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Nuclear Energy in the Context of Climate Change: A Frame Analysis of the Dutch Print Media

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ABSTRACT

The media play an important role in the way the public and policymakers come to understand the issue of nuclear energy. Nuclear energy is a low-carbon energy source that could contribute to the lowering of CO_2 emissions. However, there are significant safety and environmental risks attached to the technology. This paper investigates how the media frame nuclear energy in the context of climate change. An inductive analysis based on previous research by Gamson and Modigliani reveals nine frames in the communications on nuclear energy. Their frequency is measured in articles in the Dutch print media in 2018. Two new frames were found in relation toc limate change and the search for low-carbon energy options: ecomodernism and trade-off. However, the conclusion is that nuclear energy is infrequently framed in the context of climate change. The media coverage is still fuelled by old frames that dominate the coverage after serious accidents. This study argues that the framing process is mediated by cultural and societal factors that may encourage journalists to cover the issues with familiar narratives instead of new frames.

KEYWORDS

Media framing; nuclear energy; frame analysis; journalism; Dutch media; climate change

Introduction

Nuclear energy is gaining renewed interest as a means to address the issue of climate change. Throughout their life cycle, nuclear plants emit very little greenhouse gas. As energy consumption is expected to increase in the coming decades, nuclear power could make a significant contribution to reducing CO_2 emissions worldwide (IAEA 2018; IPCC 2018). However, accidents in Chernobyl and Fukushima have shown that the technology can be risky, and potential long-term harmfulness of nuclear waste is a concern.

The public must form an opinion based on information about the pros and cons of the technology. In this process of opinion formation, the media play an important role. With their choice of topics, frames and sources, the media put forward different narratives about societal issues, such as nuclear energy, and potentially influence public perceptions and policy choices (Gamson and Modigliani 1989; Mercado-Sáez, Marco-Crespo, and Álvarez-Villa 2019). Given the complexity of the issue and the urgency to decarbonise societies, the public is entitled to an informed debate about climate change and energy

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alternatives. The media bear a responsibility to orchestrate this debate (Devitt et al. 2019; Mercado-Sáez, Marco-Crespo, and Álvarez-Villa 2019; Prati and Zani 2013).

The Netherlands has set ambitious goals to comply with the Paris Agreement, and measures to limit greenhouse gas emissions have been laid down in a national climate agreement. By 2030, CO_2 emissions should be 49% lower than in 1990, which is betterthan the EU target of 40%. At present, the Netherlands is still far from attaining this goal, although CO_2 emissions fell by 2% in 2018 (CBS 2018). Energy extraction from sustainable sources is growing slowly and amounted to 7.4% in 2018. Most of it is biomass; sun and wind together accounted for only 2.3%. The Dutch energy transition is complicated by the government's decision to end the extraction of natural gas in the province of Groningen. Natural gas was the most important energy carrier in 2018 at 41%. The Netherlands has one nuclear power plant in Borssele, which generates approximately 3% of the electricity (Rijksoverheid 2019). In the policy debates on the energy transition, the expansion of nuclear energy has played no significant role. Politically, the liberal-conservative VVD advocates nuclear energy, while the left-wing and green parties are opposed. Public opinion about nuclear energy in the Netherlands has been negative for many years (Dekker, De Goede, and Van der Pligt 2010; Visscher and Bot 2017). However, recent opinion polls show that supporters of nuclear energy now surpass the opponents, including among voters on left-wing and green parties (Ipsos 2019; Peil.nl 2018).

The discussion about nuclear energy in the Netherlands and elsewhere does not take place in a vacuum. Opinions and perceptions are influenced by historical memories of disasters in Chernobyl and Fukushima and the nuclear arms race during the Cold War. In his book *The Rise of Nuclear Fear*, Weart (2012) describes how images of the dangers of nuclear energy, such as mutants and exploding atom bombs, have been locked into our collective memories through books, films and television shows such as The Simpsons.

The media, especially journalists, influence the understanding of nuclear energy in various ways. The media provide a space in which various stakeholders, such as politicians, environmental groups, and scientists, express their viewpoints. Positions on nuclear energy are simultaneously shaped by the media and mirrored by the media. Journalists have a special role in this process. They are part of society and tap into the same collective historical memory when they report on the issue. Hence, some authors have concluded that the cultural memory of the Chernobyl accident still leaves a mark on the reporting of nuclear energy (Bauer et al. 2019; Perko et al. 2019). However, it is important to note that the news framing process is not purely the product of the individual choices of journalists. News is socially constructed and influenced by surrounding factors, such as news routines, perceptions of the journalistic role and editorial pressures (Hanitzsch 2017; Van Gorp 2007; Vliegenthart and van Zoonen 2011).

Within this context, this paper seeks to uncover the frames in the current debate about nuclear energy and explores how news framing is influenced by the climate change issue. Specifically, it investigates how nuclear power is framed in the Dutch print media and to what extent climate-related framings are visible in the media discourse.

The Framing of Nuclear Energy

The approach in this study is a frame analysis. This study departs from early conceptualisations of frames and frame building (Entman 1993; Gamson and Modigliani 1989;

Gitlin 1980), in which frames are theorised as meta-communicative messages that tell us what is important about an issue. As such, frames manifest themselves in text via keywords, images, metaphors, moral appeals and underlying reasoning (Entman 1993; Gamson and Modigliani 1989). Together, these framing elements form coherent stories that give meaning to a subject.

This study further builds on Entman's (1993, 52) conceptualisation of the functions of framing in a communicative process. Framing is about identifying problems, diagnosing causes, making moral judgements and suggesting remedies. Moreover, frames are social constructs. They arise in processes of interaction and are part of a collection of shared stories, beliefs and worldviews with which a large group of people are familiar (Gamson and Modigliani 1989; Gitlin 1980; Van Gorp 2007). Hence, journalists, stakeholders and the public are familiar with these cultural frames and use them to construct or understand stories.

The process of media framing is important in the debate about nuclear energy. Through framing, people create an understanding of the issue at stake, the moral values involved, the possible consequences and solutions, and those responsible for acting (Entman 1993). Strong frames have the potential to reinforce emotions and beliefs in the audience. It is therefore not surprising that the framing of nuclear energy by the media has been widely studied. A closer look, however, shows that most studies use a limited concept of framing. Some are confined to the framing of single issues such as incidents and accidents, the framing of risks or the tone of the reporting. Other studies limit the concept of framing to topics and themes. Examples of recurring themes in the coverage of nuclear energy are economic benefits and risks, safety, environmental benefits and risks and health concerns (Culley et al. 2010; Devitt et al. 2019; Kristiansen 2017a; Wang, Li, and Li 2014).

Specifically, the media coverage of nuclear risks has received much attention. Kristiansen (2017a) provided a broad literature overview of studies investigating the tone and risk portrayal of nuclear energy in various countries since the 1980s. She observed a wave movement in which emphasis on the risks and benefits of nuclear energy alternate. Unsurprisingly, many studies have found that the tone of the media reports was negatively influenced by nuclear incidents. Some authors have criticised the media's coverage of nuclear incidents, arguing that they have put excessive emphasis on the risks and paid too little attention to the benefits (Friedman 2011; Kristiansen 2017a; Perko, Turcanu, and Carlé 2012). For example, Perko, Turcanu, and Carlé (2012) found that a nuclear incident in Slovenia resulted in high-intensity media coverage, emotional reactions and references to the Chernobyl accident, although the event had no safety significance.

The tone of the reporting is not only contingent upon nuclear incidents but also varies greatly by country. It is influenced, among other factors, by the presence or absence of nuclear power plants and the government policy toward nuclear energy (Devitt et al. 2019; Doyle 2011; Kristiansen 2017a; Wang, Li, and Li 2014). For example, Wang, Li, and Li (2014) investigated the reporting of nuclear energy in the Chinese press between 2003 and 2014. They concluded that most articles reflected pro-nuclear or informational statements, which is in line with the pro-nuclear government position. By contrast, Devitt et al. (2019) found that the Irish press reflected the government's anti-nuclear stance.

More recently, studies have focused specifically on the media framing of nuclear energy in the context of environmental and climate issues (Doyle 2011; Mercado-Sáez, Marco-Crespo, and Álvarez-Villa 2019). For example, Mercado-Sáez, Marco-Crespo, and Álvarez-Villa (2019) investigated to what extent news coverage of nuclear power in Spanish newspapers from 2008 to 2012 took an environmental perspective. She concluded that most articles were "eco-indifferent", which means that there were no allusions to environmental risks or climate benefits.

Recent studies provide limited insight into the way the subject is currently framed in the media. Studies that only capture the themes surrounding nuclear energy, such as "safety" and "health", say little about how exactly the issue is represented in terms of its problem definition, causal interpretation, moral evaluation or remedies (Entman 1993), Moreover, investigations that are limited to reporting after the occurrence of an incident may miss the frames that are employed by the media during quieter periods. These limitations can be overcome by an inductive analysis that aims to examine a topic with an open mind and uncover all possible frames around a subject (Semetko and Valkenburg 2000). Such an inductive method gains strength when it adopts a systematic approach to identifying the features of distinctive frames (Van Gorp 2007; Entman 1993).

An example of an inductive analysis that resulted in a comprehensive overview of various nuclear energy narratives in the media can be found in a 1989 study by Gamson and Modigliani. They analysed United States newspaper reports over a period of more than 40 years and gave an extensive description of frames that subsequently dominated the news. They found that the "progress frame" led the coverage between 1945 and 1960. This frame regards nuclear energy as a force for good that ensures economic development and social progress. An anti-nuclear discourse emerged in the 1970s, propagated by the "runaway frame" around the dangers of nuclear power. Other frames in their overview are "energy independence", "soft paths", "public accountability", "not cost-effective" and "the devil's bargain".

According to Gamson and Modigliani, viable frames are able to give meaning to an issue over time by incorporating new events. Almost two decades later, Nisbet (2006) proved this true by reassessing the media debate using Gamson and Modigliani's overview. With the statement "same frames, same debate", he concluded that the discussion about nuclear energy was still fuelled by the frames that Gamson and Modigliani had identified.

However, both studies were confined to the media coverage in the United States. Hence, the question remains whether the frame set is also recognisable in other countries. Moreover, both studies were conducted before the discussion about climate change gained momentum. Therefore, it remains to be seen whether the frame overview—and its application in the news media—has been able to incorporate this new environmental and societal context.

Purpose of the Study

The aim of this study is to examine how the climate change issue has influenced the framing of nuclear energy. Building on earlier inductive framing research by Gamson and Modigliani (1989) and a subsequent analysis by Nisbet (2006), it examines to what extent previously described frames have remained viable and to what extent new

frames have found their way into the discourse. The findings provide a comprehensive overview of nuclear energy frames which goes beyond incident- or theme-driven analyses in other studies.

In addition, this study aims to examine how the news media in the Netherlands make sense of nuclear energy in an era where climate change is high on the agenda. This is done by determining which frames and stakeholders drive the news coverage of nuclear energy and to what extent climate-related framings are present. It thereby serves as an example of the manner in which journalistic framing is influenced by broader societal and environmental contexts.

Method

Phase 1: Inductive Frame Analysis

The first phase of this research consisted of an inductive frame analysis. The purpose of an inductive frame analysis is to provide a broad overview of frames around societal issues. The frames are not determined in advance but are found in the material. Gamson and Modigliani, whose research serves as a starting point for this study, did so by looking at narratives that were promoted by certain frame sponsors. They explicitly searched for distinctive, interpretative "frame packages" consisting of framing and reasoning devices. Based on Gamson and Modigliani's conceptualisation of frames, Van Gorp (2007, 2010) developed a systematic procedure to identify them in communicative texts.

The starting point is a collection of material from a wide variety of frame sponsors, such as the industry, political parties and the environmental movement. In this material, *framing* and *reasoning devices* are identified. *Framing devices* are clear visual and textual elements, such as specific words, images, graphs and metaphors, that give the message a certain meaning. Consider, for example, the phrase "a floating Titanic" as a metaphor for a floating nuclear reactor. *Reasoning devices* are underlying ideas that form a route of causal logic about the consequences, moral values, responsibilities and solutions. These cannot always be literally found in the text but are implied by the story. For example, the warning that nuclear waste remains dangerous for many thousands of years implies that we should use alternative energy sources that are less harmful for the environment. Related framing and reasoning devices are grouped into a limited number of distinctive and coherent frame packages, which are labelled by a *core frame*, a cultural theme that represents the overarching idea of the frame.

Performing an inductive analysis is not straightforward because elements of cultural frames can be latent in a text. Moreover, a researcher must consider that his or her own mental constructs can obscure the process of frame identification (Van Gorp 2010). This has been overcome by using the constant comparative method (Corbin and Strauss 2008) in which newly collected framing and reasoning devices are continuously compared with previously identified frames. This method offers the opportunity to refine and complement preliminary findings.

Data Collection and Coding Procedure

Although Gamson and Modigliani's analysis served as a starting point, the aim of this study was to look for frames with an open mind. To that end, a wide variety of texts and images

were collected, predominantly from 2008 onwards, ranging from corporate brochures, opinion pieces, books, documentaries, websites, political party programmes and images and cartoons. Information was specifically collected from stakeholders with clear positions on nuclear energy, such as the industry, scientists, environmental and anti-nuclear organisations and political parties.

A total of 350 different items were collected. In this material, 1,104 framing and reasoning devices were detected and brought together in a matrix. For example, the matrix included expressions such as "a runaway reactor" or "the fight against climate change". Elements that belonged together were placed in one column in the matrix. The next step was to concatenate various coherent elements until the matrix showed a limited number of clearly distinctive stories (i.e., frames). Nine frames were identified via these steps. A brief summary is given in Table 1.

Phase 2: Deductive Analysis

The second phase was deductive in nature. During a deductive analysis, frames are measured in a dataset, in this case, a collection of newspaper articles. One researcher did the coding based on an extensive description of the nine frames and a codebook with interpretative questions to identify the frames in the texts. The frame descriptions from the inducive phase were taken as a starting point for the operationalisation of the frames. Moreover, the functions of framing—problem definition, causal interpretation, moral evaluation, treatment recommendation (Entman 1993)—were taken as a guideline to construct the codebook. For example, the causal interpretation of the runaway technology frame is that nuclear energy entails unacceptable dangers. Hence, the question "does the article use words like fear, danger, or disaster?" served as an identifier for this frame. Likewise, the frame cost-effectiveness states that the problem is that nuclear energy is too expensive. Hence, a question in the codebook was: "Does the article discuss the economic costs or benefits of nuclear energy?"

Data Collection and Coding Procedure

The units of analysis were Dutch newspaper articles from the year 2018. Articles were found via LexisNexis with the search terms "nuclear energy" or "nuclear power plant" (*kernenergie* or *kerncentrale*) in the headline and the lead. This search generated 656 articles from 34 different newspapers. The articles were assessed for relevance and irrelevant stories were deleted. Irrelevant articles, for example, only mentioned the location of a nuclear power plant or briefly mentioned "nuclear energy" in an article with a different theme. Some articles appeared in more than one newspaper. After removal of irrelevant and double-posted articles, 554 articles remained and were coded. Of these, 132 were opinion pieces, editorial comments and letters from readers.

In addition to measuring the frequency of frames, the coding phase served two other purposes. The first was to gain insight into the overall tone of voice of the coverage. As was observed by Gamson and Modigliani, some frames can express a pro-nuclear as well as an anti-nuclear viewpoint. Hence, the tone of voice was coded separately, using a coding scheme adapted from Devitt et al. (2019) and Wang, Li, and Li (2014). *Negative* meant that the article pointed out disadvantages, risks, problems and dangers of nuclear energy, for example, related to previous accidents, public resistance, incidents in power

Table 1. Frame matrix with nine nuclear energy frames.

Frame	Gamson and Modigliani (1989)	Problem definition	Solutions/action perspectives	Position on nuclear	Moral basis	Emotional basis
1. Runaway technology	Runaway	Nuclear energy is a dangerous technology that we cannot control	Put a halt to nuclear energy; close plants, don't built new ones	Strongly disapproving	Humbleness; humans are not God	Fear, anxiety
2. Progress	Progress	Nuclear technology increases the prosperity and well-being of all	Expansion of nuclear energy, development of improved nuclear technologies	Mostly approving	Modernization and progress are a force for good	Hope, trust in science
3. Sustainability	Soft paths	Energy sources should be sustainable and not burden the planet	Invest in natural and clean energy sources, such as sun and wind (and nuclear)	Mixed	Responsibility for the planet and future generations	Care
4. Ecomodernism		We need nuclear energy to combat climate change	Nuclear energy should be part of a low-carbon energy mix	Approving	Obligation to stop climate change	Concern
5. Trade-off		Pros and cons of energy sources must be balanced against each other	Weigh pros and cons of energy sources based on facts	Mixed	Rational consideration of options	Rationality, deliberation
6. Cost-effectiveness	Not cost-effective	Nuclear energy is too expensive (or cheap) and cannot (or can) compete with other energy sources	Investing in nuclear energy is a bad (or good) economic decision	Mixed	Ensuring our prosperity	Economical
7. Public accountability	Public accountability	Nuclear energy production is in the hands of powerful profit-making companies. We cannot trust them	Restrict and control powerful companies and authorities	Disapproving	Halting corrupting powers	Distrust
8. Social justice		Nuclear energy contributes to (or undermines) a fair and just society	Nuclear energy can increase access to electricity for the poor	Mixed	Social justice, solidarity	Compassion
9. Energy independence	Energy independence	Our dependence on foreign energy sources makes us vulnerable	Nuclear energy increases our independence from oil-exporting countries	Approving	Freedom and independence	Liberation

stations, harmful nuclear waste or the high costs of nuclear energy. Articles with a *positive* tone pointed to the advantages or possibilities of nuclear energy, such as low costs, low CO_2 emissions, public support and security of energy supply. Articles were coded as *neutral* if the headline and lead did not show a clear position about nuclear energy or if it presented a balanced position.

Secondly, the study aimed to identify the main sponsors of each frame. To that end, the stakeholders were noted. In this study, the stakeholder was the person or institution that served as the main source of information for the journalist. For example, if the article mentioned that an energy company reported a technical incident at a nuclear plant, the "industry" was the stakeholder. If the article wrote that a politician complained about a lack of information after an incident, "politicians" were the stakeholders. In case of commentaries and op-eds, the author of the piece was the stakeholder. It could be argued that journalists were stakeholders in all cases, as they are the ones who bring the issue to the fore. However, the main purpose of this paper is to identify who is feeding the media coverage. Thus, journalists were only identified as "stakeholders" if they had written a comment or op-ed on a personal title.

The research aimed to capture the framing that most catches the eye of the public. This is the reason only the most prominent frame was coded. The headline and lead were decisive during the coding process: They are the most defining parts of an article; many readers do not read beyond them. The coder noted which frame was the most important in the headline and lead. Coding the frames posed a challenge. Although the frames are conceptually different, they were often intertwined in texts. For example, a simple sentence such as "nuclear energy is dirty, dangerous, and expensive" (Telegraaf, 10 November) simultaneously refers to the runaway technology frame and the cost-effectiveness frame. This intertwining was especially visible in opinion pieces of opponents who summed up arguments against the technology in one or two sentences. In such cases, the coder continued reading and chose the frame that was most prominent in the subsequent paragraph or paragraphs. In the article in this example, this was the cost-effectiveness frame. The code "no frame" was given to factual and descriptive messages such as "Nuclear power plant in operation again" (Dagblad de Limburger, 15 September 2018).

Results

Nine Nuclear Energy Frames

The inductive analysis revealed nine distinctive frames in communications about nuclear energy. Table 1 shows the nine frame packages, each composed of a central theme (the frame), problem definition, solution/action perspective and moral and emotional basis. Below follows, in random order, a qualitative description of the frames, their sponsors and examples from the inductive material. These are complemented with some observations during the analysis process.

Runaway Technology

The first frame in this overview regards nuclear energy as a dangerous technology that we cannot control—a "runaway technology". The frame relates to the classic story of Dr. Frankenstein, who created a being over whom he had no control and who ultimately turned

against him. The frame is used to talk about the risks, dangers and consequences—radiation is invisible, nuclear waste is deadly and nuclear material attracts terrorists. The risks are often in the future; a nuclear disaster might happen, the chaos cannot be foreseen and large areas will turn into an uninhabitable landscape for centuries. The runaway frame suggests that stopping nuclear energy is the only option.

The runaway technology frame is recognisable by metaphors and superlatives—radiation is a "silent killer", nuclear power plants are a "nuclear nightmare", and a floating nuclear plant is a "nuclear Titanic". Visual elements include images of desolate landscapes, explosions and protests. An important frame sponsor of runaway technology is the environmental and anti-nuclear movement. For example, Greenpeace talks about the dangers of nuclear energy with phrases such as "life-threatening radioactive radiation" and "a huge mountain of radioactive waste".

Progress

The progress frame is based on the idea that modernisation and modern technology make our lives better. From this perspective, nuclear energy is part of the solution to the energy issue. Nuclear energy is needed to provide energy to a world with now 7 billion and soon 10 billion people with a high standard of living. In communications, this frame is used to point out the advantages: Nuclear energy is a safe, efficient, and reliable energy source. Nuclear technology is also indispensable for other sectors, such as the medical and food industries. The progress frame puts the disadvantages in perspective: the risk of accidents is small, the amount of waste is low and the waste is well monitored. Future developments, such as the thorium reactor, will only reduce existing problems and risks.

The progress frame is characterised by calm, often factual and technocratic language. It calls for the discussion to be based on facts and evidence along with faith in technology and science. Images include industrial, high-tech installations and a schematic representation of the fission process.

The progress frame is an important frame for scientists and the nuclear industry. On their websites and in corporate brochures, the industry talks about the great potential of nuclear energy with phrases such as "Nuclear technology can no longer be ignored in modern society" (from a brochure of Nucleair Nederland, a Dutch association of nuclear organisations).

Sustainability

The notion of sustainability is deeply engrained in our society, as reflected in the broad support for the Sustainable Development Goals. In the context of nuclear power, the frame is built around the notion of environmental sustainability and responsibility. We must treat the earth well and do no harm to it (now or in the future). We must find sustainable alternatives for our energy supply: clean, renewable, natural energy sources such as solar and wind. This perspective is used to argue that nuclear energy is not clean and not sustainable; nuclear waste hurts the ecology of the planet and burdens future generations with a waste problem. Moreover, the frame asserts that we do not need nuclear energy; we will achieve the climate goals through energy-efficiency and renewable energy sources.

The sustainability frame can be recognised by words such as "clean", "natural", and "sustainable", along with references to the burden of nuclear energy—notably of nuclear

waste—on the environment. The frame is visually supported with images of green landscapes with windmills and solar panels.

It was observed that many stakeholders use the sustainability frame. The environmental movement used it to argue that nuclear energy is dirty and unsustainable. Various (Dutch) political parties supported their position on nuclear energy with the sustainability frame. For example, the socialist PvdA party said, "The only way to make nuclear energy unnecessary is to invest quickly in energy that is sustainable, such as wind and solar energy".

Although sustainability was predominantly seen in an anti-nuclear context, it was noticed that proponents of nuclear energy, such as the World Nuclear Organisation, also employed the frame by arguing that nuclear energy is sustainable and clean.

Ecomodernism

Ecomodernism propagates that we need modern technology to save the planet. Hence, this frame reasons that we need nuclear energy to stop climate change. The risks of global warming are high; we cannot afford to turn our back on technology that has the potential to reduce CO_2 emissions. Solar, wind and biomass are not enough. This frame is also used to criticise the environmental movement's opposition to nuclear energy; the movement obstructs the solution to the climate problem with its persistent resistance. Those who take the climate goals seriously should embrace the advancement of nuclear energy.

The ecomodernism frame contains characteristics of both the progress and the sustainability frame. Like the progress frame, it embraces science and technology, and like the sustainability frame, it shares the concern for nature, environment and the future of the planet. The uniqueness of the frame lies in the underlying reasoning which links "high tech" and "care for the planet". In doing so, it distances itself from the desire for "naturalness" and "harmony with nature" narrative that is expressed via the sustainability frame. At the same time, it distances itself from the progress frame by departing from the moral obligationto care for the planet.

The ecomodernism frame has been used by the industry, scientists, and so-called ecomodernists, an environmental movement that propagates the use of modern technology to solve environmental and climate issues. An example is the book *Climate Gamble* in which two Finnish ecomodernists advocate nuclear energy (Partanen and Korhonen 2015). They explicitly call on the "traditional" environmental movement to end its opposition to nuclear energy.

Trade-off

A trade-off means that you weigh the pros and cons of different options and give up an advantage (or accept a disadvantage) to gain something more important. In the context of energy, this frame states that you must compare the pros and cons of nuclear energy with those of other alternatives. The trade-off frame can be used to reject or recommend nuclear energy. However, it is mainly used to argue that nuclear energy has fewer disadvantages than other forms of energy. For example, nuclear energy has claimed fewer victims than coal and gas, it emits less CO_2 than most other energy sources and it needs a smaller ground surface than wind and solar. The frame can be recognised using comparisons, often supported by figures and statistics. Like the ecomodernism

frame, the trade-off frame is also used to criticise opponents of nuclear energy because they never consider the disadvantages of other forms of energy.

A visual representation of this frame is the depiction of the number of victims per energy source, measured based on the unit of energy generated. In it, nuclear energy is a tiny block or circle compared to coal and gas. The trade-off frame was mostly seen in communications from the ecomodernists who call for a comparison between the death toll and CO_2 emissions per energy source.

Cost-Effectiveness

Cost-effectiveness discusses economic costs and benefits of nuclear energy. It is sometimes a variation of the trade-off frame when costs and benefits are compared with those of other energy sources. However, it differs from that frame, since it is predominantly used to consider the cost-effectiveness of nuclear energy on its own. The underlying idea is that investing in nuclear energy must be an economically sound decision for our society. Both proponents and opponents use this frame to argue either that nuclear energy is profitable or that it is not profitable. Opponents point out that nuclear power stations are very expensive, difficult to finance and difficult to earn back. Moreover, investment in nuclear energy inhibits investment in alternatives. Proponents argue that nuclear energy is cost-effective with low investment costs per generated energy unit and a stable price that can compete well with alternatives.

Public Accountability

The theme of public accountability is abuse of power and the failure of supervision. Nuclear energy belongs to powerful, profit-oriented companies that might not resist the temptation to compromise on safety. Moreover, nuclear energy makes society dependent on supervisory institutions and well-functioning political systems to guarantee our safety well into an uncertain future. Government, industry and regulatory authorities, therefore, have a social responsibility that they cannot forsake. In the context of nuclear energy, the frame is used to criticise their role. Examples were found in media articles such as "Building and operating nuclear power plants will always be reserved for those in power: large capital and the state" in De Correspondent (28 April 2011) and in cartoons depicting owners of nuclear plants as fat-bellied and corrupt creatures.

Social Justice

The final two frames in this overview, social justice and energy independence, were only sporadically seen during the analysis. Social justice is a strongly morally-charged frame. Our energy production and consumption raises questions about justice and equality, for example, for people in poverty. People with low incomes are deprived of the reliable and affordable energy that nuclear energy can provide. The ecomodernists Partanen and Korhonen (2015) used the frame in the context of the nuclear phase-out in Germany. They argued,

> Any coal burned in Germany simply so they could shut down their perfectly good nuclear power plants is coal that should not have been burned in the first place, but if it had to be burned, it should have been burned in a developing country to help raise their people from poverty.

The frame was also seen in a disapproving context, for example, through the attention of the anti-nuclear movements to the fate of the residents of Chernobyl and Fukushima.

Energy Independence

The final frame, energy independence, revolves around the Western dependence on foreign oil. Many oil producing countries are unstable and unreliable, which makes us vulnerable. Nuclear energy must be understood in the context of this broader geopolitical problem. To break free from oil producing countries, especially in the Middle East, we must embrace alternatives including nuclear energy. Energy independence increases our freedom. An example was found on the website of the PVV, a pro-nuclear opposition party in the Netherlands, that stated, "with nuclear energy we make ourselves independent of oil producing countries such as Russia and the Al-Qaeda fans from the Middle East".

Old and New Frames: Revisiting Gamson and Modigliani

When comparing the frame overview with that of Gamson and Modigliani, we see that two new frames have been added: ecomodernism and trade-off. Both are inspired by the discussion about the energy transition and the search for low-carbon alternatives to stop climate change. However, most of the old frames are still around; progress, runaway technology, energy independence, cost-effectiveness and public accountability have been observed in communications about nuclear energy for decades, although their relative importance has changed. For example, according to Gamson and Modigliani, the energy independence frame played a major role in the news coverage of nuclear energy in the 1970s when the energy crisis experienced a high point. However, it was not frequently seen in the current inductive analysis nor, as will be revealed in the next chapter, in the current print media coverage in the Netherlands.

One frame in Gamson and Modigliani's overview, "the devil's bargain", was not found in the material. This frame demonstrated ambivalence toward nuclear energy: "We are damned if we do and damned if we don't. And the deeper we get in, the harder it is to get out". Two frames, "not-cost effective" and "soft energy paths", changed their names. First, "not cost effective" was renamed "cost-effectiveness", since it was noted that stakeholders also argued that nuclear energy was cheap. Second, the term "soft energy path"was coined in 1976 by Amery Lovins, who pleaded for decentralised ways of generating energy with solar and wind. Hence, the soft energy paths frame promoted a route to a way of life that is in harmony with nature and sensitive to ecologial consequences. In the current overview, the more established term "sustainability" was chosen as the label for this frame.

Nuclear Energy in the Dutch Media

Figures 1–4 display the results of a frame analysis of 554 articles on nuclear energy in the Dutch media in 2018. Runaway technology (25.6%) and public accountability (15.7%) were the most important frames (see Figure 1), while government and politicians were the most important stakeholders (28.9%) (see Figure 4). An explicit example of the runaway frame was found in a Volkskrant article on 10 November 2018 in which it was stated, "Nuclear

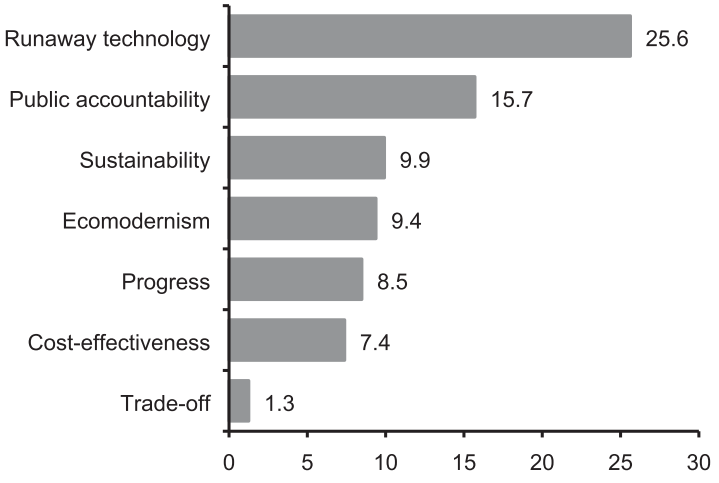

Figure 1. Frequency of nuclear energy frames (percentages) in newspaper articles in the Netherlands ($n = 554$).

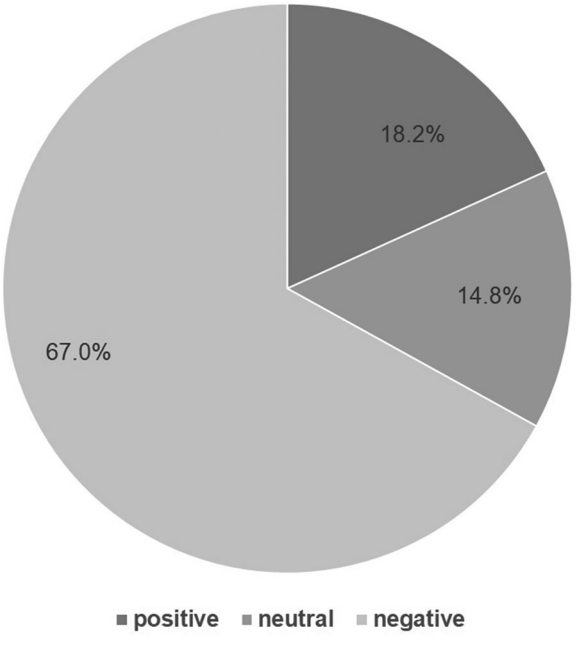

Figure 2. Tone of voice (percentages) in newspaper articles about nuclear energy in the Netherlands ($n = 554$).

energy evokes deep fears, of invisible radioactive clouds, of a catastrophe that is so much more frightening than a series of small accidents, of waste that remains radioactive when we have long been dead". The public accountability frame highlights the role of those responsible for guaranteeing public safety, notably the nuclear industry, governments and regulatory bodies. This frame was visible, for example, in the headline "Regulatory body critical of poor reactor maintenance" (Financieele Dagblad, 5 January 2018).

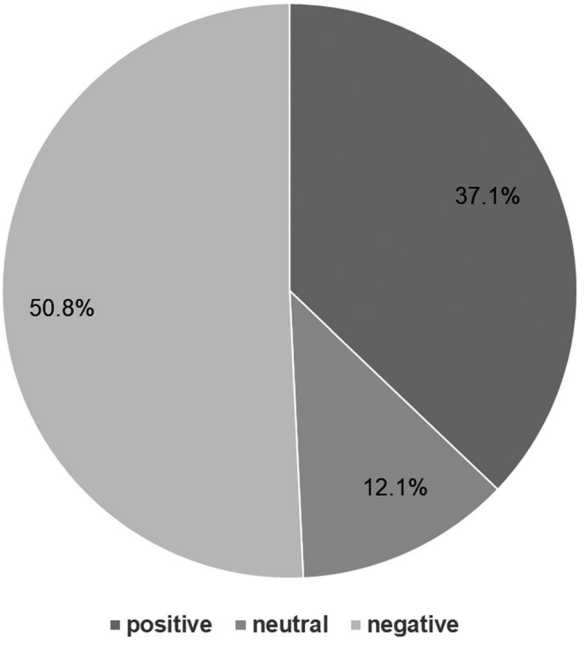

Figure 3. Tone of voice (percentages) in opinions about nuclear energy in the Netherlands ($n = 134$).

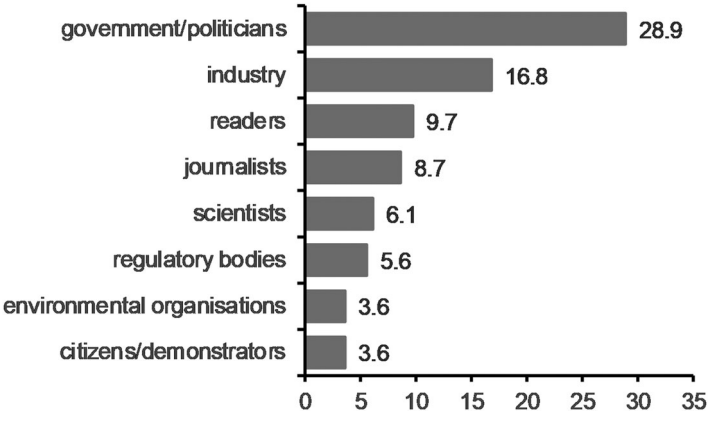

Figure 4. Stakeholders (percentages) in newspaper articles in the Netherlands ($n = 554$).

Overall, the tone of voice was mostly disapproving (67%) (see Figure 2). The majority of the articles drew attention to the risks of nuclear technology, problems with nuclear plants or the negligence of industry and authorities. Articles with runaway technology, public accountability and cost-effectiveness frames almost exclusively had a negative tone. By contrast, articles with a ecomodernism frame were mostly positive or neutral in tone, while the progress and sustainability frames were used in both approving and disapproving contexts. Examples of these frames were: "Climate problem too big to ignore nuclear energy" (Reformatorisch Dagblad, 21 November 2018); "The solution is nuclear energy and in particular thorium or molten salt reactors" (Eindhovens Dagblad, 11 January 2018); and

"There is no sustainable solution (for radioactive waste)" (De Limburger, 9 November 2018). The trade-off frame was seen on only seven occasions (1.3%), for example, "Are solar panels (and wind turbines) more deadly than nuclear energy?" (De Volkskrant, 8 May 2018). The social justice and energy independence frames were not found in the newspaper articles. In 22.4% of the articles, no frame was identified. Many of those were short and factual accounts of technical failures, delayed maintenance and temporary closure of nuclear plants.

Interestingly, the predominantly disapproving tone was less prominent in opinions (see Figure 3). A closer look revealed more than two-thirds of the opinions came from journalists ($n = 54$) or readers ($n = 41$). While journalist's opinions very nearly reflected the pattern in Figure 3, readers were positive about nuclear energy (43%) almost as often as they were negative (52%).

Media Hype

Some observations during the analysis are worth noting. There were peaks in coverage in May–June and November (see Figure 5), and they point to two instances of media hype. Media hype occurs when a news fact leads to a large number of articles in a short period of time in which the news fact is no longer central; the spiral of reactions to an event becomes news itself (Vasterman 2005). The first hype was fuelled by a leak in the water system in the nuclear plant of Doel, a Belgian plant near the Dutch border. From 29 April, various newspapers reported the incident. Although most papers wrote that the incident posed no danger for people or the environment, they nevertheless zoomed in on the potential risks, often quoting concerned local residents and politicians. On 3 May, the PZC wrote that city councils feared that groundwater would become contaminated. On 11 May, BN DeStem reported that local residents were afraid to swim in the nearby Westerschelde river. The media coverage was driven by the runaway technology frame, and emotions and the fear of possible consequences became news in themselves. Added to

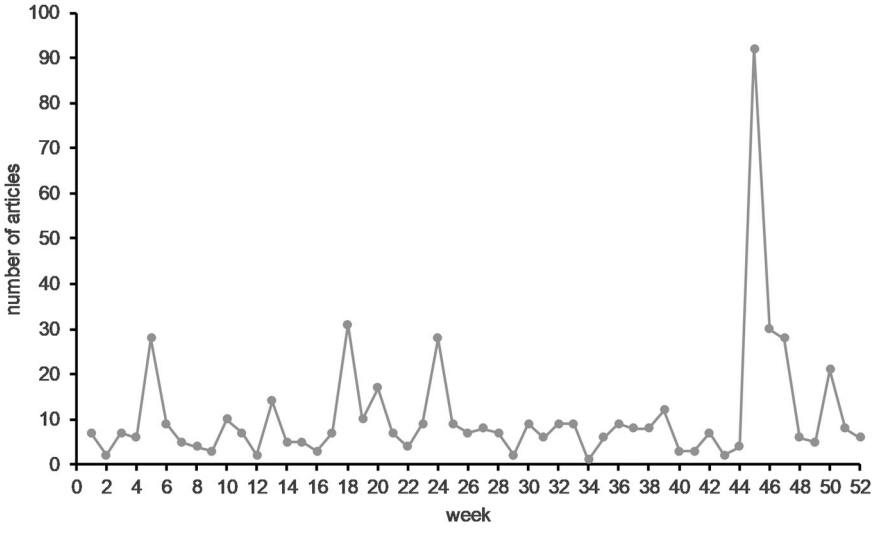

Figure 5. Articles per week about nuclear energy in Dutch newspapers in 2018 ($n = 554$).

this was the fact that it took the industry and authorities five days to report the incident. The dissatisfaction further fuelled reports with a public accountability frame with headlines such as "CDA Hulst denounces silence around Doel" (BN DeStem, 2 May 2018). The reporting quickly broadened to the safety of "outdated" nuclear power plants in general, the functioning of supervisory authorities and the call for closure of all Belgian nuclear power plants. Within a few days, the leaking water pipe, which had not presented any danger, led to parliamentary questions in Belgium and the Netherlands.

A second instance of media hype occurred in November. It was spurred by a broadcast by Arjen Lubach, a popular talk show host, who made a passionate plea for nuclear energy in his show on 4 November. Two days later, Klaas Dijkhoff, leader of the liberal VVD, openly announced that his party was in favour of building another nuclear power plant. Both Lubach and Dijkhoff substantiated their story with anecomodernism frame. Newspapers covered both events, and Dijkhoff's statement, in particular, soon became news in itself, unleashing a number of op-eds and comments. A clear frame shift was visible; for two weeks, ecomodernism dominated the coverage. These first two weeks in November were also the only weeks that a positive tone of voice prevailed over a negative one.

Incidents at Nuclear Power Plants

A second observation during the analysis concerns the attention that was given to the operation of nuclear power plants, of which the aforementioned case from the leakage in Doel is an example. In total, 171 articles (31%) covered the functioning of nuclear plants in the Netherlands, Belgium, and Germany. Journalists reported about serious problems such as the closure of six of the seven Belgian plants in the autumn of 2018. However, much attention was given to minor disruptions, planned maintenance, delayed maintenance and plants back in operation. For example, on 25 August 2018, the nuclear power plant in Borssele automatically went out of service after an electronic malfunction that damaged a pump. Nuclear safety was not at stake. The incident and the progress of the repair work was covered in 19 stories in six newspapers. The main news value seemed to be the fact that it concerned a nuclear facility.

Discussion

The findings of our inductive analysis agree with the notion that frames are viable and change little over time (Gamson and Modigliani 1989; Van Gorp 2010). Some frames turned out to be virtually unchanged, such as progress and runaway technology. Others were given a new meaning in the light of new social discussions. Moreover, our analysis demonstrated that the frame descriptions—originating from a study of American media content—were recognisable in the Dutch media discourse.

Nevertheless, the context of climate change has given space to the emergence of two new nuclear energy frames: ecomodernism and trade-off. Future research must demonstrate whether these frames remain viable and recognisable as distinctive discourses and whether, like the old frames, they are capable of adapting to changing societal contexts.

From our findings, it follows that the media coverage was largely determined by old frames, specifically runaway technology and public accountability: Nuclear energy is

predominantly framed in the context of safety, risks, and failing governance. The duo of runaway technology and public accountability frames was particularly visible in the coverage of incidents in nuclear power plants. This is consistent with previous findings from Nisbet (2006), who noticed that the runaway?public accountability frame duo became the dominant mode of interpretation in the United States after a nuclear accident at Three Mile Island in 1979 and was further strengthened after the Chernobyl disaster in 1986. The current analysis reveals that journalists also use these frames in the absence of severe detriments or accidents. This is in line with earlier findings that the media have a strong focus on the disadvantages of nuclear energy, and that even incidents without safety risks can lead to high-intensity coverage (Bauer et al. 2019; Kristiansen 2017a, 2017b; Perko, Turcanu, and Carlé 2012). The results further reinforce earlier findings that the media pay little attention to the benefits of nuclear energy, and that few articles on nuclear energy relate it to environmental and climate issues (Devitt et al. 2019; Friedman 2011; Kristiansen 2017a; Mercado-Sáez, Marco-Crespo, and Álvarez-Villa 2019).

Interestingly, ourinductive analyse demonstrated that various stakeholders have adopted climate-related framings of nuclear energy. Notably, ecomodernists and scientist-suse the narrative that we need nuclear energy to combat climate change and that we should consider the trade-offs between various energy options. This view was not widely reflected in the media coverage, with the exception of a media hype in November 2018. Moreover, it is noteworthy that public opinion in the Netherlands has shifted in a positive direction. This appears to be captured in the relatively positive tone on nuclear energy in opinions, specifically in reader's letters.

Journalistic reporting does not appear to reflect the changing mood about nuclear energy in the Dutch society. This raises questions about the power of the press to shape public opinion. It is possible that the pro-nuclear ecomodernism frame has had a greater impact on public opinion formation than is warranted by their size in reporting. Another possibility is that influential opinion leaders, such as VVD leader Dijkhoff and TV host Lubach, have the power to shift the debate after limited exposure in the media.

Moreover, the discrepancy between the public mood and frames in the news raises questions about how these frames emerge. News frames are socially constructed (Van Gorp 2007; Vliegenthart and van Zoonen 2011). A journalist's appreciation of certain frames is mediated by cultural and societal factors and news routines. For example, the faltering nuclear power plant appeals to an underlying story of derailed science and failing control, which is deeply engrained in our collective memory (Weart 2012). Hence, nuclear incidents, including minor ones, trigger journalists' antennae for risks and dangers. Other influences on the framing process are news values, such as bad news and drama (Harcup and O'Neill 2016). Moreover, journalists' enactment of the watchdog function may mediate their preference for the public accountability frame and their attention to elite sources, such as politicians and government officials (Hanitzsch 2017; Mellado and Van Dalen 2014).

Such mediating influences may contribute to a pattern in which the news media, probably unconsciously, remain tied to well-known ways of covering the issue of nuclear energy, instead of adopting new framings that take account of a changing societal and environmental context.

Conclusion

This study investigated the frames of nuclear energy in the context of climate change. By taking a thirty-year-old frame research study as a starting point, this study demonstrated that most frames are viable and able to adapt to new contexts and countries. Two new frames, ecomodernism and trade-off, were identified, and they were related to the discussion of climate change and the search for low-carbon energy alternatives.

However, a deductive analysis of Dutch newspaper content revealed that few articles framed nuclear energy in the context of climate change. The tone in the media reporting was predominantly disapproving of nuclear energy, and the coverage was mainly driven by frames that highlighted the dangers and the lack of public accountability. This study suggests that the framing process is mediated by cultural and societal factors, which may encourage journalists to use familiar narratives instead of new frames.

Limitations and Future Direction

Three limitations of the study may guide the way for future research: its case study nature; the need to further validate the findings; and its limitation to the investigation of media frames.

To begin with, the data collection for newspaper articles was limited to one country and one year in which the industry and authorities reported several minor incidents. The media attention on the operations of nuclear facilities and, hence, the negativity bias, might be less in years with fewer incidents. More research in other countries and other periods can show whether the media framing of nuclear energy differs in different contexts.

Secondly, the coding of frames was done by one coder and confined to headlines and leads with one frame per article. This enabled us to code a large number of articles, but it may have come at the expense of reliability of the results. Future frame investigations should complement our study to strengthen or refine our findings.

Thirdly, the study was limited to an investigation of media content. Ideally, the study would have paid attention to the full framing cycle, including frame building and frame setting processes (Vliegenthart and van Zoonen 2011). Future studies might look into the question of how media content relates to public perceptions of the issue. In this light, it is interesting that public opinion in the Netherlands has shifted in favour of the technology, in spite of the negative and risk-driven media coverage. Further research could investigate to what extent media frames affect peoples' perceptions of the technology.

Finally and importantly, future studies might look more closely into the frame building process, by investigating to what extent the framing of nuclear energy is influenced by journalistic routines, journalists' role perceptions, or journalists' personal visions of this subject (Engesser and Brüggemann 2016; Mellado and Van Dalen 2014). In particular, it could investigate the extent to which journalists, in light of changing societal contexts such as climate change, are open to adopting new framings to cover known topics.

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Data Availability

The data that support the findings of this study are available from the author upon request.

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