelier et al., 2017, 58-59). …". In his argument, the author does not reflect on the socio-political (and ethical) issue of siting and the proposed need to involve the general public and the local population around a potential site. Neither sees he the need to consider intergenerational issues such as potential accidental intrusion, the question whether or not to leave a mark for future generations or the challenge of communication towards the future. He gives the impression that the technical solution 'speaks for itself' and that there is no reason to think other people now and in the future will have different opinions on this. And if they would have, it's because they are 'irrational'…

3 Methodology

3.1 A comparative analysis of anti-nuclear protesters

We use data from an existing dataset, the Caught in the Act of Protest: Contextualizing Contestation Project (Klandermans et al., 2014), further referred to as CCC-project. This dataset covers, amongst other things, five protests against nuclear energy in four countries (Belgium, Sweden, The Netherlands, and Switzerland) between 2011 and 2012. The CCC project developed a standardized protest survey methodology to gather data on protest participants across various contexts. To ensure randomness in sampling, the survey design involves systematic procedures, such as selecting every n-th row in moving demonstrations or using a grid approach for static protests. The randomly selected protesters are then interviewed face-to-face during the demonstrations, complemented with postal surveys distributed to participants for later completion (for more detail on this method, see Klandermans et al., 2014).

We first discuss the data from the CCC-project and describe the variables used. We use only data on five anti-nuclear protests that took place in Sweden and the Netherlands in 2011, in Belgium in 2012, and in Switzerland in both years. The details of these protests are listed in Table 1. All these protests took place in response to the nuclear accident in Fukushima on March 11th, 2011. In total, data was collected for 1.850 respondents. In the figures in the rest of the document, Belgium will be abbreviated as BE, the Netherlands as NL, Denmark as DK, Switzerland as CH, United Kingdom as UK, and Sweden as SV.

Within this dataset, there are four socio-demographic variables we use. First, **age** is an interval variable that was asked as the age of the respondent at the time of the survey. Second, **gender** was either male or female. Third is **education**, which was initially measured as an ordinal variable, with different categories in the different countries. All these categories were recoded into a dichotomous category indicating whether or not the respondent was highly educated (everything past secondary school), ensuring comparability across countries. Finally, **subjective class** was measured from 1 to 5, 1 being upper class and 5 lower class.

Table 1: Overview of anti-nuclear protest survey data used in this analysis.

Protest name	City (country)	Date	# Respondents	Issue
Anti-nuclear demonstration	Stockholm (Sweden)	26/04/2011	279	The use of nuclear power in society
Anti Nuclear demo	Amsterdam (the Netherlands)	16/04/2011	448	the use of nuclear energy in society.
Anti Nuclear Manifestation	Beznau (Switzerland)	22/05/2011	472	for the use of nuclear energy
Fukushima never again	Brussels (Belgium)	11/03/2012	189	the holding up of the shutdown of nuclear power plants
Anti-nuclear	Mühleberg (Switzerland)	11/03/2012	462	for the use of nuclear power

Next, we include respondents' position on the **left-right political spectrum**. The variable ranges from 0 (left) to 10 (right), with 5 thus being center. Additionally, we measured respondents' cultural and economic left-right position based on their answers to four questions that are commonly associated with these concepts:

a) Government should redistribute income from the better off to those who are less well off.
b) Even the most important public services and industries are best left to private enterprise.
c) People from other countries should be allowed to come to my country and live here permanently if they want to.
d) Children should be taught to obey authority.

a) and b) reflect the economic left and right positions and c) and d) reflect the cultural left and right positions.[1] In contrast to the general left-right position, these were answered on 1 to 5 Likert scale, with 1 strongly disagreeing with the statement and 5 strongly agreeing.

Additionally, we have four questions about the emotional responses of respondents to the issue; respondents were asked if thinking about the issue (again referring to the issues mentioned in Table 1) made them feel a) angry, b) worried, c) fearful, and d) frustrated. The answer categories ranged from 1, not at all, to 5, very much.

Finally, we used **three open-ended questions** in our analysis. All three questions were asked at the beginning of the survey to avoid answes being influenced by the other questions. First, respondents were asked "*why you participated in this protest event*". Second, respondents were asked "*In your opinion, who or what is to blame for [the demonstration's issue]?"*. Finally, they were asked *"What should be done to address this issue?"*. The issue being referred to is the issue's text included in Table 1. In most cases, this was "the use of nuclear power (in society)". Belgium is the only exception, as the issue referred to the "holding up of the shutdown of nuclear power plants".

The analysis of responses was done in three steps, separately for each question. First, we identified common words, bigrams and trigrams[2] within the responses. Prior to extracting these n-grams, the text was preprocessed through a series of steps. First, the responses were tokenized, dividing the text into sentences and words. Each word was then lemmatized to group inflections and group words with the same base form together. For example, "organizing" and "organizes" were both transformed into "organize." Subsequently, stopwords, such as "the" and "and" were removed to enhance the analysis of substantive content. After preprocessing, a response such as "Respond to the urgency: radical political decisions need to be taken" was converted to "respond urgency : radical political decision need take.". The n-grams identified in the processed text then served as the foundation for creating word clouds.

We created word clouds based on the most common words, bigrams, and trigrams. This was necessary as the bigrams and trigrams may give some context to single words; 'short' by itself, for example, does not carry much meaning, but the bigram 'short term', does. On the other hand, some words or bigrams are very common, but they do not show up in the trigrams. Two good examples are 'education' and 'inform', which were relatively common for the question "what to do about *the issue*", but did not appear in the bigram or trigram wordclouds. For the wordclouds based on one-grams, we removed the common words 'nuclear', 'energy', 'power', and 'plant' as they do not add any distinct meaning but overtake the wordclouds because they are so common. Similarly, for the word clouds based on bigrams, we removed 'nuclear power', 'nuclear energy', 'power plant', and for the word clouds based on trigrams, we removed 'nuclear power plant'.

In the next step, we defined various themes that were present in the responses based on the word clouds for each question. These themes are shown in Table 2 and discussed in more detail in the results section. We then used these themes to prompt Meta's large language model Llama-3-8B-Instruct to annotate the responses. We crafted a separate prompt for each question which asked the model to annotate the presence of each theme in the survey responses. We used a few-shot prompt, giving the model a few examples (which were not in the dataset) from which it could learn. The prompts are added in the appendix (Appendix A, Appendix B, and Appendix C). To verify the robustness of the model's results,

[1] The order in the survey was random and did not follow the order in which the questions are presented above.
[2] A bigram is a sequence of two words, a trigram a sequence of three words

we manually annotated 50 random responses for each question and compared the results with the model's annotations. Without any finetuning of the prompt or the hyperparameters, the model got excellent results compared to the manual annotation. The metrics used to evaluate the model are shown in Table 2. They show that the model performs exceptionally well in terms of precision, which is 0.94 on average (across questions and themes); Recall is slightly lower, especially for the "who is to blame" question, but still very acceptable with an overall average of 0.82. Based on Cohen's kappa and Krippendorff's alpha the conclusion is similar, although it is usually argued that Krippendorff's alpha should be above 0.80, which is not the case for some themes. However, given that recall is relatively high and precision is almost perfect, one may assume that the annotations will be correct but that our results slightly underestimate the actual presence of these themes.

Based on the annotations, we then calculated, for each theme, the share of respondents for which the theme was present in their response. Given that multiple themes may be present in an answer, the sum of all shares does not add up to 100%.

Table 2: List of questions, themes for each question, and the metrics used to validate the LLM's performance against our manual annotation.

question	theme	recall	precision	f1	kappa	kalpha
What should be done?	phasing out nuclear energy	0.90	0.95	0.92	0.87	0.88
	investing in renewable and clean energy sources	0.96	1.00	0.98	0.96	0.96
	reducing energy consumption and changing behaviors	0.79	0.92	0.85	0.79	0.79
	raising awareness and providing better information	0.70	1.00	0.82	0.79	0.79
	average	0.84	0.97	0.89	0.85	0.85
Who is to blame?	critique of economic powers and profit motives	0.80	1.00	0.89	0.71	0.70
	political responsibility and governance issues	0.77	1.00	0.87	0.83	0.83
	societal and cultural accountability	0.63	1.00	0.77	0.69	0.69
	average	0.73	1.00	0.84	0.74	0.74
Why protest?	nuclear waste	0.76	1.00	0.87	0.81	0.81
	sustainable policies	1.00	0.75	0.86	0.83	0.84
	npp opposition	0.91	0.78	0.84	0.68	0.68
	average	0.89	0.84	0.85	0.78	0.77
	Total average	0.82	0.94	0.86	0.79	0.79

3.2 Environmental protests in the United Kingdom

ECOSENS collaborated with a related project at UNEXE to study the views of participants attending environmental mass protests. The concept and design of 'protest survey method' was undertaken outside of ECOSENS and UNEXE financially supported a round of information collection on the topic of nuclear as part of an existing project on environmental social movements. A large, national environmental protest event in spring 2023 was selected to sample participant views and 611 responses were obtained. Interviews with key nuclear actors were undertaken as part of a different Task within ECOSENS and helped to inform the understanding of the findings.

The survey was conducted during the 'Big One', an environmental protest organised predominantly by the UK branch of Extinction Rebellion (XR) in London on 21-24 April 2023. The aspiration of Big One was to form a large four-day mobilisation, physically outside UK governmental departments and institutions (House of the parliament, Westminster). The protest was supported by over 200 organisations, including Greenpeace and Friends of the Earth, who invited participants to gather around

a shared conviction for the urgent need of climate change public actions. The protest included a wide range of activities, such as speakers, workshops, and performances.

The pre-existing project conducts regular surveys on behalf of Extinction Rebellion (XR) and questions about views on nuclear energy were appended to the standard survey list. Out of 34 questions in the survey, four questions were added to cover the topic of nuclear energy, asking about concerns, low carbon futures and preferences.

Questionnaire – appended questions on nuclear views

Q1: To what extent do you agree or disagree with the following statements?

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
I am concerned about nuclear energy (1)	o	o	o	o	o
I think that nuclear power stations are dangerous for the environment (2)	o	o	o	o	o

Q2. How concerned are you about the following potential issues with nuclear power?

	Not at all (1)	Not very (2)	Somewhat (3)	Quite (4)	Very much (5)
The risk for a major accident in a nuclear power plant (e.g. Chernobyl) (1)	o	o	o	o	o

The financial cost of nuclear energy (2)	o	o	o	o	o
Possible issues with the management of radioactive waste (3)	o	o	o	o	o
The risk of a possible use of radioactive materials produced by nuclear plants in nuclear weapons (4)	o	o	o	o	o
Other (please specify) (5)	o	o	o	o	o

Q 3. In your view, is it worth accepting these possible issues with nuclear power in order to benefit from the acclaimed low carbon energy it produces? Please justify your response in the text box if you wish to.

o Yes (1) _____

o No (2) _____

o I am not sure (3) _____

o I don't have an opinion (4)

o I don't care (5)

Q 4. Which of the options do you think is preferable? Please justify your response in the text box if you wish to.

o A few larger nuclear power plants located in a small number of locations (1) _____

o Multiple smaller nuclear power plants spread across multiple locations (2) _____

o Don't know (3)

We acknowledge the work of the extended UNEXE team in this work and the full report (Saunders et al, 2024)[3] analyses findings of the survey across a wide range of aspects (participants affiliation with environmental organisations, demographics, preferred forms of protests, etc). In this document, we present summary data that pertains only to the perception of nuclear energy among respondents. We examine the relationship between energy production preferences and social factors (e.g., political affiliations, age group, etc).

4 Results

4.1 A comparative analysis of anti nuclear protesters

We stick to descriptives and analyse the frames of the protesters in the open questions through n-grams and topic modeling algorithms, as there was not enough variation amongst protesters (e.g., most are leftist, middle class, and higher educated) to make substantive regression analyses.

4.1.1.1 Descriptives

First, we show the overall statistics for our closed variables in Table 3 and

Table 4. Table 3 specifically shows descriptives for the dichotomous variables education and gender. A significant majority of respondents (68.05%) reported having pursued education beyond secondary school. The gender is alsi slightly biased, with about 57% of respondents being female. Table 3 presents descriptive statistics for interval variables. The AGE variable reveals a broad representation across the lifespan, with an average age of 46.94 years and a standard deviation of 15.56. The CLASS variable, reflecting subjective social class, shows a mean score of 2.76 on a scale from 1 (upper class) to 5 (lower class), suggesting a concentration in the middle-class categories. Emotional responses, measured on a scale from 1 to 5, reveal notably high levels of concern, with WORRIED (mean: 4.46) and ANGRY (mean: 4.01) being particularly prominent.

Table 3: Descriptive statistics of dichotomous variables.

VARIABLE	N	MISSING	CATEGORY	PROPORTION
EDUCATION_LONG	1806	44	1	68,05%
			0	31,95%
GENDER	1821	29	female	56,89%
			male	43,11%

[3] Please find the report here: https://hass-cornwall.exeter.ac.uk/v8media/facultysites/hass/hasscornwall/XR_Report_-_Final_Draft_(PDF)_(4)-compressed.pdf

Table 4: Descriptive statistics of interval variables.

VARIABLE	N	MISSING	MEAN	STD DEV	MIN	MAX
AGE	1821	29	46,99	15,49	13	86
CLASS	1628	222	2,76	0,75	1	5
LERI	1776	74	2,22	1,53	0	10
REDISTRIBUTE	1809	41	4,03	0,91	1	5
PRIVATISATION	1801	49	1,51	0,78	1	5
POSIMMIG	1793	57	3,61	0,96	1	5
AUTHORITY	1796	54	2,79	0,96	1	5
ANGRY	1724	126	4,01	1,05	1	5
WORRIED	1789	61	4,46	0,82	1	5
FEARFUL	1664	186	3,32	1,19	1	5
FRUSTRATED	1705	145	3,94	1,14	1	5

Second, we compare the results between countries, relying on the plots in Figure 1 to Figure 7. Where possible, we also compare the statistics with the data from the ESS 20212 wave (European Social Survey European Research Infrastructure (ESS ERIC), 2023), shown with black arrows, compared to blue dots representing the CCC data.

Regarding the socio-demographics shown in Figure 1, there are few differences between countries regarding age (40-50 on average) and subjective class (middle class, on average). Concerning age, the protesters seem to be representative of the countries as a whole, as there are no differences with the ESS data. Regarding gender balance, Sweden stands out, with about 70% of the respondents being women, versus around 50-60% in the other countries. This difference is also significant. Unsurprisingly, Sweden also significantly differs from the gender balance in the ESS. In Switzerland, women are also slightly overrepresented, but the difference is small. Finally, regarding education, there is a significantly lower proportion (60%) of highly educated respondents in the Netherlands, compared to 70% in Switzerland and 80% in Sweden and Belgium. Compared to ESS data, higher-educated people are overrepresented in all countries.

The boxplot in Figure 2, showing the distribution for age and class, provides very similar results; the distribution across countries is identical for class, and there are only minor age differences.

Figure 1: socio-demographics of nuclear energy protesters. Age, left-right position, and subjective class are averages. Highly educated is presented in terms of the share of people with a higher education. Based on CCC (blue dots) and ESS (black arrows) data.

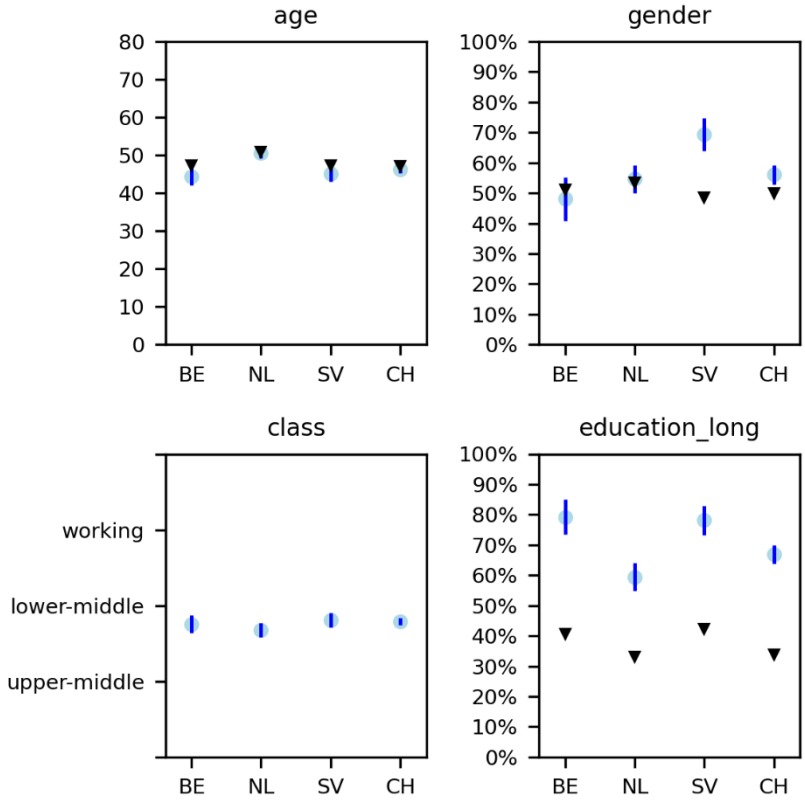


Figure 2: Boxplot of age and subjective class.

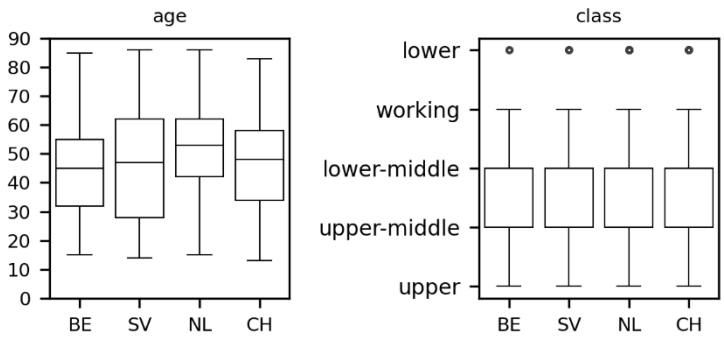
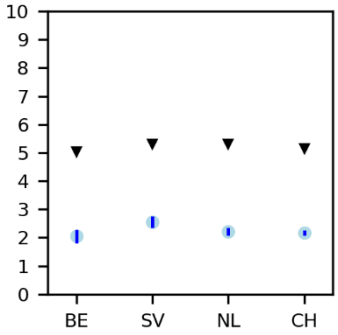


Figure 3 compares the left-right position of protesters and shows again very few differences between countries; protesters are leftist in all four countries and much more so than the average population (based on ESS data).

Figure 3: General left-right position of protesters. The blue dot shows the average response in the CCC-data on a 0-10 scale (0 being left, 10 being right, and 5 center). The black arrows show the average values of respondents in the ESS data, representing the general population.



Next, we look at the economic and cultural political values of our protesters in the four countries. Figure 4 presents the average agreement of respondents with the four key socio-economic and cultural left/right statements, disaggregated by country. Respondents generally agree with the idea of redistributing income from the better-off to those less well-off across all countries, with mean values exceeding 4. Minimal variation is observed, though the average agreement appears slightly lower in Switzerland compared to other countries. Conversely, agreement with the statement that public services and industries should be privatized is low, with mean values close to 1 across all countries. This indicates strong disagreement with this neoliberal principle, consistent with the left-leaning profile of the sample.

Support for allowing people from other countries to immigrate and live permanently is generally high, with mean values between 3.5 and 4.5. Belgium and Sweden show slightly higher levels of agreement than the Netherlands and Switzerland, though the differences are modest. Perhaps surprisingly, agreement with the statement that "children should be taught to obey authority" is relatively high; one would expect the opposite based on the previous question, as these two questions are supposed to represent the ends of the cultural scale. Moreover, there is moderate variation across countries, with values clustering around 3. Only Swedish protesters exhibit slightly lower agreement compared to those in other countries.

Overall, the results illustrate a relatively homogeneous profile among respondents across countries, with high agreement on redistributive and pro-immigration policies, strong rejection of privatization, and moderate variation in attitudes toward authority. These patterns are consistent with the general left-leaning tendencies observed in the dataset. The results of the boxplots for the same variables in Figure 5 confirm this, and show minimal variation in both the distribution across countries and within the respondents of a country. The pattern is what one would expect based on the leftist tendencies of the protesters.

Figure 4: Average agreement with cultural and socio-economic left/right values. The higher the value, the more they agreed with the statement. Redistribute refers to agreement with the question "Government should redistribute income from the better off to those who are less well off", privatisation to "Even the most important public services and industries are best left to private enterprise.", open immigration to "People from other

countries should be allowed to come to my country and live here permanently if they want to." and authority to "Children should be taught to obey authority."

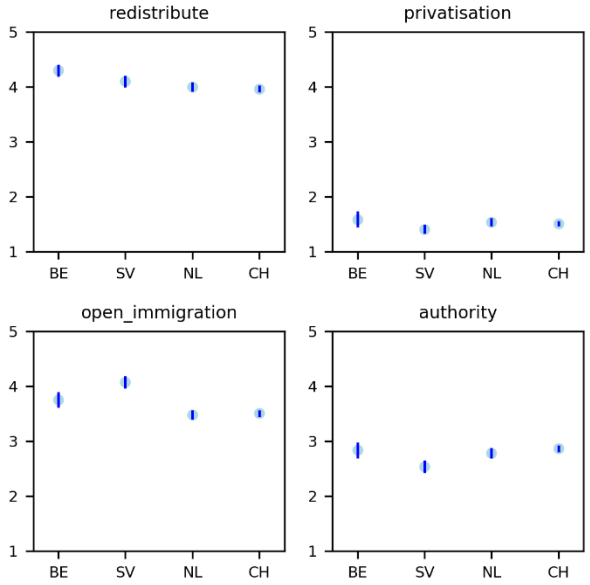
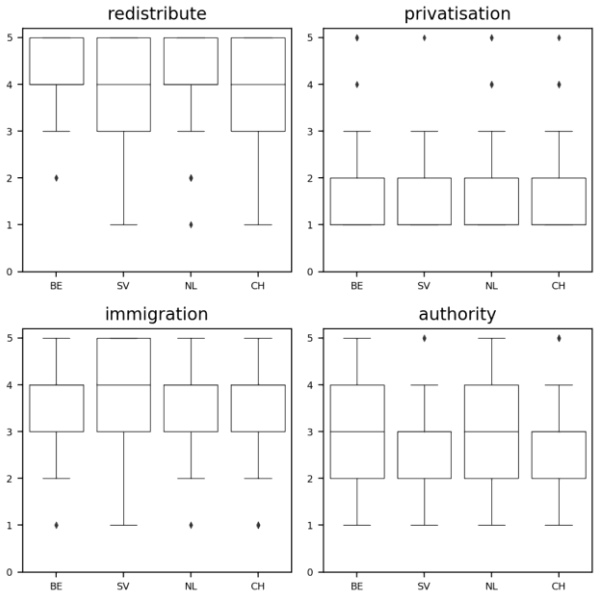


Figure 5: Boxplots for agreement with cultural and socio-economic left/right values. The higher the value, the more they agreed with the statement. Redistribute refers to agreement with the question "Government should redistribute income from the better off to those who are less well off", privatisation to "Even the most important public services and industries are best left to private enterprise.", open immigration to "People from other countries should be allowed to come to my country and live here permanently if they want to." and authority to "Children should be taught to obey authority."



Finally, we discuss the responses to the variables asking about emotions related to nuclear energy. Figure 6 shows the averages of the protesters' answers by country. The levels of anger and worry are consistently high across all countries, with mean scores above 4, indicating widespread emotional engagement. Fear, while slightly lower on average, still shows moderate intensity, with scores ranging from approximately 3 to 4. Frustration mirrors the trend of anger and worry, with mean values clustering

around 4 across all countries. There is limited variation between countries, although minor differences can be observed, such as slightly lower fear scores in the Netherlands and Switzerland compared to Belgium and Sweden. Overall, the responses demonstrate that respondents experience intense emotional reactions, particularly worry and frustration, with fear somewhat less pronounced.

The second plot presents boxplots for the same emotional responses—anger, worry, fear, and frustration—across the same countries. These boxplots highlight the variation in responses within each country. For anger and worry, the interquartile range is relatively narrow, indicating consistently high levels of emotional intensity among respondents. Fear exhibits a broader range of responses, particularly in Sweden, where the interquartile range spans from moderate to high levels of fear. Similarly, frustration shows some variation, although most are somewhat frustrated. Despite these variations, the general trend remains one of high emotional intensity across all countries, with a consistent clustering of responses in the upper part of the scale for anger, worry, and frustration.

Figure 6: Average intensity of emotions of CCC respondents when thinking about the issue

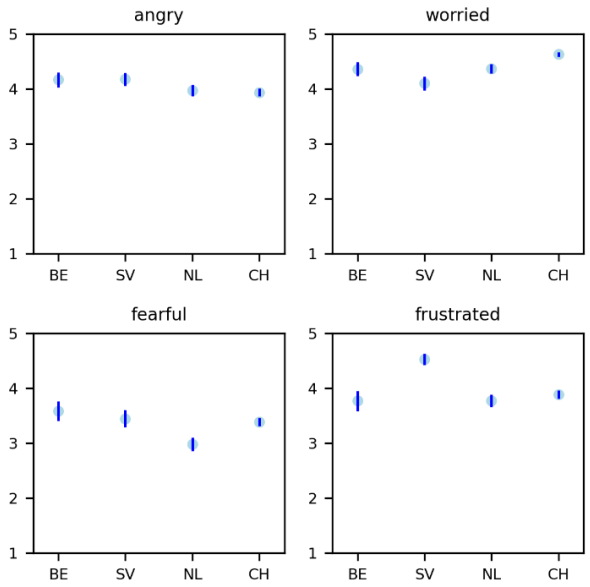
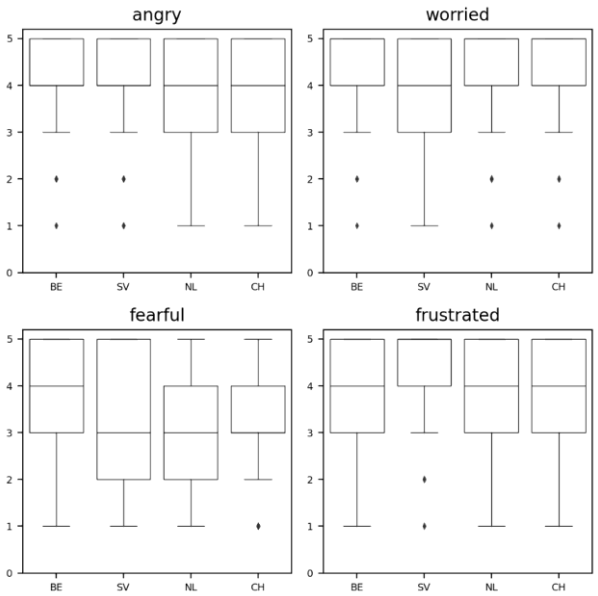


Figure 7: Boxplots that show the distribution of the answers to the questions that ask respondents how angry/worried/fearful/frustrated they feel when thinking about the issue.



4.1.1.2 Open questions

Finally, we examine the three open questions in the CCC data, listed in Table 5, with the number of missings and the average length of each answer. The responses to these questions were translated into English within the CCC project.

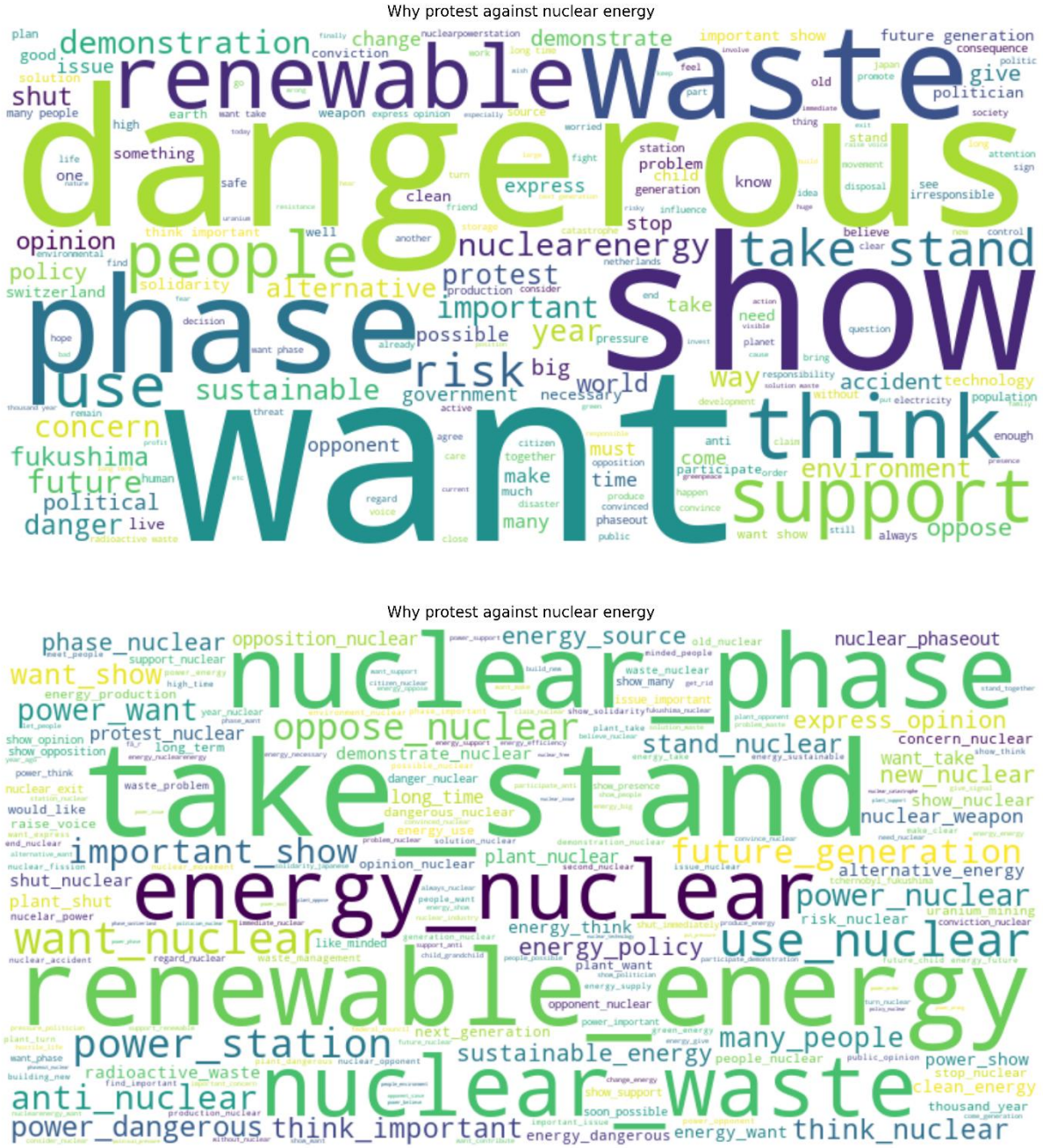
Table 5: Overview of the open questions and their descriptives

Survey question	Number of missings	Average number of characters
Please tell us why you participated in this protest event?	5 (0.27%)	89.83
In your opinion, who or what is to blame for [the demonstration's/issue]?	5 (0.43%)	42.48
What should be done to address this issue?	23 (1.24%)	51.05

4.1.1.2.1 The reasons protesters are protesting

Based on the word clouds, four themes arise. First, people came to the protest to express their opinions and take a stand against nuclear power. Second, unsurprisingly, a clear anti-nuclear expression is present; people are demanding a nuclear phase-out. Third, people mention renewable energy and alternatives. Lastly, people mention safety concerns, referring to (nuclear) waste, risks, or a general remark that nuclear energy is dangerous.

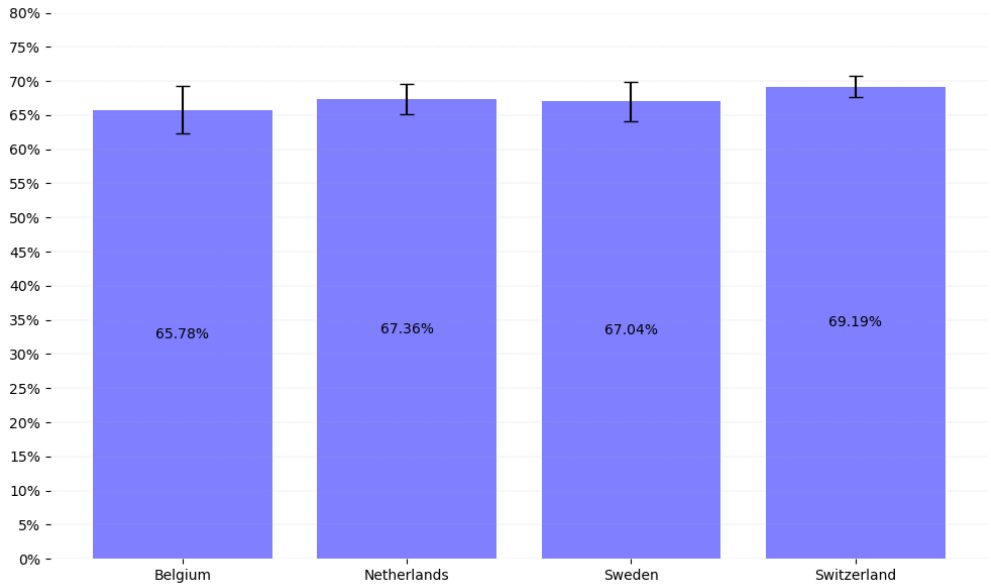
Figure 8: Wordcloud based on lemmatised responses to the question why respondents came to the nuclear energy protest. The first word cloud is based on single words, the second on bigrams, and the third on trigrams.



Given that the first theme is inherent to the idea of protesting, we leave it out of our analysis of why people came to protest against nuclear energy; we are specifically interested in themes related to nuclear energy hand. We annotated our data with the three remaining themes in mind. We compare the results between our four countries in the Figures below. Keep in mind that the issue in Belgium was slightly different, as the central issue of the protest was the lack of a nuclear phase-out, whereas, in other countries, the issue was the use of nuclear energy in society. However, given that the solution to the use of nuclear energy is a nuclear phase-out, one may expect responses to this question to be comparable across countries.

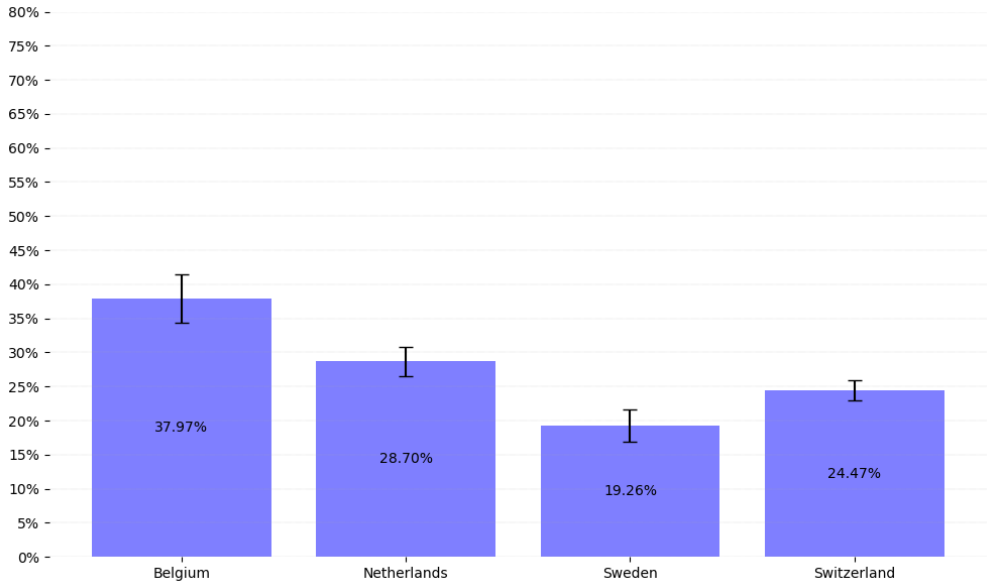
First, unsurprisingly, a large part (65%) of the protesters in all countries explicitly mention being against nuclear energy. If this theme was not present, it may be that respondents, for example, just mentioned the use of renewables without explicitly mentioning that they oppose nuclear energy. Of course, by being at the protest, this is already implicitly the case.

Figure 9: The share of respondents, disaggregated by country, whose response to the question of why they protest referred to a general opposition against nuclear energy. Vertical lines show 95% confidence intervals.



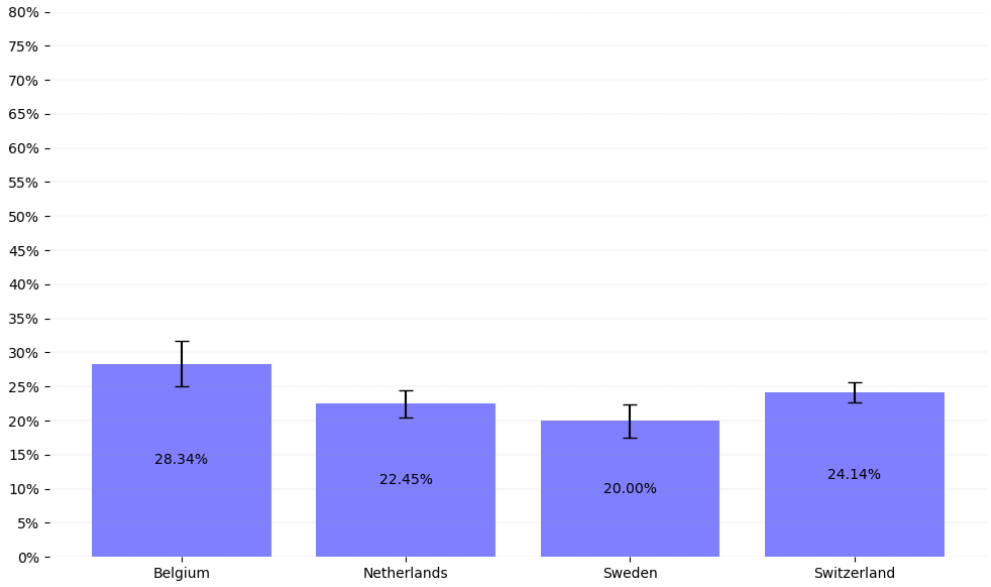
Second, in Figure 10, we see differences regarding safety concerns. This frame is primarily present in Belgium (37.97%), which makes sense given that the demonstration's name was "Fukushima never again". However, there are significant differences between the other three countries as well, so it is not only the framing of the demonstration that impacts what is on the top of respondents' minds. The issue is prominent in the Netherlands, where 28.70% of the respondents mention safety concerns, versus only about 24.47% of the respondents in Switzerland and 19.26% in Sweden.

Figure 10: The share of respondents, disaggregated by country, whose response to the question of why they protest referred to nuclear waste, risks, and other safety concerns. Vertical lines show the 95% confidence intervals.



Finally, in Figure 11, we illustrate how often respondents mention renewables and clean energy. This theme is about as present as the safety concerns, with a range of 20%-30% of respondents mentioning it. Again, there are some differences between countries, but in this case, they are small. Belgium respondents mention it significantly more often (28.34%) than those in the Netherlands (22.45%) and Sweden (20%) – the difference with Switzerland (24.14%) is not significant.

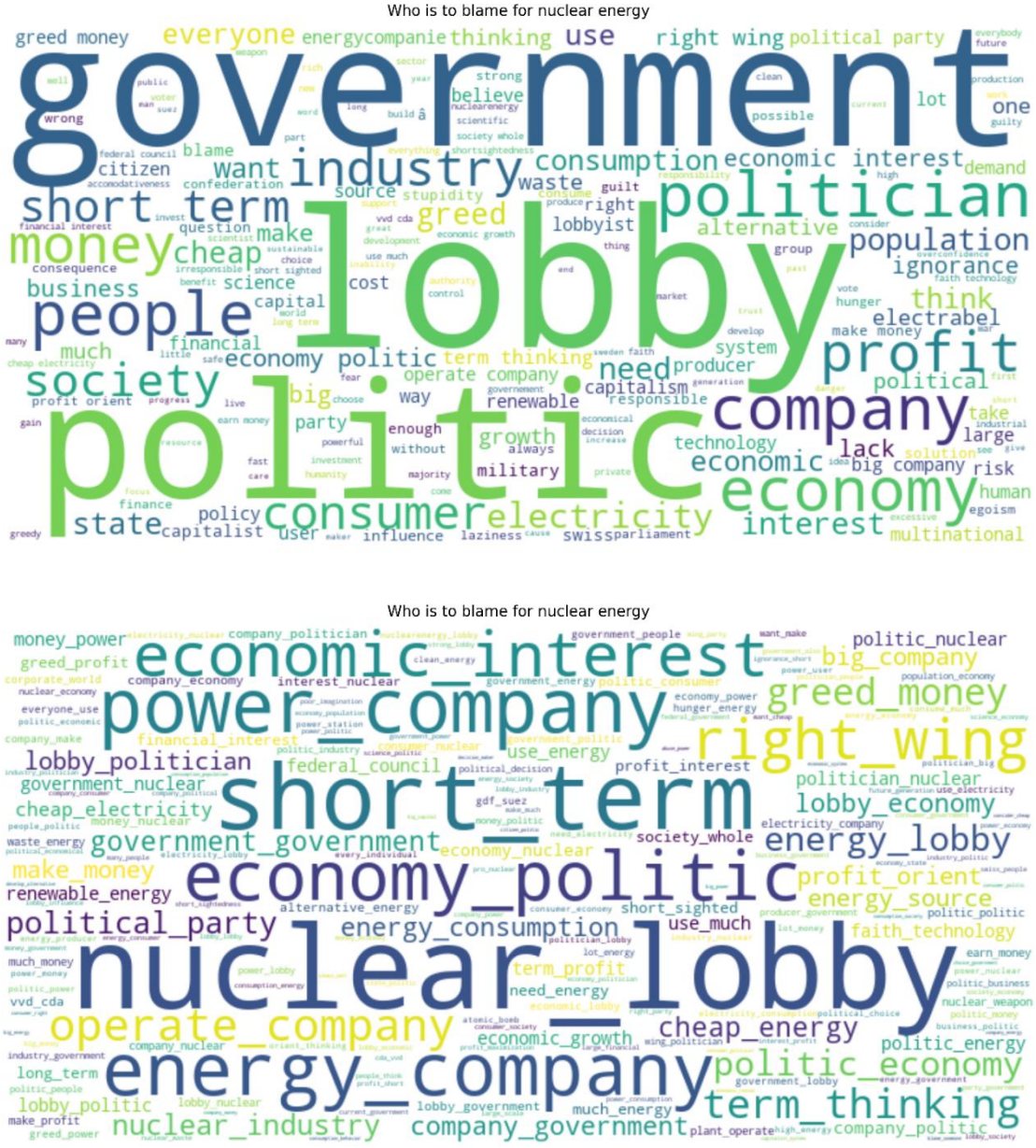
Figure 11: The share of respondents, disaggregated by country, whose response to the question of why they protest referred to sustainable and clean energy policies. Vertical lines show 95% confidence intervals.

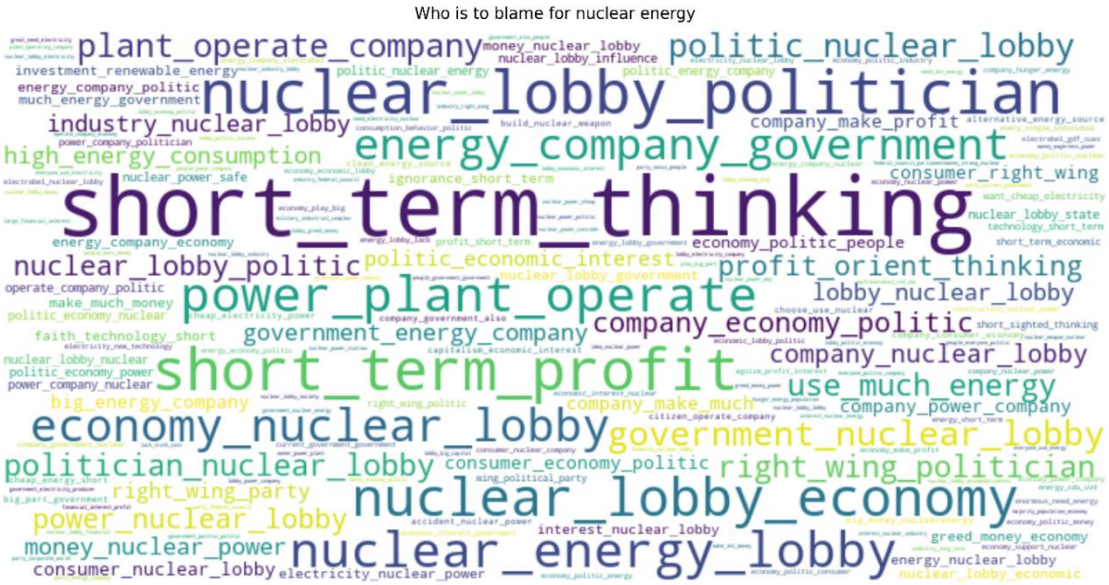


4.1.1.2.2 Who protesters think is to blame for the use of nuclear energy

The word cloud for the question "who is to blame" (Figure 12) shows that protesters blame short-term thinking, which may be also linked to cheap energy and greed, economic powers like energy companies and the nuclear industry, and political powers like the nuclear lobby, right wing, and political parties. Many bigrams also combine economics and politics, for example, "economy_politic", "lobby_economy", and "company_government". This also shows the entanglement of the different themes: they are all related to criticism of an economic and political system, one that supposedly allows nuclear energy to flourish.

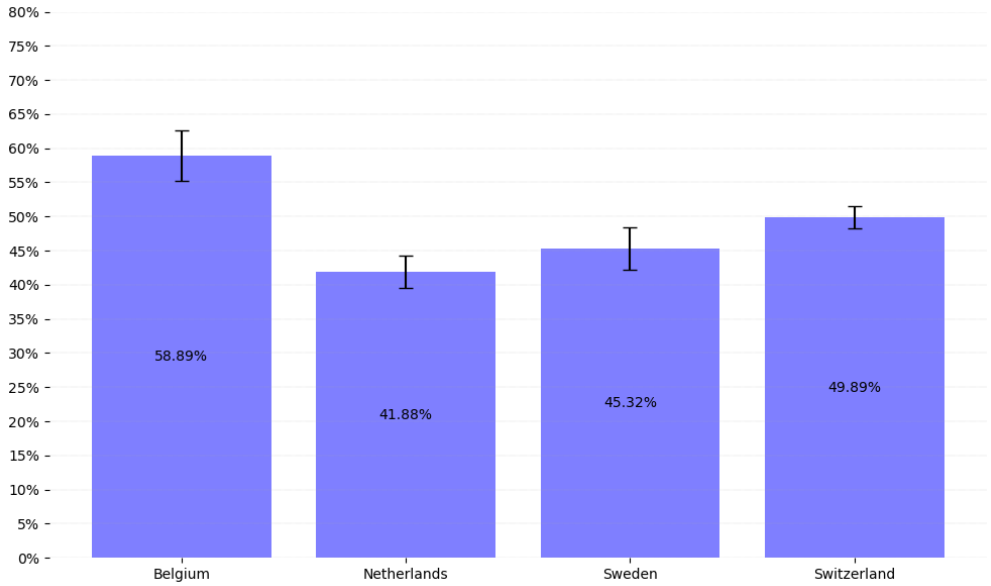
Figure 12: Wordcloud based on the bigrams of lemmatised responses to the question of who nuclear energy protesters think is to blame for using nuclear energy or the lack of a phase out.





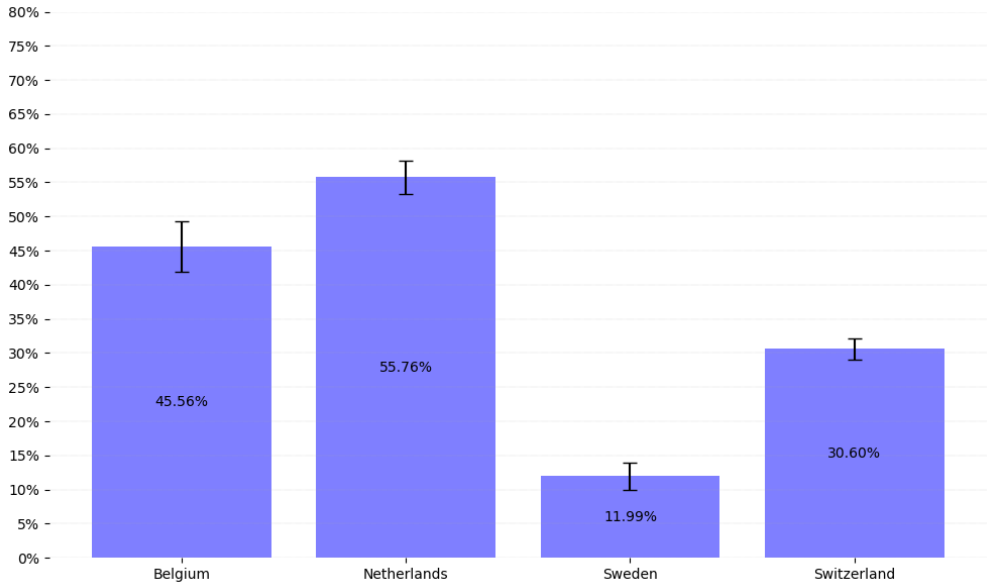
As in the previous section, we now present how often each theme was present in the responses of our respondents, by showing the proportion of each theme per country. The results reveal some cross-national variation in attributing blame to economic powers and profit motives. Belgium exhibits the highest proportion of respondents (58.89%) attributing blame, standing out as the only country where the majority hold this view. This suggests a heightened public critique of economic structures in Belgium compared to the other countries. This may also be related to the issue at hand, which was the holdup of the nuclear phase- out. In contrast, the Netherlands reports the lowest share (41.88%), with a significant gap compared to Belgium. Sweden (45.32%) and Switzerland (49.89%) display intermediate levels of blame attribution and do not differ significantly.

Figure 13: The share of respondents, disaggregated by country, whose response to the question of who they blame for the issue referred to economic powers or profit motives. Vertical lines show 95% confidence intervals.



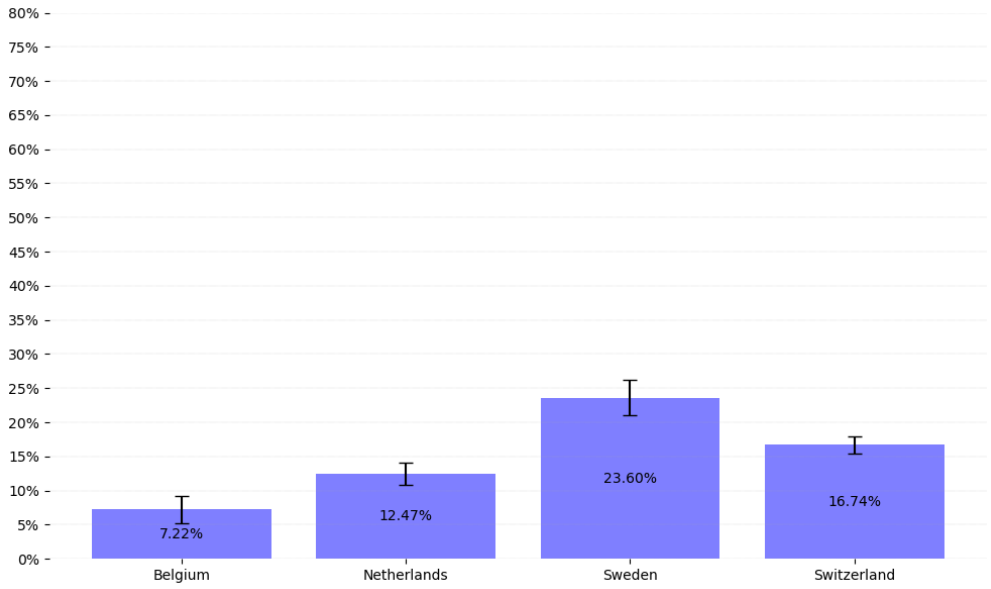
The second theme, where respondents put blame on politics (including politicians and political parties) and the government, shows the most variation between countries. Especially striking is the very low result in Sweden; only 12% of the respondents think that politics and the government are to blame for the use of nuclear energy. This is lower than the blame they put on economic powers. This is also the case for Switzerland, where about 31% of the respondents blame politics and government, versus 50% blaming economic powers, and for Belgium, where 46% blame politics and government compared to 59% blaming economic powers. Only in the Netherlands we see a reversed situation, as more than half of the respondents, 56%, blame politics and government, versus only 42% blaming economic powers.

Figure 14: The share of respondents, disaggregated by country, whose response to the question of who they blame for the issue referred to politics and the government. Vertical lines show 95% confidence intervals.



The results of the above two plots thus show that many point to systemic factors for the use of nuclear energy, which makes sense as nuclear energy is highly regulated and a consequence of energy policy. On the other hand, our final theme looks at individual blame and the culture in which one lives. Figure 15 shows the results. Interestingly, in Sweden this theme is the most common across all countries, with 23.60% of the respondents blaming culture and consumption for the use of nuclear energy. This is higher than the blame they put on the government or politics, which is somewhat counterintuitive given the issue. For the other three countries, the results are lower – especially for Belgium, which may again be related to the issue being questioned, as one may be less likely to blame culture or individual consumption for the holdout of a nuclear phase-out, which may be perceived more as a political issue.

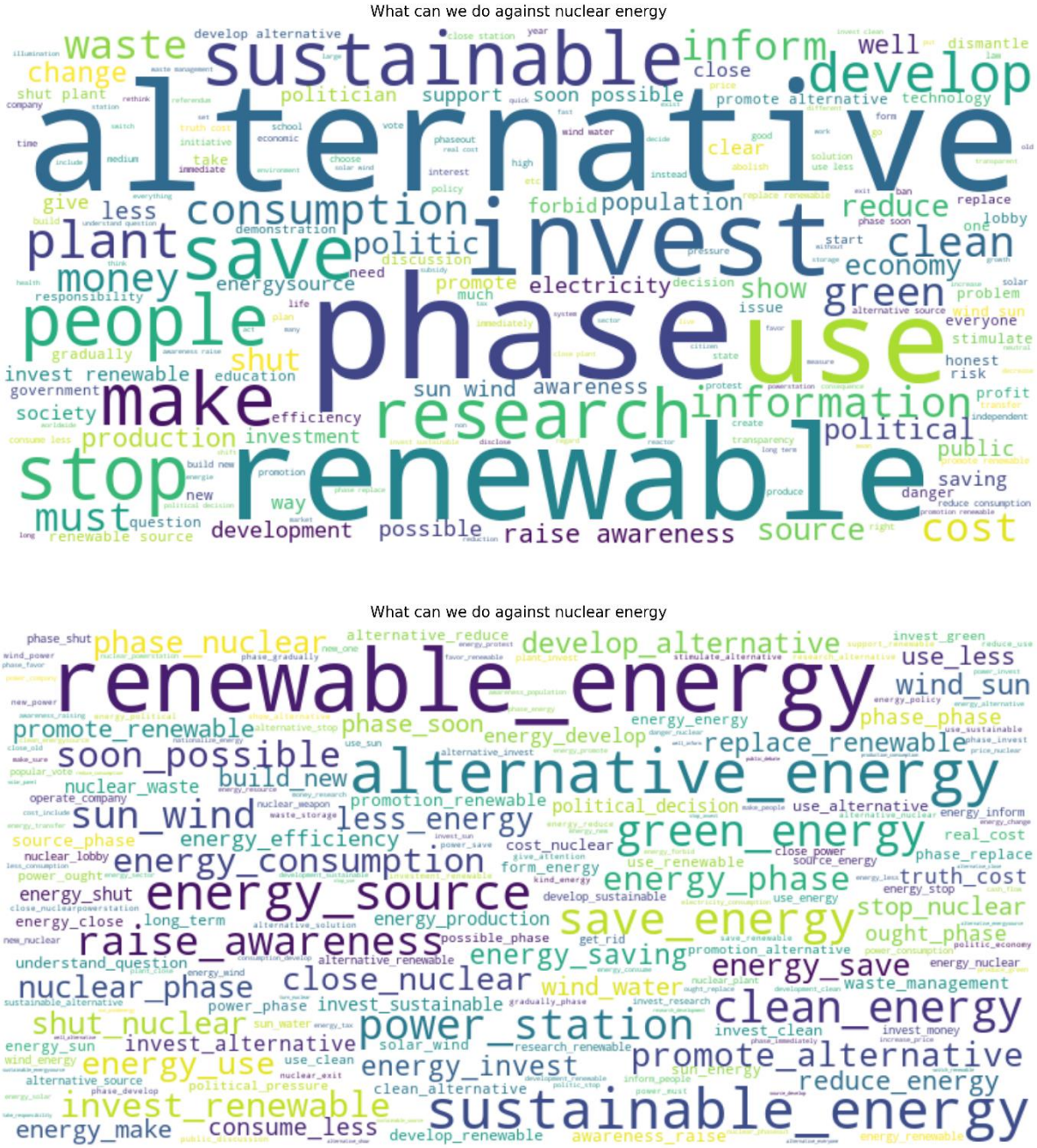
Figure 15: The share of respondents, disaggregated by country, whose response to the question of who they blame for the issue referred to culture and consumption. Vertical lines show 95% confidence intervals.

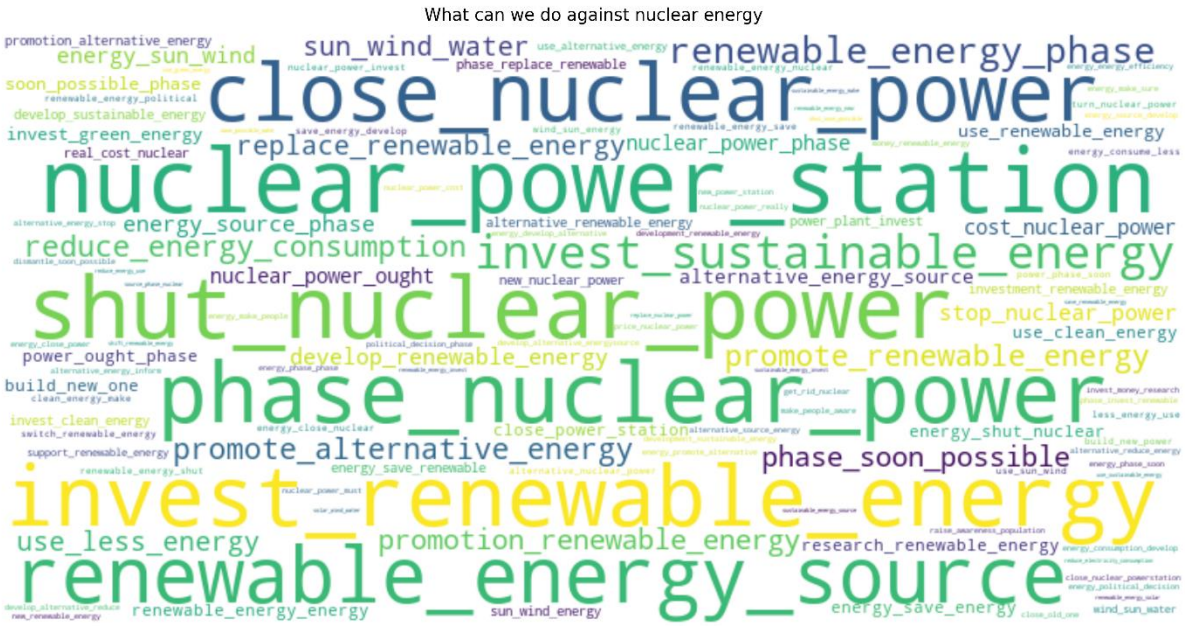


4.1.1.2.3 What protesters think should be done about the issue

Finally, we examine the responses to the question of what respondents think should be done about the issue. Again, Belgium is somewhat different from the other countries, as respondents were asked what they think should be done *about the delay of the nuclear phase-out*, whereas the others were asked what they think should be done *about the use of nuclear energy*. Based on the word clouds, we can distinguish four main themes. First, of course, is the nuclear phase-out. Second, many point to investing, promoting, and developing renewables and other clean energy sources. Third, there are references to changing our ways and reducing energy consumption. Potentially related to this, some mention increasing energy taxes and prices. Finally, protesters believe that raising awareness and providing better and more honest information and education may prevent the use of nuclear energy. Importantly, this implies that these respondents think nuclear energy is dangerous and that the information currently being disseminated is dishonest or, at the very least, misleading.

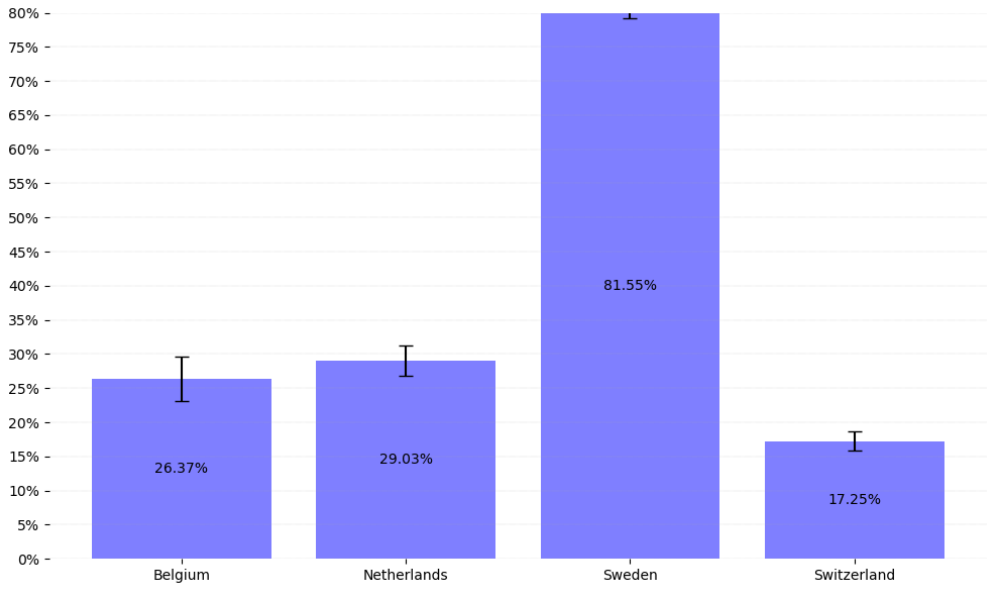
Figure 16: Wordcloud based on lemmatised responses to the question what nuclear energy protesters think should be done to address the use of nuclear energy.





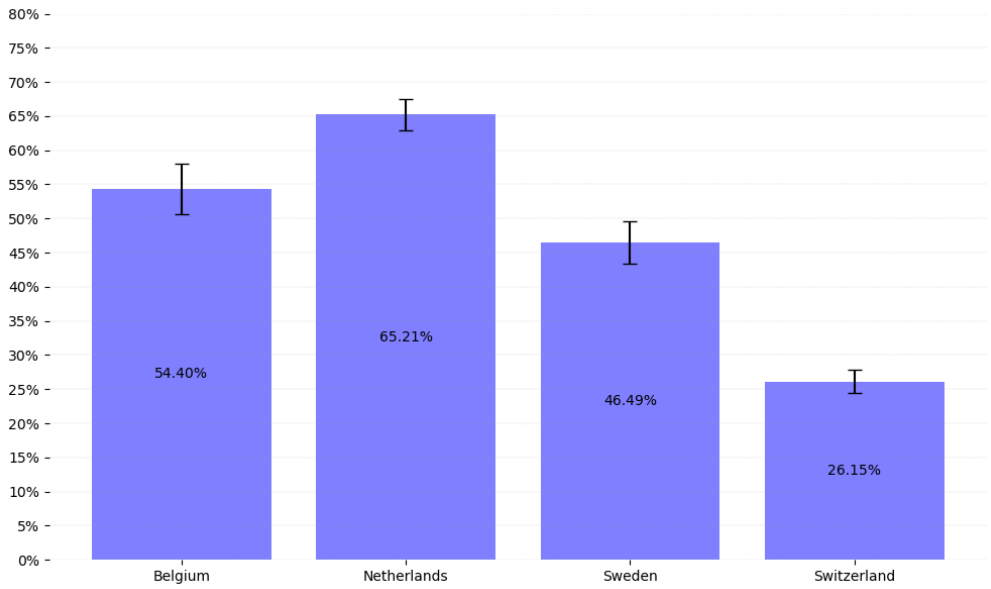
We first look at the number of respondents explicitly referring to a nuclear phase-out. Interestingly, the call for a nuclear phase-out is much more prominent in Sweden, where 81.55% refer to it, than in the other three countries. However, these results do not suggest that the other people do not want a nuclear-phase. Given that the respondents were protesting against nuclear energy, it seems likely that most of them would like to see a nuclear phase-out but may not explicitly mention it in their response. Especially in Belgium, the postponement of the phase-out was the issue being discussed; as such, it would be unusual for a nuclear phase-out to be a solution.

Figure 17: The share of respondents, disaggregated by country, whose response to the question of what should be done referred to (enforcing) a nuclear phase-out. Vertical lines show 95% confidence intervals.



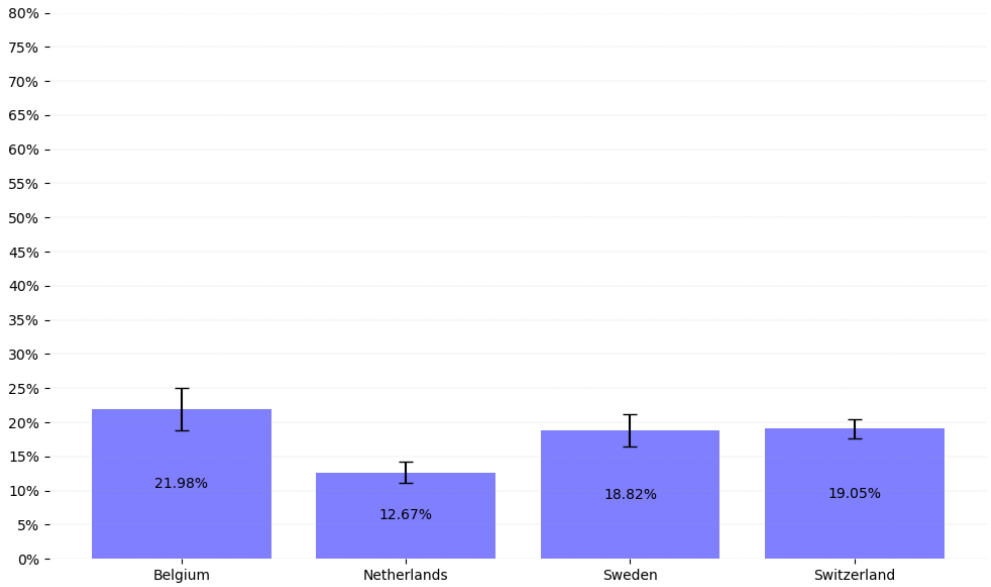
Next, we discuss how often respondents mention the promotion of renewables and clean energy policies as a solution. These references can be very broad, ranging from investing in new batteries to advocating for clean energy policies (that exclude nuclear energy as a clean energy source). There are, again, significant differences between countries. In the Netherlands and Belgium, more than half of the respondents, respectively 65.21% and 54.40%, refer to clean energy or alternative energy sources to help move away from nuclear energy. In Switzerland, on the other hand, only about a fourth of the respondents, 26.15% mentioned this. Also in Sweden, renewables seem like a good alternative for many protesters, as 46.49% of them mention them.

Figure 18: The share of respondents, disaggregated by country, whose response to the question of what should be done referred to promoting and investing in renewables and clean energy policies. Vertical lines show 95% confidence intervals.



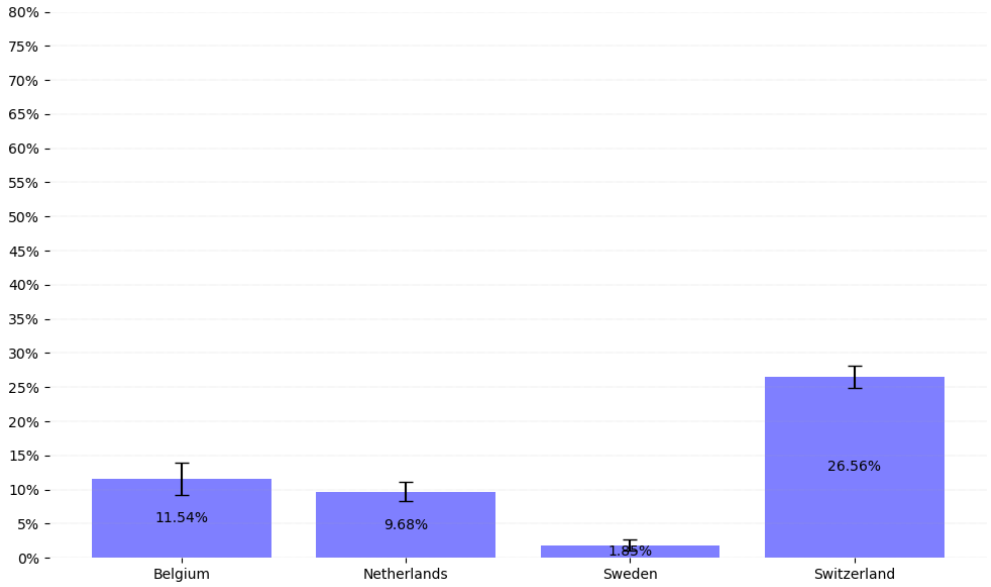
Next, some of the protesters also see changing behavior as a solution. This may refer to reducing energy consumption at an individual level by consumers but also at a societal level, such as by companies or public agencies. It also includes people suggesting higher taxes on the use of energy, which is a way of making people consume less or make the high consumers pay. The responses across countries do not vary much; in Belgium, Sweden, and Switzerland, around 19%-22% of the protesters mention this as a way of changing the use of nuclear energy or enforcing a phase-out in the case of Belgium. In the Netherlands, significantly less respondents (12.67%) mentioned this as a solution. Interestingly, these results are not entirely in line with the responses to the question of who is to blame. In Belgium, fewer people blamed individuals than in the Netherlands, but they do see individuals more likely to change the use of nuclear energy compared to the Netherlands. Even if the phrasing if different, if someone is to blame, one would expect that those to blame are also those who can solve it.

Figure 19: The share of respondents, disaggregated by country, whose response to the question of what should be done referred to changing behavior at an individual level. Vertical lines show 95% confidence intervals.



Finally, we examine how often respondents mention that informing and educating the public on nuclear energy will help reduce the use of nuclear energy or enforce a nuclear phase-out. This is somewhat ironic, as good communication and stakeholder involvement is often seen as a way of increasing public acceptance of nuclear energy. Compared to the other themes, this one is relatively uncommon. The exception is Switzerland, where about 26.56% of the people mention it. In Switzerland, it is also the most common theme. In Sweden, however, it is hardly mentioned (1.85%). Also in Belgium and the Netherlands it is relatively rare and the least common theme, used in about 9-12% of the responses.

Figure 20: The share of respondents, disaggregated by country, whose response to the question of what should be done referred to educating the public and honest information. Vertical lines show 95% confidence intervals.



4.1.1.3 Conclusion

The results of the socio-demographic profiles of protesters from Belgium, Germany, Switzerland, Sweden, and the Netherlands show that protesters typically share similar demographic characteristics: they are predominantly highly educated, politically left-leaning, middle class, and disproportionately female. They exhibit strong emotional engagement with their cause, driven by significant concern over nuclear safety and environmental risks.

The framing employed by anti-nuclear protesters consistently emphasizes the dangers associated with nuclear waste, safety concerns, and the environmental impacts of nuclear energy. Blame is primarily attributed to economic interests, political institutions, and governance structures, which are perceived to be prioritizing short-term economic gains over long-term environmental sustainability. Proposed solutions strongly advocate for phasing out nuclear energy, increasing investments in renewable and clean energy sources, encouraging reduced energy consumption, and enhancing public education and transparency about nuclear issues.

When compared to climate change protesters, as documented in existing literature, notable similarities arise. Both groups share comparable socio-demographic characteristics—young, well-educated, leftist, and largely female—and employ similar framing strategies that emphasize environmental risks, critique existing economic and political systems, and advocate for sustainable policy solutions.

Overall, these findings highlight the strong alignment between anti-nuclear and climate change protesters regarding their socio-demographic profiles and collective action frames, reinforcing the interconnectedness of their environmental and societal concerns.

4.1.2 Environmental protests in the UK

4.1.2.1 The context of nuclear in the UK

Although there has been flux in UK nuclear policy over recent decades, there is currently a plan to increase the share of energy from nuclear, ramping up significantly by 2050. The plan involves new large nuclear plants, small modular reactors and advanced modular reactors. SMR development in particular has experienced a political push in the UK. Advocating the need for nuclear in the UK net zero strategy, but with doubts on the commercial viability of conventional nuclear power plants (especially high capital costs), the UK government is seeking to foster the development of SMRs. The merits of the business case on which SMRs are based, one that sees a shift from the economy of scale (fewer larger units) to the economy of numbers (more smaller units built in factories), are still questioned: '*There comes this idea of 'small is beautiful'. […] We say 'let's make small reactors', which are more expensive per unit, but we will produce them in an automatised fashion in factories, the number will enable to reach the economic optimum. […] But to build a factory, you need a lot of orders*' (Interviewee 1, lines 45-50). '*The relative economics of an SMR production remains unproven until very many SMR units have been produced, which can't happen until you have a very full order book*' (Interviewee 2, lines 289-291). Although SMR developers and proponents talk of this technology with conviction and the certainty that it will happen, the theoretical stage which SMR technologies occupy do not allow the practical assessment of their merits: '*it's difficult to distinguish sometimes between the PR for SMRs and the reality of SMRs*' (Interviewee 2, lines 170-171).

In a context where the debate over the failed historical promises of nuclear power runs unabated, and where new promises are being made, critics of SMR question the viability of the programme. Moreover, any delay in delivering expectations will have an impact on the need for climate change mitigation. '*How can SMRs help with climate when in fact, they're still in development and any of their first deployment, .. may come into the late 2030s […] Whether you like nuclear, whether you don't like nuclear, whether you like SMRs, whether you don't like SMRs, in terms of practicality, unfortunately, in terms of climate, they will be too late*' (Interviewee 2, lines 653-659).

It was in this context that ECOSENS collaborated with a related project at UNEXE to study the views of participants in environmental mass protests.

4.1.2.2 Demographics

Participants to the Big One protest came from a variety of age groups: under 25 (11%); 25-34(18.7%); 35-44 (15.4%); 45-54 (17.3%); 55-64 (22.6%); over 65 (15%) (see Saunders et al., 2024: 17). Participants were also highly educated (85% had or were studying for a degree). In total, participants named 55 different organisations of which they were members. The most frequently mentioned organisations are Extinction Rebellion (41.2% are members of a local or national XR group), Greenpeace (12.9%), Friends of the Earth (3.5%) and Just Stop Oil (2.9%). Information on political leanings was also collected, enabling some description of how personal political positions related to views on energy futures.

4.1.2.3 Headline Findings

The outcome of analysis of the four questions specifically relating to nuclear issues showed that:

- 58.9 % of respondents expressed concern regarding nuclear energy, 17.3% did not have an opinion, 17.6% did not have concerns, 6.2% did not respond.
- 62% of respondents thought nuclear power plants were dangerous for the environment, 16.3% thought the opposite, 15.2% did not have an opinion, and 6.4% did not respond.
- 29.3% expressed concern about the economics of nuclear power. 58.7% expressed concern about radioactive waste management.
- In regard to nuclear power plant sizes and scale of deployment, the political 'extreme left' and 'left' are both widely in favour of a few larger plants in a few locations, while respondents in the 'centre' group show a slim preference for multiple smaller plants in multiple locations.
- Older participants (45 and older) expressed significantly more concerns regarding nuclear energy then younger respondents.
- For the sake of climate change mitigation, what are commonly described as the 'four nuclear problems' (risk of a major nuclear accident, issues with radioactive waste management, financial concerns, proliferation risk) are deemed mostly acceptable by younger respondents (below 45) while they are deemed mostly unacceptable by older participants (above 45)
- Those who affiliate with the Liberal Democrats or who place themselves at the centre of the 'left-right' political spectrum tended to be less concerned with nuclear energy than those who identify with the Labour and Green parties (or as being left or extreme left).
- Those who identify as 'Green' do not think in majority that the four nuclear problems are worth taking even in the pursuit of climate change mitigation; those who identify as 'Liberal democrats' think they are worth taking; those who identify as 'Labour' are divided.
- Radioactive waste management is the issue that raises most concern across all participants.

4.1.2.4 Conclusions

In the UK, age was evident as a key differential in informing opinions in relation to nuclear energy. This was the case across several dimensions, such as overall level of concern, worry about accidents and financial costs of nuclear. A concern about radioactive waste management was evident across all age groups.

Despite significant concerns expressed towards the four nuclear problems that were surveyed (risk of a major nuclear accident, issues with radioactive waste management, financial concerns, proliferation risk), overall participants' perception towards their acceptability for the pursuit of climate change mitigation is not clear-cut. While 34% of respondents do not think these issues are acceptable, 26.5% think otherwise and 26.9% have not made up their minds. However, looking at this question according to age categories, differing views become evident. While a majority of respondents from older age groups (45 and older) believe that the nuclear problems listed are not worth it, younger age groups believe that climate change mitigation is worth these risks. Moreover, two patterns can be clearly identified. The acceptability of nuclear risks decreases with age; the unacceptability of nuclear risks increases with age.

While those identify as 'Green' on the political spectrum do not consider it worth it in a majority to accept the possible nuclear problems listed in order to tackle climate change (45.5%), both 'Labour' and 'none' respondents are more reserved, with no clear indication of a preference (similar percentages of 'yes' and 'no') and an important share of uncertainty ('I am not sure'). However, here again Liberal Democrats stand out, with a large majority (65%) who consider that climate change mitigation is worth taking the nuclear risks listed.

The results point to some interesting aspects on nuclear views of members of environmental protest groups. The survey was relatively small scale in application and the findings suggest further research is needed.

5 Final remarks

The two survey studies conducted within the project, examining attitudes towards nuclear energy among protesters in Belgium, Germany, Switzerland, Sweden, the Netherlands, and the United Kingdom, provide several key insights.

Firstly, the demographic and ideological profiles of anti-nuclear protesters across these countries are notably consistent, with respondents typically being highly educated, politically left-leaning, and concerned about environmental and safety risks associated with nuclear energy. Moreover, they express strong emotional responses, including anger, worry, and frustration.

Secondly, common framing strategies emerge among anti-nuclear protesters, notably emphasizing the risks associated with nuclear waste management and nuclear safety. The dominant diagnostic frames used by protesters attributes blame to economic interests, political powers, and governance structures that are perceived as prioritizing profit or short-term gain over environmental and societal welfare. The prognostic frames that are used, i.e., the solutions advocated by protesters, include phasing out nuclear energy but also promoting renewable energy alternatives and changing consumption, alongside calls for better public education and more transparent communication about nuclear risks.

Comparatively, these findings align closely with characteristics identified in climate change protesters, as indicated in the literature. Both groups exhibit similar demographic profiles—typically young, highly educated, leftist, and predominantly female. Moreover, the shared framing strategies highlight a common narrative around environmental threats, emphasizing the urgency of transitioning towards sustainable energy sources and critiquing economic and political structures perceived to obstruct such transitions.

Finally, the UK-focused survey adds nuance by highlighting generational differences. Younger respondents show greater openness to nuclear power as a viable, albeit cautious, solution for mitigating climate change compared to older respondents, who remain significantly more skeptical. Concerns over nuclear waste management are widespread and consistent across age groups, underscoring this as a universally salient issue.

In conclusion, the findings from both surveys illustrate substantial alignment in the core concerns and proposed solutions advocated by anti-nuclear and environmental protesters across multiple European contexts. These insights underscore the ongoing tension between public apprehension regarding nuclear risks and emerging considerations of nuclear power's potential role in achieving environmental and climate objectives. The generational divergence revealed in the UK highlights a critical area for future dialogue, emphasizing the need for inclusive public engagement that addresses both historical skepticism and contemporary climate imperatives.

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6 References

Arndt, C. (2023). Climate change vs energy security? The conditional support for energy sources among Western Europeans. *Energy Policy*, *174*, 113471. https://doi.org/10.1016/j.enpol.2023.113471

Asafu-Adjaye, J., Blomqvist, L., Brand, S., Brook, B., et al. (2015). An Ecomodernist Manifesto. http://www.ecomodernism.org/

Bain, P. G., & Bongiorno, R. (2020). It's not too late to do the right thing: Moral motivations for climate change action. *WIREs Climate Change*, *11*(1), e615. https://doi.org/10.1002/wcc.615

Benford, R., & Snow, D. (2000). Framing Processes and Social Movements: An Overview and Assessment. *Annual Review of Sociology*, *26*, 611–639.

Blühdorn, I., & Welsh, I. (2007). Eco-politics beyond the paradigm of sustainability: A conceptual framework and research agenda. *Environmental Politics*, 16(2), 185–205.

Boucher, J. L., Kwan, G. T., Ottoboni, G. R., & McCaffrey, M. S. (2021). From the suites to the streets: Examining the range of behaviors and attitudes of international climate activists. *Energy Research & Social Science*, *72*, 101866. https://doi.org/10.1016/j.erss.2020.101866

Brand, S. (2009). Whole Earth Discipline: An Ecopragmatist Manifesto. *Viking*.

Corner, A., Venables, D., Spence, A., Poortinga, W., Demski, C., & Pidgeon, N. (2011). Nuclear power, climate change and energy security: Exploring British public attitudes. *Energy Policy*, *39*(9), 4823–4833. https://doi.org/10.1016/j.enpol.2011.06.037

de Moor, J., Uba, K., Wahlström, M., Wennerhag, M., & De Vydt, M. (Eds.). (2020). *Protest for a future II: Composition, mobilization and motives of the participants in Fridays For Future climate protests on 20-27 September, 2019, in 19 cities around the world*. https://urn.kb.se/resolve?urn=urn:nbn:se:sh:diva-40271

Dempsey, J., & Ewing, J. (2011, May 30). Germany, in Reversal, Will Close Nuclear Plants by 2022. *The New York Times*. https://www.nytimes.com/2011/05/31/world/europe/31germany.html

Duffy, C. (2024, December 24). *AI bigwigs want to go all-in on nuclear. They also happen to be behind nuclear companies | CNN Business*. CNN. https://www.cnn.com/2024/12/24/tech/nuclear-energy-ai-leaders/index.html

Durdovic, M., Turcanu, C., Sala, R., Geysmans, R., López-Asensio, S., & Gonçalves, L. (2024). The outlooks of nuclear energy in society: Unraveling public attitudes in the context of climate and energy security challenges. *Progress in Nuclear Energy*, *174*, 105286. https://doi.org/10.1016/j.pnucene.2024.105286

European Social Survey European Research Infrastructure (ESS ERIC). (2023). *ESS6—Integrated file, edition 2.6* [Dataset]. Sikt - Norwegian Agency for Shared Services in Education and Research. https://doi.org/10.21338/ESS6E02_6

European Union. (2023). *Nuclear energy in the European Union*.

Flam, H., & Honda, H. (2021). Anti-nuclear movements in the US, Europe, and Asia. In M. Grasso & M. Giugni, *The Routledge Handbook of Environmental Movements* (1st ed., pp. 155–169). Routledge. https://doi.org/10.4324/9780367855680-13

Foley, J. A., Ramankutty, N., Brauman, K. A., et al. (2011). Solutions for a cultivated planet. *Nature*, 478(7369), 337–342.

Glaeser, E. (2011). Triumph of the City. *Penguin Press*.

Johnston, H., & Noakes, J. A. (Eds.). (2005). *Frames of protest: Social movements and the framing perspective*. Rowman & Littlefield Publishers, Inc.

Joppke, C. (1993). *Mobilizing Against Nuclear Energy: A Comparison of Germany and the United States* (Reprint 2019). University of California Press. https://doi.org/10.1525/9780520912526

Kitschelt, H. P. (1986). Political Opportunity Structures and Political Protest: Anti-Nuclear Movements in Four Democracies. *British Journal of Political Science*, *16*(1), 57–85. https://doi.org/10.1017/S000712340000380X

Klandermans, B. (2003). Collective political action. In O. Sears, L. Huddy, & R. Jervis (Eds.), *Oxford handbook of political psychology* (pp. 670–709). Oxford University Press.

Klandermans, B., van Stekelenburg, J., & Gaidyte, T. (2014). *Caught in the act of protest: CCC-project* [Dataset]. DANS Data Station Social Sciences and Humanities. https://doi.org/10.17026/DANS-ZWJ-GKEU

Koopmans, R., & Duyvendak, J. W. (1995). The Political Construction of the Nuclear Energy Issue and Its Impact on the Mobilization of Anti-Nuclear Movements in Western Europe*. *Social Problems*, *42*(2), 235–251. https://doi.org/10.2307/3096903

Kristiansen, S., Bonfadelli, H., & Kovic, M. (2016). Risk Perception of Nuclear Energy After Fukushima: Stability and Change in Public Opinion in Switzerland. *International Journal of Public Opinion Research*, edw021. https://doi.org/10.1093/ijpor/edw021

Kristof, N., (2005). I have a Nightmare, *The New York Times*. https://www.nytimes.com/2005/03/12/opinion/i-have-a-nightmare.html

Latour, B. (2014). Agency at the time of the Anthropocene. *New Literary History*, 45(1), 1–18.

Latour, B. (2015). Fifty Shades of Green, *Undisciplined Environments*. https://undisciplinedenvironments.org/2015/06/27/fifty-shades-of-green-bruno-latour-on-the-ecomodernist-manifesto/

Lynas, M., (2014). Nuclear 2.0: Why A Green Future Needs Nuclear Power, *Bloomsbury USA*.

Matthew Smith. (2021, October 18). *What role should nuclear play in Britain's climate change strategy? | YouGov*. YouGov. https://yougov.co.uk/politics/articles/38824-what-role-should-nuclear-play-britains-climate-cha

McCalman, C., & Connelly, S. (2019). Destabilizing Environmentalism: Epiphanal Change and the Emergence of Pro-Nuclear Environmentalism. *Journal of Environmental Policy & Planning*, *21*(5), 549–562. https://doi.org/10.1080/1523908X.2015.1119675

Memmott, T., Carley, S., & Konisky, D. (2021). Who participates in energy activism? Profiling political engagement in the United States. *Energy Research & Social Science*, *77*, 102095. https://doi.org/10.1016/j.erss.2021.102095

Mol, A. P. J., & Sonnenfeld, D. A. (2000). Ecological modernization around the world: An introduction. *Environmental Politics*, 9(1), 3–14.

Müller, W. C., Thurner, P. W., Müller, W. C., & Thurner, P. W. (Eds.). (2017). Nuclear Energy in Western Europe: Revival or Rejection? An Introduction. In *The Politics of Nuclear Energy in Western Europe* (p. 0). Oxford University Press. https://doi.org/10.1093/oso/9780198747031.003.0001

Parks, L. (2021). Framing environmental issues. In M. Grasso & M. Giugni, *The Routledge Handbook of Environmental Movements* (1st ed., pp. 405–418). Routledge. https://doi.org/10.4324/9780367855680-31

Pidgeon, N. F., Lorenzoni, I., & Poortinga, W. (2008). Climate change or nuclear power—No thanks! A quantitative study of public perceptions and risk framing in Britain. *Global Environmental Change*, *18*(1), 69–85. https://doi.org/10.1016/j.gloenvcha.2007.09.005

Polls find strong support for nuclear in UK and Switzerland. (n.d.). World Nuclear News. Retrieved January 31, 2025, from https://world-nuclear-news.org/articles/polls-find-strong-support-for-nuclear-in-uk-and-sw

Poortinga, W., Aoyagi, M., & Pidgeon, N. F. (2013). Public perceptions of climate change and energy futures before and after the Fukushima accident: A comparison between Britain and Japan. *Energy Policy*, *62*, 1204–1211. https://doi.org/10.1016/j.enpol.2013.08.015

Shellenberger, M., Nordhaus, T., (2004). The Death of Environmentalism – Global Warming in a Post Environmental World. *The Breakthrough Institute*. https://thebreakthrough.org/articles/the-death-of-environmentalism

Selje, T. (2022). Comparing the German exit of nuclear and coal: Assessing historical pathways and energy phase-out dimensions. *Energy Research & Social Science*, *94*, 102883. https://doi.org/10.1016/j.erss.2022.102883

Smil, V. (2010). Energy Transitions: History, Requirements, Prospects. *Praeger*.

Snow, D., Vliegenthart, R., & Ketelaars, P. (2018). The Framing Perspective on Social Movements. In *The Wiley Blackwell Companion to Social Movements* (pp. 392–410). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119168577.ch22

Sonnberger, M., Ruddat, M., Arnold, A., Scheer, D., Poortinga, W., Böhm, G., Bertoldo, R., Mays, C., Pidgeon, N., Poumadère, M., Steentjes, K., & Tvinnereim, E. (2021). Climate concerned but anti-nuclear: Exploring (dis)approval of nuclear energy in four European countries. *Energy Research & Social Science*, *75*, 102008. https://doi.org/10.1016/j.erss.2021.102008

Sovacool, B. K., Hess, D. J., Cantoni, R., Lee, D., Claire Brisbois, M., Jakob Walnum, H., Freng Dale, R., Johnsen Rygg, B., Korsnes, M., Goswami, A., Kedia, S., & Goel, S. (2022). Conflicted transitions: Exploring the actors, tactics, and outcomes of social opposition against energy infrastructure. *Global Environmental Change*, *73*, 102473. https://doi.org/10.1016/j.gloenvcha.2022.102473

Spence, A., Poortinga, W., Pidgeon, N., & Lorenzoni, I. (2010). Public Perceptions of Energy Choices: The Influence of Beliefs about Climate Change and the Environment. *Energy & Environment*, *21*(5), 385–407. https://doi.org/10.1260/0958-305X.21.5.385

Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. *Research Policy*, 42(9), 1568–1580.

Switzerland to scrap ban on building nuclear power stations. (2024, August 28). *Reuters*. https://www.reuters.com/world/europe/switzerland-scrap-ban-building-nuclear-power-stations-2024-08-28/

Szulecki, K., Waluszko, J., & Borewicz, T. (2022). *The Chernobyl Effect: Antinuclear Protests and the Molding of Polish Democracy, 1986–1990* (1st ed.). Berghahn Books. https://doi.org/10.3167/9781800736191

Turuban, S. B., Pauline. (2024, August 30). Could Switzerland build new nuclear power plants? *SWI Swissinfo.Ch*. https://www.swissinfo.ch/eng/swiss-politics/could-switzerland-build-new-nuclear-power-plants/87464326

UNEP (United Nations Environment Programme). (2011). Decoupling Natural Resource Use and Environmental Impacts from Economic Growth. https://www.resourcepanel.org/

Van Aelst, P., & Walgrave, S. (2001). Who is that (wo)man in the street? From the normalisation of protest to the normalisation of the protester. *European Journal of Political Research*, *39*(4), 461–486. https://doi.org/10.1111/1475-6765.00582

van Stekelenburg, J., & Klandermans, B. (2013). The social psychology of protest. *Current Sociology*, *61*(5–6), 886–905. https://doi.org/10.1177/0011392113479314

Verhulst, J. (2011). *Mobilizing issues and the unity and diversity of protest events*. https://hdl.handle.net/10067/973370151162165141

Visscher, M., Bodelier, R., et al., (2017). Ecomodernisme – Het nieuwe denken over groen en groei. *Nieuw Amsterdam*.

Wackernagel, M., Schulz, N. B., Deumling, D., et al. (2002). Tracking the ecological overshoot of the human economy. *Proceedings of the National Academy of Sciences*, 99(14), 9266–9271.

Wahlström, M., Wennerhag, M., & Rootes, C. (2013). Framing "The Climate Issue": Patterns of Participation and Prognostic Frames among Climate Summit Protesters. *Global Environmental Politics*, *13*(4), 101–122. https://doi.org/10.1162/GLEP_a_00200

Weg met de kernuitstap: Regering-De Wever "streeft" naar vier gigawatt nucleaire energie. (2025, February 1). De Standaard. https://www.standaard.be/cnt/dmf20250201_94735593

Wikipedia (2025). Ecomodernism. https://en.wikipedia.org/wiki/Ecomodernism

Whyte, K. P. (2017). Indigenous climate change studies: Indigenizing futures, decolonizing the Anthropocene. *English Language Notes*, 55(1–2), 153–162.

Wolfgang C. Müller & Paul W. Thurner (Eds.). (2017). *The Politics of Nuclear Energy in Western Europe* (Vol. 1). Oxford University Press. https://doi.org/10.1093/oso/9780198747031.001.0001

World Nuclear Association. (n.d.). *Nuclear Power in Belgium—World Nuclear Association*. Retrieved June 4, 2024, from https://world-nuclear.org/information-library/country-profiles/countries-a-f/belgium

World Nuclear Association. (2024, December 6). *Nuclear Power in the United Kingdom*. World Nuclear Association. https://world-nuclear.org/information-library/country-profiles/countries-t-z/united-kingdom

7 Appendices

Appendix A. Prompt for annotating answers to the question Why someone is protesting should be done

You are an expert at annotation and qualitative analysis and are tasked with analyzing open-ended survey responses about nuclear energy and sustainability.

Your goal is to identify whether any of the following three **topics** are present in each response.

For each topic, specify **Yes** (present) or **No** (not present), and provide a brief rationale.

Topics:

1. **Nuclear Waste and Safety Concerns**

- This topic focuses on concerns about nuclear waste, its dangers, and long-term risks (e.g., for future generations).

Keywords: nuclear waste, danger, dangerous, risks, future generations, anti-nuclear, harmful, toxic.

2. **Sustainable and Clean Energy Policies**

- This topic highlights discussions about sustainable energy policies, the role of renewable energy, alternative energy, and clean energy transitions.

Keywords: sustainable, clean energy, renewable, policy, energy transition, climate-friendly, solar, wind, green energy.

3. **General opposition to Nuclear Power Plants (NPPs)**

- This topic pertains to a general opposition to nuclear power plants, calls to shut them down, and not build any new ones.

Keywords: shut down, nuclear plants, NPPs, closure, opposed, opposition, anti-NPP, stop nuclear, phase out.

Instructions:

For each response:

1. Evaluate the text for the presence of each topic.

2. Annotate each topic as **Yes** (present) or **No** (not present).

3. Provide a **brief rationale** (1-2 sentences) explaining why you determined the topic is or is not present.

4. Return the annotations in **JSON format** as shown below.

Do not include any text or explanations in your answer besides the JSON object. If you include anything else, it will be rejected.

Format for Annotation (JSON):

```
{
  "survey_response": "[Insert survey response here]",
  "annotations": {
    "nuclear_waste_and_safety_concerns": {
      "present": "Yes/No",
      "rationale": "[Brief rationale]"
    },
    "sustainable_and_clean_energy_policies": {
      "present": "Yes/No",
      "rationale": "[Brief rationale]"
    },
    "opposition_to_nuclear_power_plants": {
      "present": "Yes/No",
      "rationale": "[Brief rationale]"
    }
  }
}
```

Examples:

```
{
  "survey_response": "I think nuclear waste is too dangerous for future generations. We should phase out nuclear energy completely.",
  "annotations": {
    "nuclear_waste_and_safety_concerns": {
      "present": "Yes",
      "rationale": "The response mentions 'nuclear waste', 'dangerous', and 'future generations', indicating safety concerns."
    },
    "sustainable_and_clean_energy_policies": {
      "present": "No",
```

```
      "rationale": "No mention of renewable energy, sustainability, or clean energy policies."
    },
    "general_opposition_to_nuclear_power_plants": {
      "present": "Yes",
      "rationale": "The phrase 'phase out nuclear energy' implies opposition to nuclear power."
    }
  }
}

{
  "survey_response": "We should focus on renewable energy sources like solar and wind to ensure a sustainable future.",
  "annotations": {
    "nuclear_waste_and_safety_concerns": {
      "present": "No",
      "rationale": "The response does not discuss nuclear waste or safety issues."
    },
    "sustainable_and_clean_energy_policies": {
      "present": "Yes",
      "rationale": "Mentions renewable energy ('solar and wind') and sustainability."
    },
    "general_opposition_to_nuclear_power_plants": {
      "present": "No",
      "rationale": "No mention of nuclear plants or shutting them down."
    }
  }
}

{
  "survey_response": "Nuclear plants are dangerous and should be shut down as soon as possible.",
  "annotations": {
    "nuclear_waste_and_safety_concerns": {
```

```
    "present": "No",
    "rationale": "While 'dangerous' is mentioned, the focus is on nuclear plants, not waste."
  },
  "sustainable_and_clean_energy_policies": {
    "present": "No",
    "rationale": "The response does not mention renewable or sustainable policies."
  },
  "general_opposition_to_nuclear_power_plants": {
    "present": "Yes",
    "rationale": "Explicitly states that nuclear plants should be 'shut down'."
  }
 }
}
```


Appendix B. Prompt for annotating answers to the question who is to blame for the issue

You are an expert at annotation and qualitative analysis and are tasked with analyzing open-ended survey responses about nuclear energy and sustainability.

Your goal is to identify whether any of the following three **themes** are present in each response.

For each theme, specify **Yes** (present) or **No** (not present), and provide a brief rationale.

Themes:

1. **Critique of Economic Powers and Profit Motives**

- This theme focuses on critiques of corporations, energy companies, or economic systems that prioritize profits over safety, sustainability, or public well-being.

Keywords: profit, greed, capitalist, monopoly, energy company, financial interest, nuclear industry, exploitation.

2. **Political Responsibility and Governance Issues**

- This theme highlights blame placed on governments, political leaders, or institutions for their role in nuclear energy policies or failures to act on phase-outs and sustainability.

Keywords: government, political party, policy, inaction, short-term thinking, lobbying, lack of courage, right-wing.

3. **Societal and Cultural Accountability**

- This theme relates to societal behaviors, such as overconsumption, wastefulness, or public complacency, as contributing factors to reliance on nuclear energy or unsustainable practices.

Keywords: overconsumption, materialism, waste, ignorance, societal behavior, complacency, cultural mindset.

Instructions:

For each response:

1. Evaluate the text for the presence of each theme.

2. Annotate each theme as **Yes** (present) or **No** (not present).

3. Provide a **brief rationale** (1-2 sentences) explaining why you determined the theme is or is not present.

4. Return the annotations in **JSON format** as shown below.

Do not include any text or explanations in your answer besides the JSON object. If you include anything else, it will be rejected.

Format for Annotation (JSON):

```
{
 "survey_response": "[Insert survey response here]",
 "annotations": {
  "critique_of_economic_powers_and_profit_motives": {
   "present": "Yes/No",
   "rationale": "[Brief rationale]"
  },
  "political_responsibility_and_governance_issues": {
   "present": "Yes/No",
   "rationale": "[Brief rationale]"
  },
  "societal_and_cultural_accountability": {
   "present": "Yes/No",
   "rationale": "[Brief rationale]"
  }
 }
```

}

Examples:

{

"survey_response": "The government and big energy companies only care about maximizing their profits, leaving citizens to bear the risks of nuclear energy.",

"annotations": {

"critique_of_economic_powers_and_profit_motives": {

"present": "Yes",

"rationale": "Mentions energy companies prioritizing profit over safety, highlighting economic motives."

},

"political_responsibility_and_governance_issues": {

"present": "Yes",

"rationale": "Blames the government for inaction and complicity with energy companies."

},

"societal_and_cultural_accountability": {

"present": "No",

"rationale": "Does not mention societal behaviors or public responsibility."

}

}

}

{

"survey_response": "We, as a society, waste energy and fail to think about the environmental consequences of our actions.",

"annotations": {

"critique_of_economic_powers_and_profit_motives": {

"present": "No",

"rationale": "No mention of economic actors or profit motives."

},

"political_responsibility_and_governance_issues": {

```
      "present": "No",
      "rationale": "Does not mention governments or political issues."
    },
    "societal_and_cultural_accountability": {
      "present": "Yes",
      "rationale": "Discusses societal waste and lack of environmental awareness."
    }
  }
}

{
  "survey_response": "The capitalist system exploits nuclear energy for profit while ignoring its long-term dangers to public safety.",
  "annotations": {
    "critique_of_economic_powers_and_profit_motives": {
      "present": "Yes",
      "rationale": "Explicitly criticizes capitalism and profit motives linked to nuclear energy."
    },
    "political_responsibility_and_governance_issues": {
      "present": "No",
      "rationale": "Does not directly reference governments or political actors."
    },
    "societal_and_cultural_accountability": {
      "present": "No",
      "rationale": "Does not discuss societal behaviors or cultural factors."
    }
  }
}

{
  "survey_response": "Governments fail to invest in renewable alternatives because they are influenced by powerful energy lobbies.",
  "annotations": {
```

```
  "critique_of_economic_powers_and_profit_motives": {
    "present": "Yes",
    "rationale": "Blames energy lobbies for hindering investments in renewable energy."
  },
  "political_responsibility_and_governance_issues": {
    "present": "Yes",
    "rationale": "Criticizes governments for inaction and being influenced by lobbies."
  },
  "societal_and_cultural_accountability": {
    "present": "No",
    "rationale": "Does not mention societal or cultural factors."
  }
 }
}

{
 "survey_response": "People are too reliant on cheap energy and unwilling to sacrifice for sustainable solutions.",
 "annotations": {
  "critique_of_economic_powers_and_profit_motives": {
    "present": "No",
    "rationale": "Does not mention economic powers or profit motives."
  },
  "political_responsibility_and_governance_issues": {
    "present": "No",
    "rationale": "Does not address political or governmental actors."
  },
  "societal_and_cultural_accountability": {
    "present": "Yes",
    "rationale": "Criticizes public reliance on cheap energy and lack of willingness to change."
  }
 }
```

```
}

{
  "survey_response": "Short-term thinking by policymakers allows energy companies to keep profiting from outdated nuclear plants.",
  "annotations": {
    "critique_of_economic_powers_and_profit_motives": {
      "present": "Yes",
      "rationale": "Blames energy companies for profiting from outdated plants."
    },
    "political_responsibility_and_governance_issues": {
      "present": "Yes",
      "rationale": "Criticizes policymakers for short-term thinking."
    },
    "societal_and_cultural_accountability": {
      "present": "No",
      "rationale": "Does not mention societal behaviors."
    }
  }
}

{
  "survey_response": "The nuclear lobby and multinational corporations prioritize financial gain over environmental health.",
  "annotations": {
    "critique_of_economic_powers_and_profit_motives": {
      "present": "Yes",
      "rationale": "Focuses on the financial motivations of the nuclear lobby and corporations."
    },
    "political_responsibility_and_governance_issues": {
      "present": "No",
      "rationale": "Does not address governmental or political responsibility."
    },
```

```
  "societal_and_cultural_accountability": {
    "present": "No",
    "rationale": "Does not mention societal or cultural factors."
  }
 }
}
```

Appendix C. Prompt for annotating answers to the question What should be done

""" You are an expert at annotation and qualitative analysis and are tasked with analyzing open-ended survey responses about nuclear energy and sustainability.

Your goal is to identify whether any of the following four **themes** are present in each response.

For each theme, specify **Yes** (present) or **No** (not present), and provide a brief rationale.

Themes:

1. **Phasing Out Nuclear Energy**

   - This theme focuses on stopping, phasing out, or closing nuclear power plants. It also includes calls for bans or moratoriums on nuclear energy development.

   Keywords: phase-out, close, stop, moratorium, nuclear shutdown.

2. **Investing in Renewable and Clean Energy Sources**

   - This theme includes mentions of promoting, developing, or investing in renewable energy sources such as solar, wind, geothermal, biomass, and the use of batteries. References to "green energy" "clean energy" or any alternative forms of energy also belong here.

   Keywords: renewable energy, clean energy, green energy, solar, wind, alternative energy.

3. **Reducing Energy Consumption and Changing Behaviors**

   - This theme includes calls to reduce energy consumption through efficiency measures, societal behavioral changes, or structural or systemic changes. References to increasing energy taxes or prices to encourage reductions also belong here.

   Keywords: energy saving, efficiency, use less, consume less, energy taxes, behavioral change.

4. **Raising Awareness and Providing Better Information**

   - This theme focuses on raising public awareness, educating people about nuclear risks and renewable alternatives, and addressing misinformation about nuclear energy. Responses implying that existing information is insufficient or biased also fall here.

   Keywords: raise awareness, education, honest information, misinformation, transparency, public awareness.

Instructions:

For each response:

1. Evaluate the text for the presence of each theme.

2. Annotate each theme as **Yes** (present) or **No** (not present).

3. Provide a **brief rationale** (1-2 sentences) explaining why you determined the theme is or is not present.

4. Return the annotations in **JSON format** as shown below.

Do not include any text or explanations in your answer besides the JSON object. If you include anything else, it will be rejected.

Format for Annotation (JSON):

```
{
  "survey_response": "[Insert survey response here]",
  "annotations": {
    "phasing_out_nuclear_energy": {
      "present": "Yes/No",
      "rationale": "[Brief rationale]"
    },
    "investing_in_renewable_and_clean_energy_sources": {
      "present": "Yes/No",
      "rationale": "[Brief rationale]"
    },
    "reducing_energy_consumption_and_changing_behaviors": {
      "present": "Yes/No",
      "rationale": "[Brief rationale]"
    },
    "raising_awareness_and_providing_better_information": {
      "present": "Yes/No",
      "rationale": "[Brief rationale]"
    }
  }
}
```

Examples:

{

"survey_response": "We must phase out nuclear power immediately and invest in renewable energy like wind and solar.",

"annotations": {

"phasing_out_nuclear_energy": {

"present": "Yes",

"rationale": "Mentions the need to phase out nuclear power immediately."

},

"investing_in_renewable_and_clean_energy_sources": {

"present": "Yes",

"rationale": "Specifically calls for investment in renewable energy sources like wind and solar."

},

"reducing_energy_consumption_and_changing_behaviors": {

"present": "No",

"rationale": "Does not mention energy consumption or behavioral changes."

},

"raising_awareness_and_providing_better_information": {

"present": "No",

"rationale": "Does not address awareness or information issues."

}

}

}

{

"survey_response": "We need better education about the dangers of nuclear energy and the benefits of green alternatives.",

"annotations": {

"phasing_out_nuclear_energy": {

"present": "No",

"rationale": "Does not directly mention phasing out nuclear energy."

},

```
  "investing_in_renewable_and_clean_energy_sources": {
    "present": "No",
    "rationale": "Does not mention investment or promotion of renewable energy."
  },
  "reducing_energy_consumption_and_changing_behaviors": {
    "present": "No",
    "rationale": "Does not mention reducing energy consumption or changing behaviors."
  },
  "raising_awareness_and_providing_better_information": {
    "present": "Yes",
    "rationale": "Mentions the need for education about nuclear risks and alternatives."
  }
 }
}


{
 "survey_response": "Promote clean energy like wind and solar, and inform the public about the risks of nuclear power.",
 "annotations": {
  "phasing_out_nuclear_energy": {
    "present": "No",
    "rationale": "Does not mention phasing out or stopping nuclear energy explicitly."
  },
  "investing_in_renewable_and_clean_energy_sources": {
    "present": "Yes",
    "rationale": "Specifically promotes clean energy sources like wind and solar."
  },
  "reducing_energy_consumption_and_changing_behaviors": {
    "present": "No",
    "rationale": "Does not address reducing energy consumption or changing behaviors."
  },
  "raising_awareness_and_providing_better_information": {
```

```
      "present": "Yes",
      "rationale": "Calls for informing the public about the risks of nuclear power."
    }
  }
}

{
  "survey_response": "Close all nuclear plants and reduce energy consumption to create a more sustainable system.",
  "annotations": {
    "phasing_out_nuclear_energy": {
      "present": "Yes",
      "rationale": "Specifically calls for the closure of nuclear plants."
    },
    "investing_in_renewable_and_clean_energy_sources": {
      "present": "No",
      "rationale": "Does not mention investing in renewable energy."
    },
    "reducing_energy_consumption_and_changing_behaviors": {
      "present": "Yes",
      "rationale": "Calls for reducing energy consumption."
    },
    "raising_awareness_and_providing_better_information": {
      "present": "No",
      "rationale": "Does not address awareness or information issues."
    }
  }
}

{
  "survey_response": "We should raise awareness about the dangers of nuclear waste and help people understand renewable energy options.",
  "annotations": {
```

```
  "phasing_out_nuclear_energy": {
    "present": "No",
    "rationale": "Does not explicitly call for phasing out nuclear energy."
  },
  "investing_in_renewable_and_clean_energy_sources": {
    "present": "No",
    "rationale": "Does not mention investment in renewable energy."
  },
  "reducing_energy_consumption_and_changing_behaviors": {
    "present": "No",
    "rationale": "Does not address energy consumption or behaviors."
  },
  "raising_awareness_and_providing_better_information": {
    "present": "Yes",
    "rationale": "Emphasizes raising awareness about nuclear risks and renewable options."
  }
 }
}

{
 "survey_response": "Reduce energy waste and invest in sustainable solutions like solar and wind energy.",
 "annotations": {
  "phasing_out_nuclear_energy": {
    "present": "No",
    "rationale": "Does not mention stopping or phasing out nuclear energy."
  },
  "investing_in_renewable_and_clean_energy_sources": {
    "present": "Yes",
    "rationale": "Calls for investment in sustainable energy solutions like solar and wind."
  },
  "reducing_energy_consumption_and_changing_behaviors": {
```

```
    "present": "Yes",
    "rationale": "Calls for reducing energy waste, which implies changing consumption behaviors."
   },
   "raising_awareness_and_providing_better_information": {
    "present": "No",
    "rationale": "Does not address awareness or information issues."
   }
  }
}

{
 "survey_response": "We need a political decision to phase out nuclear energy and promote clean, renewable sources.",
 "annotations": {
   "phasing_out_nuclear_energy": {
    "present": "Yes",
    "rationale": "Explicitly calls for a political decision to phase out nuclear energy."
   },
   "investing_in_renewable_and_clean_energy_sources": {
    "present": "Yes",
    "rationale": "Mentions promoting clean and renewable energy sources."
   },
   "reducing_energy_consumption_and_changing_behaviors": {
    "present": "No",
    "rationale": "Does not mention reducing consumption or changing behaviors."
   },
   "raising_awareness_and_providing_better_information": {
    "present": "No",
    "rationale": "Does not address raising awareness or providing information."
   }
  }
}
```