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Citation

Mors, E. ter, Leeuwen, E. A. C. van, Boomsma, C., & Meier, R. (2023). Media coverage of carbon capture and storage: an analysis of established and emerging themes in Dutch national newspapers. *Energies*, 16(4). doi:10.3390/en16042056

Version: Publisher's Version


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Downloaded from: <https://hdl.handle.net/1887/3631057>

Note: To cite this publication please use the final published version (if applicable).

Article

Media Coverage of Carbon Capture and Storage: An Analysis of Established and Emerging Themes in Dutch National Newspapers

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Abstract: Policymakers in several European countries are considering the implementation of carbon capture and storage (CCS) technology as part of a strategy to prevent further climate change. Successful CCS implementation requires societal support but planned CCS projects have encountered significant opposition. In this study, we examine the CCS coverage in Dutch national newspapers from 2017 to 2019, a period during which the Dutch CCS landscape underwent several substantial changes, and compare the results to those of earlier media analyses conducted between 1991 and 2011. Most of the 324 articles identified discussed CCS in a neutral (36.4%) or balanced (24.4%) manner, and more critical articles than supportive ones were found (23.1% vs. 16.0%). Consistent with the earlier media analyses, the potential of CCS to reduce carbon dioxide emissions was a major theme in the positive portrayal of CCS, while the argument that CCS implementation is needed for the prompt reduction in emissions gained prominence. High CCS deployment costs and the perception that CCS is an unproven technology have remained major themes in the negative portrayal of CCS. The availability of and preference for alternative solutions was a more prominent theme in the conversation compared to earlier years, whereas the subject of CCS safety was discussed less than before. The study illustrates how media coverage can shed light on the evolving relationships between society and CCS, and on the established and emerging themes in arguments used for and against the technology.

Keywords: carbon capture and storage (CCS); Netherlands; media analysis; societal perception; societal acceptance; argumentation; policy



Citation: ter Mors, E.; van Leeuwen, E.; Boomsma, C.; Meier, R. Media Coverage of Carbon Capture and Storage: An Analysis of Established and Emerging Themes in Dutch National Newspapers. *Energies* **2023**, *16*, 2056. <https://doi.org/10.3390/en16042056>

Academic Editor: Alberto Maria Gambelli

Received: 22 January 2023

Revised: 15 February 2023

Accepted: 17 February 2023

Published: 20 February 2023



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1. Introduction

Carbon capture and storage (CCS) refers to a climate change mitigation technology that has the potential to reduce carbon dioxide (CO₂) emissions from industrial and energy-related sources [1,2]. CCS generally refers to the process whereby CO₂ emissions from large point sources, such as power plants or industrial facilities, are captured, transported, and stored in onshore or offshore underground geological reservoirs. Policymakers around the world are becoming more interested in CCS, and the technology is part of energy and climate policy in several European countries, including the Netherlands [3–5]. While CCS has been successfully implemented in some European countries, implementation has been slow in others, with a lack of societal support recognized as a major factor [2,3,5–9]. Several planned CCS projects have encountered societal opposition and have been delayed or cancelled in recent years (e.g., [10]).

The media's coverage of CCS sheds light on the evolving relationships between society and this technology [8,9,11–18]. The way CCS is portrayed in the media provides insight into the key arguments used for and against the technology, and reflects how various stakeholders, such as the government, political parties, companies, environmental NGOs, local representatives, citizens, and civil society organizations, see the technology [7,19]. Previous

studies have explored the media coverage of CCS in a number of countries [6,7,9,14–24]. The findings of these studies highlight the importance of the national context of CCS for how the technology is portrayed, including the stage of development of the technology and the types of CCS applications being considered in a given country.

The main aim of this study was to examine the key themes and arguments used in favor of and against CCS in Dutch newspapers. In response to the lack of studies on media representations of CCS [11,17,22,25], we present the results of a two-year media analysis of CCS coverage in Dutch national newspapers (August 2017–July 2019). As will be discussed in Section 1.1, the Dutch CCS landscape underwent several substantial changes during this period. There has been a change in government support (with new financial policy instruments), CCS application (applications in heavy industry with few alternatives rather than power generation, offshore instead of onshore CO₂ storage), and CCS context (an increased focus on climate change) in the Netherlands. There have been no media analyses of CCS in the Netherlands since 2011, and the image of CCS in Dutch society under these relatively novel circumstances is largely unknown [3,5]. The current study aims to answer the pertinent questions of whether and how recent changes in the Dutch CCS landscape have influenced the societal debate about the technology as reflected in the written media. We compare the media representations of CCS in 2017–2019 with those found in earlier analyses in 1991–2011 that used a comparable methodology [7,19,26] to identify established and emerging themes in media presentations of CCS in the Netherlands. In the following sections, we briefly discuss the development of CCS in the Netherlands, as well as the main findings from the media analyses carried out earlier.

1.1. CCS in the Netherlands

The option of CCS has been discussed for a long time in the Netherlands, and several large CCS demonstration projects have been proposed since the early 2000s, but none have been implemented to date (2023 status).

In the past, deployment of CCS was hindered by a combination of shifts in political support, a lack of viable business cases, insufficient legal and governance frameworks, and a lack of societal support [3,5,10,27–29]. Ambitions for CCS initially focused on CCS applications with onshore CO₂ storage in depleted natural gas fields. Onshore demonstration projects were proposed near the town of Barendrecht (CO₂ capture at a refinery, transport via pipelines) and in the north of the Netherlands (CO₂ capture at coal-fired power plants, transport via pipelines), but were cancelled in the early 2010s. After the cancellations, the Dutch government excluded onshore locations as a possibility for CO₂ storage.

August 2017–July 2019 period covered in the study. Another proposed CCS project, the ROAD project (CO₂ capture at a coal-fired power plant, transport via pipelines, and offshore storage in depleted natural gas fields), was cancelled in September 2017. After a period of hampered enthusiasm for CCS, the installation of a new Dutch government in October 2017 put CCS back on the policy agenda. The government committed to developing CCS as part of its effort to reduce CO₂ emissions. The negotiations for the Dutch National Climate Agreement, which was announced in June 2019, took place during the time period covered in the study—an agreement that was negotiated by over 100 societal partners representing five sectors in the Netherlands (industry, the built environment, mobility, agriculture and land use, and electricity). Since then, ambitions for CCS have focused on applications of CCS in industry rather than power generation, as well as on storing CO₂ emissions in offshore depleted natural gas fields [3,5,30]. Specifically, the Dutch government set a target of reducing industrial CO₂ emissions by 14.3 million tons annually by 2030, a target to be achieved to a significant extent through large-scale deployment of CCS. New financial policy instruments, such as a carbon tax for industrial emissions and a subsidy scheme (SDE++) [3,5], were proposed to support these goals. The Netherlands had several industrial CCS projects in preparation during the time period covered in the study, including the Porthos project in the Port of Rotterdam area and the Athos project in the North Sea Canal area. The most likely applications of CCS in the Netherlands involve CO₂

capture at industrial installations, transport via pipelines, and offshore storage in depleted natural gas fields [3,5,29].

1.2. Newspaper Coverage of CCS in Dutch National Newspapers from 1991–2011

In this article, we describe the main themes and arguments used in Dutch newspapers for and against CCS from 2017 to 2019. In this way, we expand on insights from previous studies describing the media coverage of CCS in the Netherlands from 1991 to 2011.

Van Alpen and colleagues [7] examined CCS coverage in Dutch national daily newspapers over the period of 1991 to June 2006. When compared to earlier years, coverage was higher from 2005 onward. Policy announcements (e.g., the reservation of EUR 80 million for CCS projects in 2005), the publication of scientific reports (e.g., the IPCC special report on CCS in September 2005), conferences (e.g., the COP 11 Climate Change Conference at the end of 2005), and the development of CCS projects could all be linked to the increase in coverage. Over time, the overall evaluation of CCS in the articles changed from neutral (75% of articles from 1991 to 1996 compared to 31% of articles from 2005 to June 2006) to quite favorable (8% “positive” and 17% “negative” articles from 1991 to 1996 compared to 59% “positive” and 10% “negative” articles from 2005 to June 2006). Across the 1991–2006 period, the average number of arguments in favor of CCS per article was higher than the average number of arguments against it. The ability of CCS to reduce CO₂ emissions was a key theme and argument in the positive portrayal of CCS in the Dutch media from 1991 to 2006. This was also tied to a perceived large geological storage potential for CCS. The high deployment costs of CCS were a dominant theme and argument in the negative portrayal of the technology. Another major concern was that CCS would be an end-of-pipeline solution (i.e., no solution to the problem, rather than preventing CO₂ from being emitted, it is captured and stored).

Kliest [26] investigated CCS coverage in Dutch national newspapers from July 2006 to April 2009. From 2007 onward, coverage was higher compared to that in 2006. Coverage could be linked to the preparation of CCS pilot projects (especially the proposed Barendrecht CCS project), policy announcements (e.g., the EU’s allocation of a EUR 180 million subsidy for CCS projects in the Netherlands in October 2008), and the publication of research reports and organized conferences (e.g., the UN climate change conference in December 2007). With regard to the evaluation of CCS in the articles, between July 2006 and April 2009, 67.8% of articles either discussed CCS in a neutral manner or only mentioned the term. The proportion of “positive” articles was relatively high in 2006 (29.4% “positive”, 11.8% “negative”), but started to decline after that year (2007: 23.6% “positive”, 10.1% “negative”; 2008: 16.0% “positive”, 15.1% “negative”; 2009: 7.0% “positive”, 22.4% “negative”). The proportion of arguments in support of CCS versus arguments against it followed a similar pattern. The rise in the proportion of “negative” articles and opposing arguments over time could be directly related to media coverage of the contested Barendrecht CCS project. To some extent, this reporting reflected the (perceived) unfavorable attitudes of the Barendrecht city council and local population toward the project. The potential of CCS to reduce CO₂ emissions and the technology’s significant geological storage potential were major themes and arguments in the media’s favorable representation of CCS from 1991 through 2009 [7,26]. Additionally, the framing of CCS as a safe and dependable technology gained prominence from 2006 to 2009. The high costs of CCS deployment continued to be a key theme and argument in the negative image of CCS (cf. [7]). From 2006 to 2009, however, the most common argument was that CCS is not safe and reliable and is an unproven technology. Furthermore, concern was expressed about a lack of societal support for the deployment of CCS. The notion that CCS is an end-of-pipeline technology was no longer a central theme.

Paukovic and colleagues [19] analyzed the coverage of CCS in Dutch national newspapers from May 2009 to October 2011. Specific CCS projects, particularly the Barendrecht CCS project, were the focus of media coverage. The Barendrecht CCS project, which would be abandoned in June 2010, received the most attention in November 2009, when the Dutch

government announced its decision to approve it. There were more “negative” articles about CCS than “positive” articles (32% vs. 11%, respectively) from May 2009 to October 2011, but a majority of the articles (56%) either discussed the technology in a neutral way or only mentioned the term. Furthermore, there were more arguments against CCS than in favor of the technology. The main themes discussed were CCS safety, the role of CCS in mitigating climate change, and CCS costs. In line with the media analyses conducted between 1991 and 2009 [7,26], CCS was positioned as a climate change mitigation technology that can reduce CO₂ emissions. In contrast to the earlier media analyses, the subject of CCS safety and the specific concerns raised regarding the risks of CO₂ storage leakage took on a more prominent role. While CCS was presented as a safe and proven technology in some articles, it was portrayed as an unsafe technology with unknown risks in others, with more negative than positive safety arguments being used. As in the earlier media analyses [7,26], the high costs of CCS deployment were discussed, but a new central subtheme regarding costs emerged: the concern that CCS may lower the value of neighboring houses.

2. Materials and Methods

Newspaper articles were retrieved from the LexisNexis® Academic database using the Dutch keywords for CO₂, carbon dioxide, CCS, capture, and storage. The search term used was “(CO₂ OR kooldioxide OR koolstofdioxide OR CCS) AND (afvang OR opsla). (We used “opsla” to represent two equivalent Dutch words for storage: “opslag” and “opslaan”). Articles from the following major national daily newspapers, which span the full political spectrum, were gathered over a two-year period (August 2017–July 2019): Algemeen Dagblad; De Telegraaf; De Volkskrant; Het Financieele Dagblad; Het Parool; Nederlands Dagblad; NRC Handelsblad/nrc.next; Reformatorisch Dagblad; and Trouw. After the removal of duplicates and irrelevant articles, the remaining set of newspaper articles about CCS contained 324 articles. Table 1 presents the number of articles published about CCS in each newspaper, as well as the average number of printed issues for the selected newspapers.

Table 1. The number of articles published about CCS in each newspaper during the investigated period and the average number of printed issues for the selected newspapers in 2017.

Newspaper	Number of Articles Published about CCS (August 2017–July 2019)	Average Number of Printed Issues in 2017 [30]
Algemeen Dagblad	14	340,758
De Telegraaf	18	385,501
De Volkskrant	51	239,219
Het Financieele Dagblad	79	47,363
Het Parool	16	49,455
Nederlands Dagblad	13	19,593
NRC Handelsblad/nrc.next ¹	65	138,589
Reformatorisch Dagblad	13	31,464
Trouw	55	42,967

Note¹ Nearly 60% of the content on nrc.next comes from its parent paper, NRC Handelsblad [31]. For the purposes of our analyses, we treated nrc.next and NRC Handelsblad as a single newspaper and eliminated duplicate articles from the dataset.

Each article was coded using Qualtrics and Atlas.ti software. We coded and reported when articles were published, the type of article (e.g., news article, opinion piece), whether CCS was a primary topic or not, whether the article focused on CCS in the context of the Netherlands or other countries, whether new policy plans of the Dutch government were mentioned, and which CCS components (CO₂ capture, transport, and/or storage) were discussed. We further coded the overall evaluation of CCS in each of the articles using the following categories: “positive” if the article mainly contained positive associations;

“negative” if the article mainly contained negative associations; “balanced” if the article contained diverse associations; and “neutral” if no judgment was made about CCS.

In addition, with a focus on the arguments for and against CCS, we identified the main themes and arguments used to discuss CCS in Dutch newspaper articles. First, a preliminary thematic analysis of a sample of articles published between July 2017 and July 2018 was carried out to identify (sub)themes for coding. The resulting framework of (sub)themes was used to analyze all articles (also see Tables 2 and 3). The principal researchers who established the coding framework reviewed a sample of the work produced by the two coders in order to reduce bias and ensure that everyone on the team was using the same coding approach. (More specific details about the coding approach and materials used are available upon request from the corresponding author.)

3. Results

3.1. CCS Media Coverage

In total, 324 relevant articles in Dutch national newspapers were identified for the time period covered by the study. Figure 1 depicts the distribution of the articles over time. Media coverage of CCS peaked in October 2017 when the new Dutch government announced its coalition agreement and CCS plans. The publication of the 2018 IPCC report, as well as the discussions and developments surrounding the Dutch National Climate Agreement negotiations at the end of 2018, caused a second peak that occurred between October 2018 and December 2018.

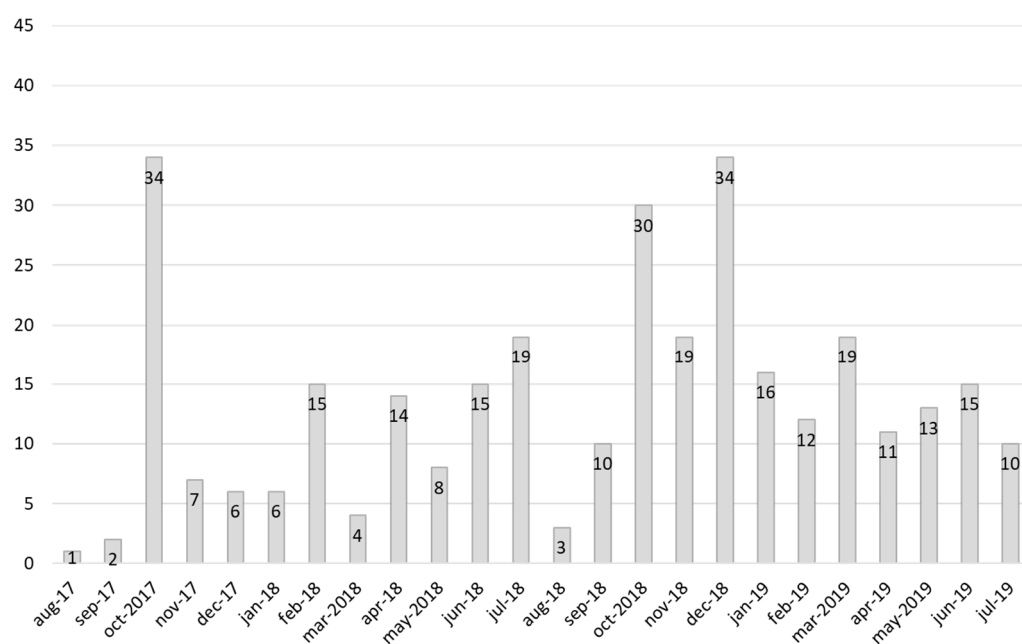


Figure 1. The number of articles published about CCS in the Netherlands during the investigated period.

The majority of the articles were news articles ($n = 228$, 70.4%) or opinion pieces ($n = 60$, 18.5%). Interviews ($n = 22$, 6.8%), letters from readers ($n = 4$, 1.2%), and other types ($n = 10$, 3.1%) made up the remaining articles.

CCS was the primary topic in about a quarter of the 324 articles ($n = 80$, 24.7%). The majority of the articles focused on CCS in the context of the Netherlands ($n = 277$, 85.5%). The new CCS-related policy plans proposed by the government were mentioned in more than half of the articles ($n = 176$, 54.3%). CCS was often discussed in connection with the Dutch National Climate Agreement and the country’s emission reduction targets. The most frequently mentioned application of CCS was that in industry, either by referring to industry in general or by mentioning specific industries, such as refineries, steel, fertilizers, and cement.

The two CCS components that were mentioned most were CO₂ storage ($n = 315$, 97.2% of the articles) and CO₂ capture ($n = 171$, 52.8% of the articles). The CO₂ transport component was rarely discussed ($n = 44$, 13.6% of the articles), and when it was, it was almost always in relation to the full CCS chain. Only a few articles mentioned all three components of the CCS chain ($n = 39$, 12.0%), whereas about half of the articles mentioned the combination of CO₂ capture and CO₂ storage ($n = 166$, 51.2%). We also coded the degree of specificity used to describe CO₂ capture, transport, and storage. Most articles that mentioned CO₂ capture and/or CO₂ storage did not go much further than mentioning the terms (CO₂ capture, $n = 128$ of 171 articles, 74.9%; CO₂ storage, $n = 249$ of 315 articles, 79.0%). In contrast, the majority of articles that mentioned the transport of CO₂ also included more detailed information ($n = 27$ of 44 articles, 61.4%).

3.2. Evaluation of CCS

Most of the 324 articles on CCS were neutral or balanced in their discussion of the technology, either by not passing judgment on it (“neutral”: $n = 118$, 36.4%) or by discussing both arguments in favor of and against it (“balanced”: $n = 79$, 24.4%). About a quarter of the articles primarily contained negative associations with CCS (“negative”: $n = 75$, 23.1%). The least prevalent category was that of articles that primarily contained positive associations with CCS (“positive”: $n = 52$; 16.0%). There were more “negative” than “positive” articles about the technology, $z = 2.28$, $p = 0.011$.

3.3. Argumentation for and against CCS

The majority of the 324 articles included at least one argument in favor of or against CCS ($n = 199$, 61.4%, and $n = 218$, 67.3%, respectively). On average, the articles contained more arguments against CCS than for it ($M = 1.84$, $SD = 2.68$, 0–18 range; $M = 1.29$, $SD = 1.79$, 0–13 range, respectively), $t(323) = -4.10$, $p < 0.001$, Cohen’s $d = -0.23$.

Sustainability and Inevitability were the two main themes in arguments in favor of the technology (see Table 2).

- Sustainability. CCS was described as an important option for climate change mitigation. Discussions centered on how CCS implementation can help the Netherlands reduce CO₂ emissions and meet its (inter)national climate agreement targets. Examples of quotes from the articles include: “Application of CCS in gas-fired power plants and other industries will result in a further CO₂ reduction”; “Half of the reduction, 7 megatons, is achieved by storing CO₂ underground”; “Capture and storage of the greenhouse gas [CO₂] should be implemented swiftly to meet Paris climate targets”; and “For governments, CCS is a crucial tool to meet national and international climate targets”.
- Inevitability. There was an overall sense that CCS would be needed to reduce carbon emissions on time. Arguments were made that society is running out of time or options to meet climate agreement targets and that CCS will be part of the solution alongside other technologies. Examples of quotes from the articles are as follows: “Without CCS, it is nearly impossible to meet climate targets”; “CCS storage is inevitable: time is running out”; “[CO₂] storage is a “necessary evil”; “Greenhouse gas emission reduction can only be achieved by using less energy, using more sustainable energy, and by capturing CO₂”; “We will need the combination of bio-energy and offshore CO₂ storage”; and “Nuclear energy and CO₂ capture and storage will play a role in the transition”.

Table 2. Arguments in favor of CCS: (sub)themes and the proportion of articles that use at least one argument within each (sub)theme ($n = 324$ articles).

Theme	%	Subtheme	%
Sustainability	35.5	CO ₂ emission reduction	21.3
		To meet climate agreement targets	14.8
		To prevent further climate change	3.4
		Rapid large-scale emission reduction	2.8
		Other	0.9
Inevitability	21.9	Technology is needed/running out of time	12.0
		Key technology in mitigation portfolio	9.0
		No (current) alternative available	4.3
		Important bridging technology	2.5
Infrastructure and technology	14.5	(Innovation) opportunities for companies	4.3
		Proven technology	4.0
		Reuse of existing infrastructure	3.7
		Successful (foreign) projects	3.4
		Other	1.9
Risk and support	12.0	Societal/policy/industry support	10.8
		Safe technology	1.5
Economy and finance	11.7	Other	5.9
		Cost-effective (compared to other options)	3.1
		Financial policy instruments enable use	2.8
		Costs will decline	1.9
Other	3.4	/	/

Economy and finance, Infrastructure and technology, and Alternative technologies were the three main themes among the arguments against the technology (see Table 3).

- Economy and finance. CCS was described as an expensive technology with uncertain funding. Discussions centered on the perceived high costs associated with CCS, its challenging and unclear financing (also linked to who should pay for it), and the notion that without subsidies, it will not be cost-effective. Examples of quotes from the articles include: “The costs of CCS are incredibly high”; “The financing still needs to be worked out”; “The question is who will pay for it”; and “Projects are not cost-effective currently”.
- Infrastructure and technology. CCS was described as an untested, unproven technology with limited potential. Arguments focused on a lack of experience with CCS, a lack of successful projects, and the idea that the technology and its aims are unrealistic. Examples of quotes from the articles are as follows: “The technology is still in its infancy”; “There is hardly any experience with the technology”; “Many projects were ended prematurely”; “The yearly 18 million tons of CO₂ to be stored by industry is unrealistic”; and “They [plan to apply CO₂ storage] on a huge planetary scale that is yet to be invented and that many scientists fear will never be ready in time and will anyway be impossible to deliver at the scale assumed”.
- Alternative technologies. Articles discussed CCS in comparison with other climate change mitigation options. Arguments discussed the availability of and preference for alternative solutions or technologies, such as CO₂ reuse, direct air capture, electrification, forestation, solar parks, and nuclear energy. Examples of quotes from the articles include the following: “Even better, have [CO₂] reused as a new raw material”; “Rather filter CO₂ out of the air, and make a fuel out of it (using methane) that airplanes can use”; “We argue for a method that is much cheaper, that has already proven itself, and that Wiebes [then Minister of Economic Affairs and Climate Policy] can implement almost immediately: the plantation of new forests”; and “And then there is yet another CO₂-free alternative: nuclear energy”.

Table 3. Arguments against CCS: (sub)themes and the proportion of articles that use at least one argument within each (sub)theme ($n = 324$ articles).

Theme	%	Subtheme	%
Economy and finance	31.5	High costs	21.3
		Funding unclear/debated	12.3
		Other	4.3
		Little financial return	4.0
Infrastructure and technology	26.9	Unproven technology	13.6
		Unrealistic aims/limited potential	10.8
		Need for new infrastructure	5.6
		Complex technology	2.8
		Lack of suitable storage sites	1.9
Alternative technologies	22.5	Alternative technologies preferred	14.5
		Alternative technologies available	6.5
Sustainability	17.0	No climate change solution	9.3
		Delays transition of energy and industry systems	9.0
		Prolongs the use of fossil fuels	6.5
		Uses additional energy	1.9
Risk and support	16.7	Leaves/creates problems for future generations	1.9
		Lack of societal/policy/industry support	12.0
		Risks: earthquakes, leaks, unspecified	6.2
Other	9.6	/	/

3.4. CCS (Not) as Primary Topic in the Articles: Evaluation of CCS and CCS Argumentation

CCS was the primary topic in about a quarter of the 324 articles ($n = 80$). We expected that this subsample of articles would contain more “positive” and/or “negative” articles and more arguments for and/or against CCS than the subsample of articles in which CCS was not the primary topic ($n = 244$). The main question we sought to answer when comparing the two subsamples was whether the 324 articles’ main themes and arguments used to discuss CCS were similar or dissimilar.

The results showed that the primary topic subsample contained more “negative” articles (primary: 35.0%; not primary: 19.3%, $z = 2.89$, $p = 0.004$) and fewer “neutral” articles (primary: 13.8%; not primary: 43.9%, $z = -4.85$, $p < 0.001$) than the not primary topic subsample did. There were no statistically significant differences between the subsamples in the proportions of “balanced” (primary: 28.7%; not primary: 23.0%, $z = 1.03$, $p = 0.303$) and “positive” (primary: 22.5%; not primary: 13.9%, $z = 1.82$, $p = 0.069$) articles. Furthermore, the subsample with CCS as the primary topic had higher averages for both the number of arguments for and against the technology (arguments in favor of CCS: $M_{primary} = 2.50$, $SD = 2.75$ vs. $M_{not\ primary} = 0.89$, $SD = 1.07$, Welch $t(87.01) = 5.11$, $p < 0.001$, Hedges $g = 0.97$; arguments against CCS: $M_{primary} = 4.05$, $SD = 4.19$ vs. $M_{not\ primary} = 1.12$, $SD = 1.30$, Welch $t(84.04) = 6.15$, $p < 0.001$, Hedges $g = 1.24$). Finally, the results demonstrate that while most argument themes were discussed more frequently in articles where CCS was the primary topic (see Table 4), the main themes and arguments used were comparable between the two subsamples. The main themes (i.e., top 2) in the positive portrayal of CCS in both subsamples were Sustainability and Inevitability, while the main themes (i.e., the top 2) in the negative portrayal of CCS were Economy and finance and Infrastructure and technology (see Table 4).

Table 4. Arguments in favor of and against CCS: Themes and the proportion of articles that use at least one argument within each theme as a function of whether CCS is the primary topic in the articles.

Theme	Primary Topic <i>n</i> = 80		Not a Primary Topic <i>n</i> = 244	
	%	Rank Order	%	Rank Order
<i>Arguments in favor of CCS</i>				
Sustainability	52.5 *	1	29.9 *	1
Inevitability	38.8 *	2	16.4 *	2
Infrastructure and technology	32.5 *	3	8.6 *	4/5
Economy and finance	21.3 *	4	8.6 *	4/5
Risk and support	16.3	5	10.7	3
Other	7.5 *	6	2.0 *	6
<i>Arguments against CCS</i>				
Economy and finance	56.3 *	1	23.4 *	1
Infrastructure and technology	47.5 *	2	20.1 *	2/3
Alternative technologies	30.0	4	20.1	2/3
Sustainability	37.5 *	3	10.2 *	5
Risk and support	28.7 *	5	12.7 *	4
Other	10.0	6	9.4	6

Note Per row, percentages with * differ statistically significantly at $z \geq 1.96$, $p \leq 0.05$.

4. Discussion

Policymakers in several European countries, including the Netherlands, are considering the use of carbon capture and storage (CCS) technology as part of a strategy to prevent further climate change [3–5]. Support from society is an important prerequisite for CCS implementation [2,11,32–35], yet planned CCS projects have encountered significant opposition in recent years (e.g., [10]). Media coverage provides insight into the evolving relationships between society and the technology [8,9,11–18]. The way CCS is portrayed in the media sheds light on the key arguments used for and against the technology and reflects how various stakeholders see the technology [7,19]. In the current study, we examined CCS coverage in Dutch national newspapers between August 2017 and July 2019, a time during which the Dutch CCS landscape underwent several substantial changes. The current study's main contribution is that it is among the first to provide insight into the image of CCS in Dutch society under these relatively novel circumstances. The comparison with previous media analyses conducted between 1990 and 2011 further sheds light on established and emerging themes in arguments used for and against the technology in the Netherlands.

The results of the media analyses showed that CCS received significant news coverage in Dutch newspapers during the time period investigated. Peaks in coverage could be attributed to developments in (inter)national climate policy. CCS was frequently discussed in connection with the Dutch National Climate Agreement and the Netherlands' emission reduction targets. The most frequently mentioned application of CCS was in industry. Most of the 324 articles identified discussed CCS in a neutral (36.4%) or balanced (24.4%) manner, and more critical articles than supportive ones were found (23.1% vs. 16.0%). On average, the articles contained more arguments against CCS than for it. Sustainability and Inevitability were the main themes in arguments in favor of CCS, while Economy and finance, Infrastructure and technology, and Alternative technologies were the main themes among arguments against the technology. These main themes were comparable between the subsample of articles where CCS was the primary topic and the subsample of articles where it was not.

4.1. Comparison with Previous Media Analyses

The distribution of “positive” and “negative” articles, as well as of arguments for and against CCS, as found in the present research, was consistent with earlier media analyses conducted in the Netherlands between 2009 and 2011 by Kliet [26] and Paukovic and colleagues [19], who also found more “negative” articles and arguments against CCS than “positive” articles and arguments in its favor.

As in the earlier media analyses [7,19,26], the potential of CCS to reduce CO₂ emissions was a main theme in the positive portrayal of CCS. Compared to earlier media analyses, the perception that CCS implementation is inevitable substantially increased. It was argued that society is running out of time or options to meet climate agreements, and that CCS, along with other technologies, will be part of the solution. The increased focus on climate change risks and mitigation in society in recent years, the publication of the 2018 IPCC report, and the connection with the Dutch National Climate Agreement discussions and negotiations during the study’s time period can all be considered contributing factors to the prominence of the theme of inevitability.

The results of our study further showed that the perception of CCS as an unproven technology and its high implementation costs have persisted as main themes in the negative portrayal of the technology [7,19,26]. When compared to earlier media analyses, the availability of and preference for alternative solutions or technologies appeared to be a more prominent theme. The negotiations for the Dutch National Climate Agreement, which took place during the investigated period, may have made alternative solutions more salient and discussed in relation to CCS than in earlier periods. Interestingly, the safety of CCS received less focus than it had in previous time periods [19,26], and the concern that CCS may lower the value of neighboring houses [19] was no longer a main topic. In contrast to the period between 2006 and 2011 [19,26], when specific CCS projects, particularly the onshore Barendrecht CCS project, received most attention, the discussion about CCS in the Netherlands from 2017 through 2019 seemed to be more focused on CCS policy and implementation in general. Furthermore, from 2017 onward, the Netherlands’ CCS plans target storing CO₂ offshore rather than onshore. These factors most likely contributed to the decreased focus on CCS safety and disrupted property values compared to previous time periods. In the coming years, it is conceivable that concrete CCS projects under development will again come to the forefront of societal debate in the Netherlands, with the topic of CCS safety potentially coming to the fore.

4.2. Possible Implications for Public Opinion

The way CCS is portrayed in the media may have implications for public debate [6–9,11–17,19–23,26,36,37]. Based on the findings from our media analyses, what can be said about the possible impact of current media coverage on public opinion about CCS in the Netherlands?

First of all, the results show that news articles tend to provide incomplete explanations of CCS (particularly with regard to CO₂ capture and CO₂ storage; cf. [9,19]), as well as use contradictory frames both within and across articles (e.g., CCS is cost-effective vs. CCS is expensive; CCS is a proven technology vs. CCS is a technology with limited experience; CCS is necessary to meet climate agreement targets vs. CCS is ineffective/there are better alternatives; cf. [17]). Considering that the general public is still largely unfamiliar with CCS [3,16,18,32], this incomplete and contradictory view presented in the media may limit development of stable, informed opinions. Uninformed opinions are held with less confidence than informed opinions, are less stable over time, and are less accurate predictors of future opinions, intentions, and behavior [3,38–40].

Second of all, whereas perceived safety did not emerge as a main theme in the current media analysis, it was a relatively strong predictor of citizens’ opinions about industrial CCS in a recent Dutch study [3]. This shows that care should be taken when interpreting the results of the media analysis. In particular, it is important to not assume that the

prevalence of certain themes is an indicator of how important these themes are in forming citizens' opinions.

4.3. Directions for Future Research

The current media analysis gives insight into how national newspapers in the Netherlands covered CCS between 2017 and 2019, a time during which the Dutch national context for CCS changed compared to earlier years. This study sheds light on established and emerging themes in the societal debate about CCS in the Netherlands over the years. Future research should continue to monitor and examine CCS coverage in the Dutch media on a regular basis to see how the societal debate about the technology evolves. When doing so, it may be relevant to distinguish between various stakeholders' arguments [7,26] in order to identify frames and narratives used by specific stakeholder groups [16,26,29]. As visual framings tend to promote particular ways of conceptualizing an issue or topic [41,42], it is also advised to examine the images provided in the media to see how CCS is visually framed. In addition, it is recommended to include both traditional and new forms of written media in the analyses. While traditional media continue to play an important role in society (for example, in the Netherlands, the percentage of daily newspaper readers is still significant at roughly 35%), new forms of media are on the rise (e.g., social media are now the most used type of media by the Dutch population) [43]. Furthermore, there is added value in employing a mixed-method approach, in which media analyses are combined with, for example, interviews and surveys, to obtain a more complete and comprehensive view of stakeholders' perceptions of CCS in the Netherlands. Finally, future research could examine how the consistency and stability of citizens' opinions regarding CCS is influenced by traditional and new media.

Author Contributions: Conceptualization, E.t.M. and C.B.; methodology, E.t.M. and C.B.; formal analysis, E.t.M., C.B. and R.M.; writing—original draft preparation, E.t.M. and E.v.L.; writing—review and editing, C.B. and R.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research was conducted as part of the H2020 ACT ALIGN-CCUS Project (No 271501). This project was supported by RVO (NL), FZJ/PtJ (DE), Gassnova (NO), UEFISCDI (RO), BEIS (UK); the European Commission [grant number 691712].

Data Availability Statement: The materials and data that support this study are available upon reasonable request from the corresponding author. The data are not publicly available due to third party copyright restrictions.

Acknowledgments: We would like to thank Michelle Droog and Isabelle Tegelaar for their assistance in the data analysis.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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