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Media Coverage of Nuclear Energy after Fukushima

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Media Coverage of Nuclear Energy after Fukushima

Oltra, C.; Román, P.; Prades, A.
48 pp. 35 figs.19 ref. 2 tables

Abstract:
This report presents the main findings of a content analysis of printed media coverage of nuclear energy in Spain before and after the Fukushima accident. Our main objective is to understand the changes in the presentation of nuclear fission and nuclear fusion as a result of the accident in Japan. We specifically analyze the volume of coverage and thematic content in the media coverage for nuclear fusion from a sample of Spanish print articles in more than 20 newspapers from 2008 to 2012. We also analyze the media coverage of nuclear energy (fission) in three main Spanish newspapers one year before and one year after the accident. The results illustrate how the media contributed to the presentation of nuclear power in the months before and after the accident. This could have implications for the public understanding of nuclear power.

La Cobertura en los Medios de la Energía Nuclear después de Fukushima

Oltra, C.; Román, P.; Prades, A.
48 pp. 35 figs.19 ref. 2 tablas

Resumen:

Este informe presenta los resultados principales de un análisis de contenido de la cobertura en prensa de la energía nuclear en España antes y después del accidente de Fukushima. Nuestro principal objetivo es entender los cambios producidos en la presentación de la energía nuclear de fisión y fusión ha evolucionado como resultado del accidente en Japón. Para ello, se analiza el volumen de cobertura y el contenido temático de la cobertura en los medios de la fusión nuclear a partir de una muestra de artículos impresos españoles en más de 20 periódicos desde 2008 a 2012. También se analiza la cobertura de los medios de la energía nuclear de fisión en diarios españoles un año antes y un año después del accidente. Los resultados ilustran cómo los medios de comunicación han contribuido a la presentación de la energía nuclear tras el accidente. Esto puede tener implicaciones significativas para la comprensión pública de la energía nuclear.

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1. Introduction

The aim of this report is to present the content analysis of nuclear energy-related media coverage in Spain before and after the accident in Fukushima Daiichi Nuclear Power Plants. Our main objective is to understand how the media coverage and presentation of nuclear fission and fusion has evolved as a result of the accident. We assume that accidents such as the one occurred in Fukushima can have significant impacts on the media coverage of nuclear technologies, which in turn may influence the public understanding and perception of these technologies. It is also important to understand the media presentation of fusion energy in the current stage of development, given the tendency of frames that are diffused widely in news coverage in an early stage to persist over time and to be influential in shaping public opinion (Nisbet et al., 2003; Weaver et al., 2009).

We specifically analyze the volume of coverage and thematic content in the media coverage for nuclear fusion from a sample of Spanish print articles in more than 20 newspapers from 2008 to 2012. We also analyze the media coverage of nuclear energy (fission) in three main Spanish newspapers one year before and one year after the accident. The results illustrate how the media contributed to the presentation of nuclear power in the months before and after the accident. This could have implications for the public understanding of nuclear power.

This report has been prepared for the EFDA Workprogramme in the area of Socio Economic Studies (Task 2012WP12-SER-ACIF-1)

Media framing of nuclear energy

The media coverage of technology has been the object of research in science and technology studies. From nanotechnology to nuclear energy, studies of media coverage have been aimed at investigating how technologies are presented in the media, understanding and characterizing the existing frames and measuring its prevalence. To frame is to select some aspects of a perceived reality and make them more salient in a communicating text (Entman, 1993). It is assumed that the framing and presentation of events and news in the mass media influences how the audiences of the news understand these events (Price, Tewksbury and Powers, 1997).

Traditional news media coverage of scientific issues often follows a pattern whereby coverage is positive in the early stages and grows increasingly more negative and conflict-driven over time (Cacciatore et al., 2012; Nisbet and Huge, 2006). This ‘issue-attention cycle’ was initially proposed by Downs (1972). Applied to the nuclear context, the model could through light upon the differences between media presentation of nuclear fission and nuclear fusion. Fusion, compared to nuclear fission, is still in an early stage of development, so media presentation of fusion should be more positive and less controversy oriented than the media presentation of fission.

The framing of nuclear energy was first investigated by Gamson and Modigliani in 1989. This study provided a deeper understanding of the frames present in the media (e.g. "nuclear power is necessary for maintaining economic growth and our way of life") that accompanied the development of nuclear energy. Recent social research has explored nuclear energy-related media coverage, looking at the volume of news stories, framing, and thematic emphasis in various countries and applying both quantitative and qualitative analysis (Doyle, 2011; Yun, 2012).

Of special importance has been the investigation of the reframing of new nuclear power as a means of tackling climate change and guaranteeing security of future energy supplies. This political reframing of nuclear energy emerged in the public debate after 2005. In countries like the UK, this new framing received widespread support from the nuclear industry, numerous scientists and some members of the British government (Bickerstaff et al., 2006). Bickerstaff et al (2008) have also addressed the question of how this new and emergent framing of nuclear power may affect lay understandings and views about nuclear energy. More recently, Doyle (2011) has researched how the UK news media contributed to the reframing of nuclear power. The analysis suggests that the new official discourse on nuclear power has been variously reproduced and contested across the newspapers.

The role of the media during the nuclear accident in Fukushima has been investigated by Perko et al. (2011) by means of a quantitative content analysis of the Belgian print media. In line with previous studies of media coverage of nuclear accidents (Rowe, Frewer and Sjöberg, 2000), the authors explore thematic content, orientation towards nuclear, presentation of conflict, risk comparisons an other variables regarding the media presentation of the Fukushima accident. From a different perspective, Friedman (2011) analyses media coverage of nuclear accident, comparing the coverage of the Fukushima accident with that of the Three Mile Island or Chernobyl accidents.

Media presentation of nuclear fusion

There is little published evidence on the media coverage of fusion energy. The available evidence (Borrelli, 2004) shows that media attention to fusion from 1989 to 2002 does not remain constant, i.e., daily press only pays attention to the topic when a special event or a new technological achievement takes place. This limited and irregular coverage, it is argued, does not seem to be enough to stimulate the attention of the public. The dominant framing seems to be quite neutral and purely technological, with little attention to wider social and political dimensions of the fusion R&D Programme (Borrelli et al, 2003).

Other studies have focused on the media framing of the siting of ITER. In this context, media presentation changes significantly, as it is more focused on the siting issues than on the technological ones (Prades et al, 2003). The study of the media framing carried out in Spain during 2002-2003 in the context of the Vandellós candidacy to host ITER found the following results: i) ITER had a wider impact on the local press. The more closeness to the proposed site, the more prominence is given to the project; ii) The Spanish press transmitted basically news articles (facts) about ITER. iii) Around 41% stories presented a neutral tone, in other words, no position towards ITER became apparent; iv) The institutional support to the candidature, i.e. the promotion of the Vandellós candidacy, has been the axis of most articles. ("the hosting dynamic"); v) The energy debate has held a relevant position in the ITER stories. This debate seems to be unavoidable connected to the fusion project itself; vi) The economic dimension of the project captured a lot of the press attention. The investments in the project, the effects of such investments, and the infrastructures were the more mentioned economic aspects of ITER.

The study by Prades et al. (2007) based on earlier work on media coverage of nuclear fusion concludes that: i) it is still early to observe a clear formation of media frames about nuclear fusion given that media attention is limited and irregular, and framing tends to be purely technological and neutral; ii) there are no clear data about how the nuclear brand is associated with fusion energy in

the media coverage. iii) The study at Vandellós shows, although its results have to be understood in the context of the siting of an international technological facility, that media coverage of the siting of ITER expressed a positive attitude. It seems that the nuclear brand was not, in this context, an important frame in the media discourse.

The Spanish context

Nuclear energy accounts for around 20% (2010) of the electricity generated in Spain. Eight nuclear reactors, built from the 1960's, are currently active in Spain. The last nuclear reactor in Spain was opened in 1986. In 1984, the Spanish government cancelled the nuclear program. Finally, in 1991, the construction of five new nuclear power plants was stopped and canceled some years later. From the 1980s, no new nuclear power plant has been projected in Spain.

From 2007-2008, in line with the international trend towards a possible nuclear power industry revival, more articles suggest the need to initiate a public debate on nuclear energy in Spain. Concerns over climate change and dependence on overseas supplies of fossil fuels are mentioned as key justification for an increasing use of nuclear power. Some articles in the analyzed period start expressing the possibility of building a new nuclear power plant in Spain. In july 2010, a representative from the nuclear lobby states that three new nuclear power plants should be constructed in Spain.

But apart from safety, political and public opinion issues, the growth in renewable energy production in Spain (hidro and wind account for around 27%), the decline of electricity consumption in the last five years and the investment costs of new nuclear reactors play against nuclear energy. The former and current Spanish governments have extended the life of two nuclear power plants, indicating that nuclear power will be part of the energy mix in the next decades. The building of new nuclear power plants is, however, not very likely in the coming decades.

Regarding fusion developments, Spain has been actively involved in fusion research. The ITER site decision (Spain was one of the potential sites) attracted substantive media attention in 2003. After this, scientific and technological developments, national and international, are, as we will see in the following pages, relatively covered by the written media. Spain has competitive research centers on fusion technology. Decisions on the ITER budget also attract media attention.

2. Method and data

This report draws on a quantitative content analysis and a qualitative thematic analysis of Spanish media articles dealing with nuclear (fission and fusion) energy.

Content analysis

Content analysis is a research technique based on measuring the amount of some themes, events, characteristics or variables in a representative sample of mass-media communicative elements, such as news articles, texts, etc. (Macnamara, 2005). In order to carry out the content analysis, we developed a standardized coding protocol to a sample of articles with nuclear fusion and nuclear fission content.

Sample

For fusion energy content analysis, a total of 166 print news stories were collected from 20 newspapers for the period 2008-2012. We searched the keywords "nuclear fusion" and "fusion energy" from January 2008 to July 2011. We relied on the online databases of each newspaper.

For fission energy- related content, we searched in three of the most representative Spanish newspapers (El País, El Mundo and La Vanguardia). The search period was between January 2010 and July 2012. Nuclear-related stories were searched using the keywords "nuclear" and "nuclear energy". After gathering only the articles published in the first 15 days of the month, the final sample included a total of 485 articles.

Year	Nuclear fusion	Nuclear fission
2008	27	--
2009	32	--
2010	52	96
2011	40	288
2012	15	102
Total	**166**	**486**

Table 1. *Articles included in the sample*

Analysis

We conducted statistical analyses at two levels. A first descriptive level consisted of Frequencies and Examine procedures of SPSS (Statistical Package for Social Sciences). At a second level, bivariate analyses were applied: contingency tables and comparison of means, both to explore significant covariations between dependent variables (e.g. valuation attributed to nuclear, primary theme, risks and benefits) and independent variables such as the period of publication of the article (mainly, before and after Fukushima accident).

Thematic analysis

Thematic analysis is a qualitative analytic method for 'identifying, analyzing and reporting patterns (themes) within data. It first organizes and describes the data set in detail. Second, it allows the interpretation of the various aspects of the research topic (Braun and Clarke, 2006, p.79)

In order to carry out the analysis, we developed a template approach. This involved the development of a template in the form of codes to be applied as a means of organizing text for subsequent analysis and interpretation. When using a template, a researcher defines the template (or codebook) before commencing an in-depth analysis of the data. The codebook was based on our research questions and our previous quantitative analysis. We allowed also for an inductive approach in order to gather new emergent codes.

Sample

We worked with one set of data: articles where nuclear fusion is mentioned. A sample of 20 articles was collected by means of a purposive sampling. As in any purposive or strategic sample, the main criteria for selection were diversity and saturation. A sample of 28 articles was selected, covering different thematic frames and the different roles of fusion (articles where fusion energy is the core subject and where it is not). In addition, five articles mentioning the accident in Fukushima were included.

	Core subject	Not core subject
Scientific events and research projects	10 articles	3 articles
Other themes	8 articles	3 articles
Articles mentioning Fukushima	5 articles	

Table 2. *Purposive sample of articles (n=28)*

The stages involved in the thematic analysis were:

- Stage 1: Developing the code manual. Definition and description of the codes (in table 3)
- Stage 2: Applying template of codes and additional coding to the text. Using the analytic template, we apply the codes from the codebook to the text with the intent of identifying meaningful units of text1. We code the text by matching the codes with segments of data selected as representative of the code. The segments of text are then sorted. We need to do this for the whole sample of articles.

[1] A textual unit can be a sentence or a paragraph.

- Stage 3: Identification of patterns and connections within and between codes. As the data is organized into codes or categories, patterns and connections will appear. The objective is to summarize the information pertaining to one code, capturing similarities or differences in the units of text within a code. Key questions to answer: What are the key ideas being expressed within the code? What are the differences and similarities in the articles? Are two or more codes consistently together?
- Stage 4: Interpretation. The objective is to attach meaning and significance to the data. We can develop first a list of important findings for every code. Synthesizing them and attaching meaning to these results will be the objective of the conclusions of this section. We have to keep in mind our main question: what is the public discourse on fusion?

3. Presentation of results

3.1. Fusion energy

General characterization of articles

The volume of nuclear fusion content in the Spanish print newspapers is relatively limited. In the period under study (January 2008 to July 2012), 175 articles mentioning fusion were registered in 20 newspapers. This means an average of 3.2 articles per month with fusion content, being the most frequent value 2 articles per month. In general terms, the volume of content on fusion has remained stable in the analyzed period. As shown in figure 1, there are only three outliers months (June and July 2010 and March 2011) with around ten articles each. These articles deal with various topics such as the funding of ITER or new scientific advances. March 2011 shows a significant increase in the number of articles mentioning nuclear fusion, but not all these articles are related to the accident at Fukushima. Between March 2010 and March 2011, 64 articles were registered. 37 articles were registered between March 2011 and May 2012.

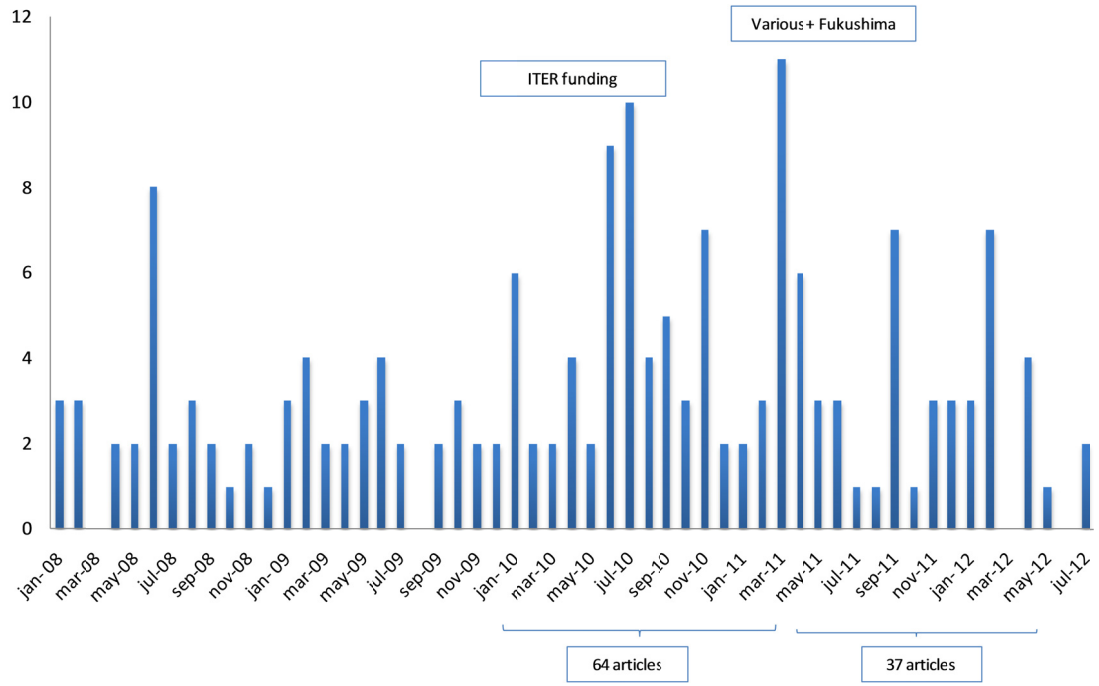


Figure 1. *Evolution of the number of articles with fusion energy-related content (twenty newspapers) from January 2008–July 2012 (n= 166)*

The figure 1 shows very clearly that the number of articles mentioning fusion has been almost constant around a very low level (two articles per month) in the last four years. The coverage of fusion energy seems to be quite regular in the Spanish print media. However, if we consider each of

the newspapers separately, **the range of articles per year is around 3 to 7 articles**. An average reader would be, then, exposed to a limited volume of fusion-related content.

The fluctuations in the number of articles showed in the figure seem to be linked to specific events, as mentioned before, as well as to random processes. Among the various events registered in the Spanish news articles, the funding of ITER is the one having the greatest impact. On the other hand, as an example of more random processes, in February 2012, six articles were published mentioning fusion. This is a significant increase in the trend, but it is not linked to any specific events. The six articles deal with various issues such as the future of energy, the North-Korean nuclear program, the funding of a research institute in Spain on physics and fusion, a conference on nuclear fusion in Spain, an article on science divulgation about fusion, and an article on cold fusion in a popular magazine.

In general terms, the data seems to show that the coverage of fusion energy in the Spanish press is not directly associated with the coverage of the Fukushima accident or, more generally, with the coverage of nuclear fission. Nuclear fusion is a topic in itself and the evolution of the volume of coverage is driven by a variety of events and technological achievements such as the news on the funding of ITER or the various scientific devices (e.g. the National Ignition Facility) and events.

The role of fusion

Fusion energy is still not a main topic in the print media. So articles mentioning fusion do not always treat it as a core subject. In 47% of the articles with fusion-related content fusion is the core of the subject. Only in 6% of the articles fusion is a subsidiary subject in the context of nuclear fission. In 16% of the articles, fusion is a subsidiary subject in other context such as energy policy. And in 31% of the articles fusion has a marginal role, which means that fusion is only mentioned in other context but not discussed or characterized in a deeper way.

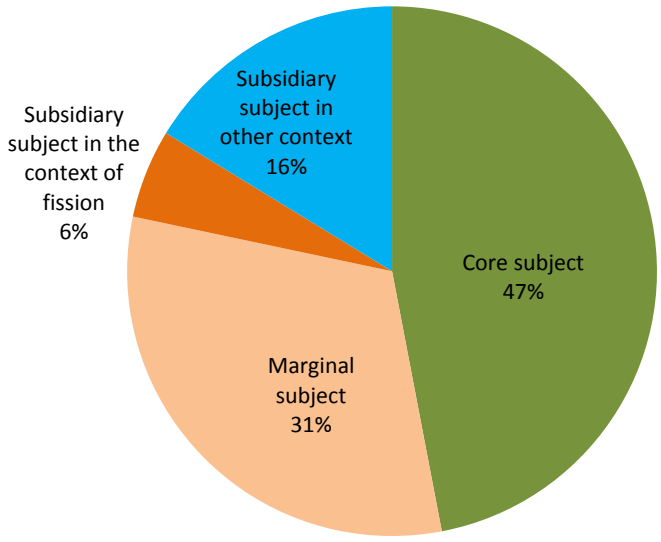


Figure 2. *Role of fusion in the fusion related articles from January 2008–July 2012 (v16; in % of articles; n= 166)*

There are no significant differences in this variable before and after Fukushima. Articles were fusion energy is a subsidiary subject in the context of fission or in other context increase around 3%. Articles were fusion energy is a marginal subject decrease after Fukushima, from 34% to 26% of the sample.

The majority of the articles (64%) do not explain the basic science behind fusion energy; 25% of them give some information and **only 10% of the articles provide deeper information on fusion**. This 10% of the articles explain the process of fusion, often using the metaphor of the star and the sun, the existing projects and advances, discuss its main characteristics, and argue about its potential benefits. Articles providing superficial information (25% of the sample) often explain in one to two sentences the basics of fusion. Some of these articles may cover recent developments in fusion research or energy policy, but are not aimed at providing a broad picture of nuclear fusion.

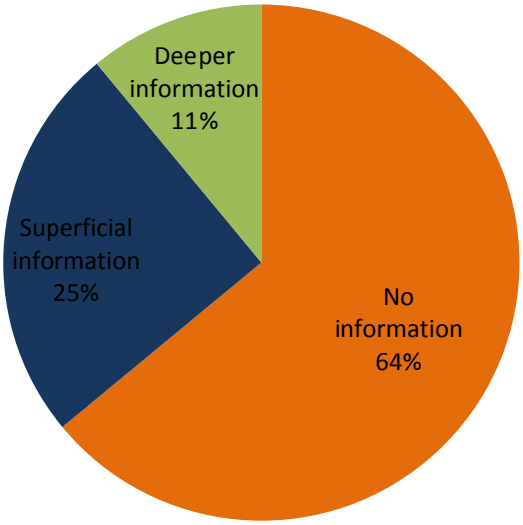


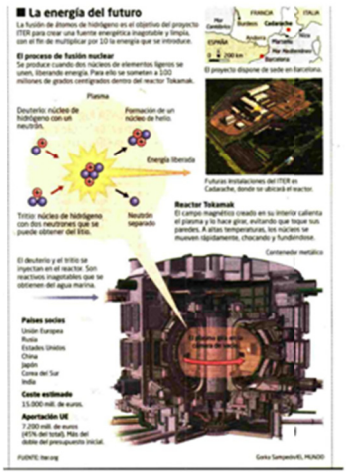
Figure 3. *Percentage of articles providing information about fusion from January 2008–July 2012 (v30; % of fusion related articles; n= 166)*

Articles providing deeper information (10%)


Merkel quiere prolongar la vida de las nucleares más allá del 2022

Mantener más años las centrales agrada al lobby eléctrico, pero critica a la oposición socialdemocrata

Articles not providing a information on fusion (63%)




SOCIEDAD

«La energía nuclear acabará pero es inevitable construir nuevas centrales»

Steven Cowley Jefe del organismo británico para la energía atómica

Articles providing superficial information (25%)

Table 3. *Examples of articles mentioning fusion according to the level of information provided*

Fusion is not totally associated with nuclear fission. The data show that 65% of the articles with fusion-related content do not mention nuclear fission and only 35% of the articles mention both concepts in the same article. This indicates that the coverage of fusion is somehow independent of nuclear fission. In the articles mentioning both concepts, no confusion was found between fusion and fission. Only one article in the sample confused fusion with fission.

Thematic content

Nuclear fusion is a topic associated with a variety of areas in the Spanish press, but mainly with scientific and research developments, energy policy and investment costs. **Around 44% of the articles mentioning nuclear fusion deal with science and research issues**. New scientific advances and discoveries and the status of fusion research projects are included in this category. Nuclear fusion is also mentioned in the context of energy policy debates (in 14% of the articles). Investments costs are the third most frequent topic. This is mainly related to the costs of funding ITER. Fusion is also mentioned in many various topics such as regional development in Spain, science policy or international relations. Nuclear fusion is poorly associated with climate protection, but also to risk management or accidents.

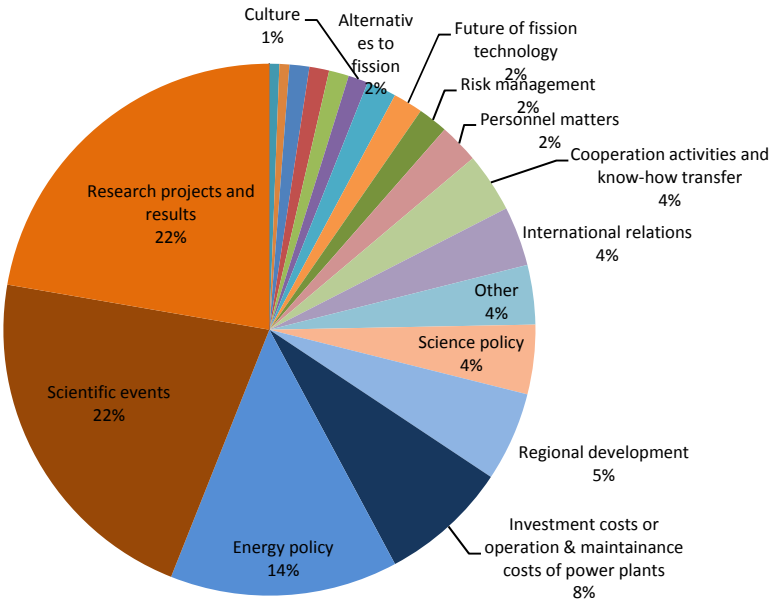


Figure 4. *All thematic content in print media articles on fusion from January 2008–July 2012 (v22 & v23; % of fusion related articles; n= 166)*

The role of ITER

ITER is frequently mentioned in the articles on fusion energy. Almost 40% of the articles with fusion-related content mention or are focused on ITER (mainly regarding its funding). But other facilities are also mentioned. The National Ignition Facility (California) laser shot record was mentioned in a number of articles in the considered period. These scientific events play a significant role in the coverage of fusion energy and research.

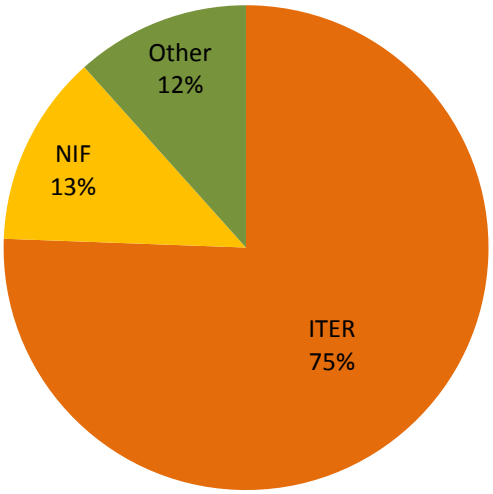


Figure 5. *Main research devices focused or mentioned in the fusion related articles from January 2008–July 2012 (v25; % of devices mentioned; n= 86)*

Actors

The most frequent actors mentioned in the news on fusion are operative directors (mainly related to ITER) (32%), scientists (30%) and non-Spanish politicians (15%). The coverage of fusion is clearly linked to ITER, so actors around ITER are the main actors in fusion stories. Scientists are the other main actor, probably explained by the fact that fusion is linked to basic science discoveries and events. Despite the fact that nuclear fusion is also framed in terms of energy policy, national politicians and environmental groups are underrepresented, as compared to nuclear fission.

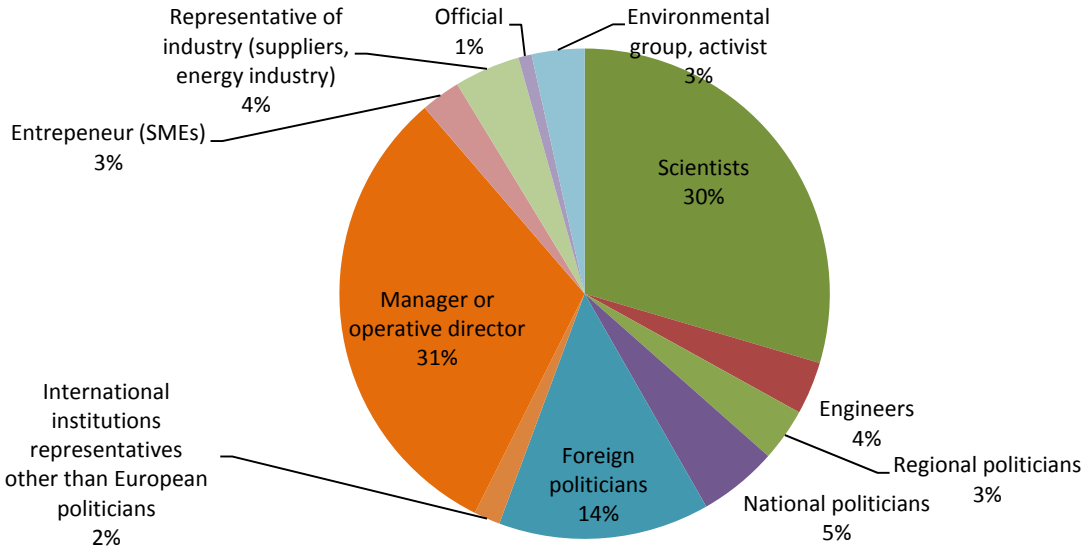


Figure 6. *Main actors in nuclear fusion stories from January 2008–July 2012 (v27; % of all actors; n= 106)*

Significantly, the actors associated to nuclear fusion and mentioned in the articles are generally positive about fusion. As shown in the figure, 66% of the actors are represented as supporters of nuclear fusion and 14% as supporters of both fusion and fission. Only 6% of the actors were opposed or negative about fusion.

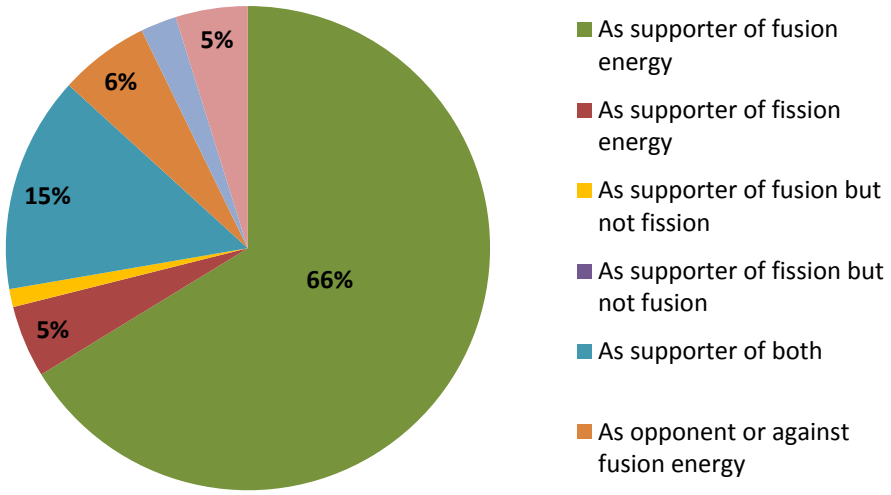


Figure 7. *The position of the main actors in fusion stories from January 2008–July 2012 (v28; % of all articles; n= 106)*

Valuation of nuclear fusion

We registered the general valuation of the articles towards nuclear fusion. The articles were ranged depending on whether they provided positive or negative arguments about fusion and whether the article was generally framed in positive or negative terms. Following this criteria, we find that half of the sample (54% of the articles) provides a positive valuation of fusion. Another 17% gives a very positive valuation of fusion. A 44% of the articles give a neutral valuation of fusion. Almost no negative articles were found regarding nuclear fusion.

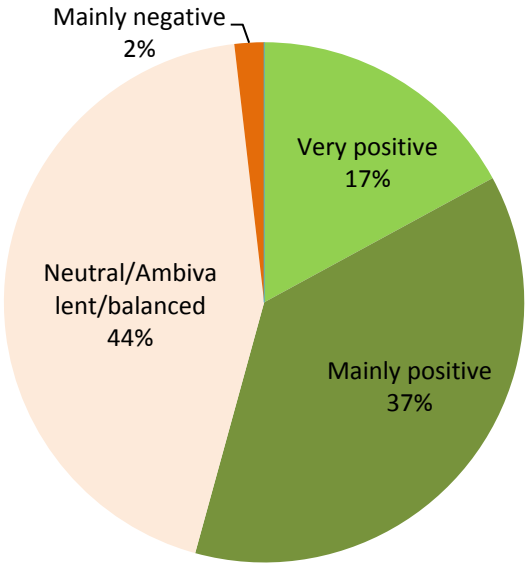


Figure 8. *General valuation of fusion energy in the fusion related articles from January 2008–July 2012 (v33; % of articles; n= 166)*

The articles providing a very positive evaluation of fusion generally focus on the potential benefits of developing nuclear fusion. Fusion is presented as a very positive step forward in science and also as a potential solution to the energy problems.

The following figure represents the valuation of fusion in the articles in the five most frequent thematic areas. The data show that valuation of fusion differs depending on the thematic frame. Articles dealing with research projects are, on average, more positive towards fusion than those dealing with energy policy or investment costs. Only 25% of the articles in this thematic frame are neutral. Evaluation of fusion is dominantly neutral when the articles deal with the investment costs. Significantly, around 10% of the articles in the energy policy thematic area show a negative evaluation of fusion energy.

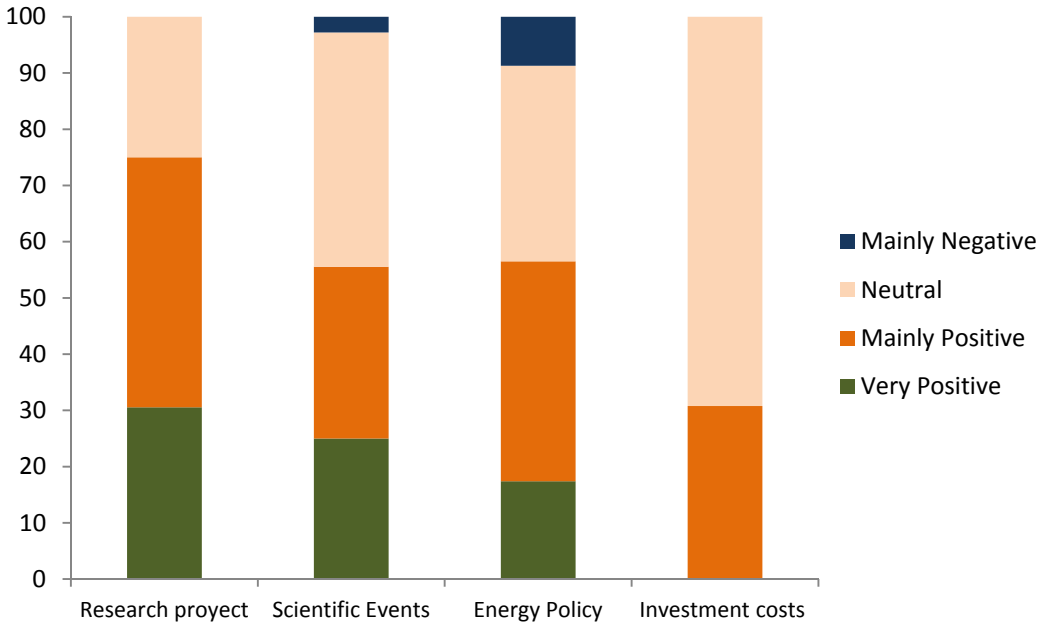


Figure 9. *Valuation of fusion energy in the various themes from January 2008–July 2012 (v33 vs v22; % of articles; n= 166)*

The picture is different for nuclear fission when mentioned in articles mentioning fusion. Articles mainly give a neutral view of fission (46%). But a significant percentage (23%) of the articles provides a negative valuation of fission.

Statements on benefits and costs

On average, articles mention 1.7 statements regarding the potential benefits and costs of fusion. But a significant 28% of the articles do not provide any statement about nuclear fusion. They just mention nuclear fusion or provide information related to fusion energy or fusion research, but do not provide any idea or argument regarding fusion characteristics. A significant amount of articles mention one (25%) or two (15%) themes to discuss fusion properties. Some of these themes are just mentioned (e.g. "fusion could be a source of clean energy"); others are more developed in the article.

The most frequent themes in the articles are "**energy source limits**" (mentioned in almost 52% of the articles mentioning at least one benefit/cost), "**energy source cleanliness**" (in 47% of the articles) and "**technology feasibility**" (in 43%). "Energy source limits" refer mainly to the characterization of fusion energy as an unlimited source of energy. Half of the articles referring to at least one theme mention this idea. The cleanliness of fusion energy, as compared to conventional energy sources, and the feasibility are the other most frequent themes.

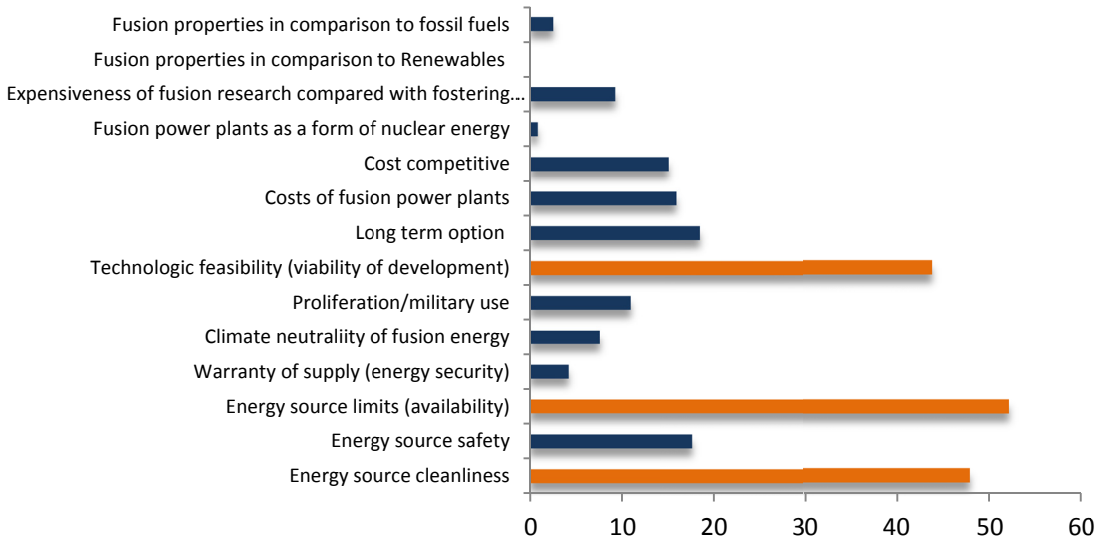


Figure 10. *Percentage of articles mentioning various fusion-related costs/benefits from January 2008–July 2012 (v35; % of articles; n= 166)*

Fusion energy is often presented as an unlimited, safe and clean source of energy. In the data, we can see that the idea that fusion energy will be an abundant and unlimited source of energy is the idea more positively portrayed (4.2 in a 1 to 5 scale). The other ideas more positively presented (see figure below) are the clean character of fusion and its safety.

The viability of development of nuclear fusion receives a more neutral view in the articles (value of 3 in the scale). 43% of the articles discussing benefits and costs of fusion mention this idea. This means that the viability of fusion is frequently mentioned in the articles, but that this is not strongly considered a negative issue.

The idea that fusion is a long term option is relatively frequent in the articles. Almost 15% of the articles mention this idea. The valuation associated, as seen in the figure, is neutral to negative.

The costs of fusion power plants and the expensiveness of fusion research are other significant ideas related to the fusion energy content. Almost 20% of the articles refer to the economic costs of fusion energy (if we add the expensiveness of fusion research as compared to renewable and the costs of fusion power plants). As seen in the graph, these two statements are, on average, the most negatively portrayed (average lower than 3). The idea that fusion is expensive is, in fact, the most negative idea registered in the articles.

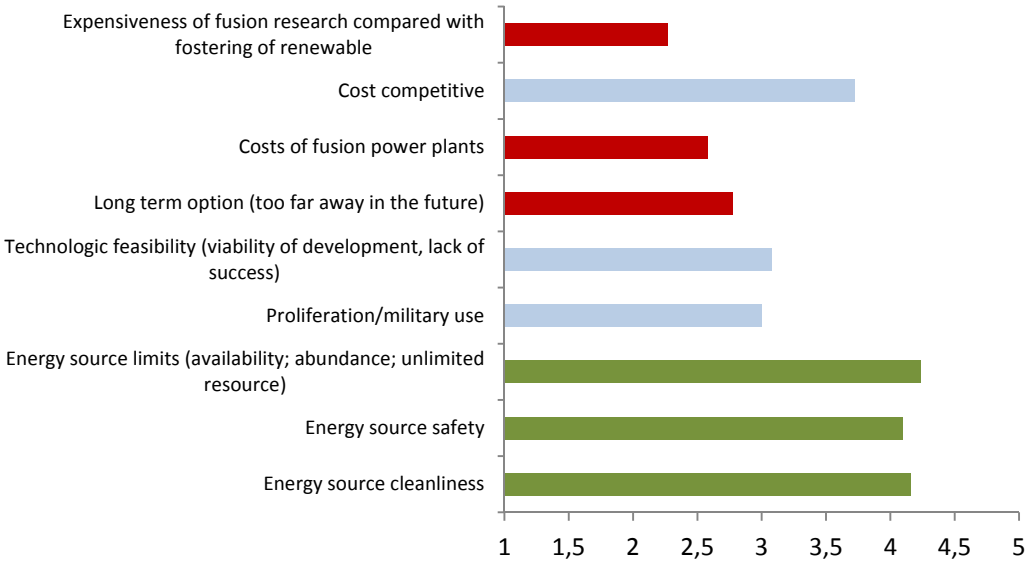


Figure 11. *Average evaluation of the various themes regarding nuclear fusion from January 2008–July 2012 (1- Very negative; 5- very positive) (v35, average value per item; n= 166)*

Finally, nuclear fusion is poorly associated with climate protection and the warranty of supply, but also to risk management or accidents.

We can conclude that the unlimited character of fusion energy is the main benefit associated with fusion in the articles, followed by the clean character of fusion and its viability of development. Even articles not providing a deep characterization of fusion energy tend to present it as an unlimited and clean source of energy that could solve current energy problems. The data also show that fusion energy is not linked to climate change mitigation, and very few articles mention the idea that fusion energy does not produce CO_2 emissions.

The effect of the Fukushima accident

The effect of the Fukushima accident on the coverage of nuclear fusion seems to be quite limited. The data show a decrease in the number of articles with fusion-related content after the accident. But this may be only linked to a high volume of content in 2010 as a result of the debate around the funding of ITER. Even if the coverage of nuclear fusion is not totally associated with the Fukushima accident, some of the articles on nuclear fusion also mention the accident at Fukushima power plant. The volume of content on nuclear fusion fluctuates with its own dynamics and only 32% of the analyzed articles from March 2011 to July 2012 mention the Fukushima accident.

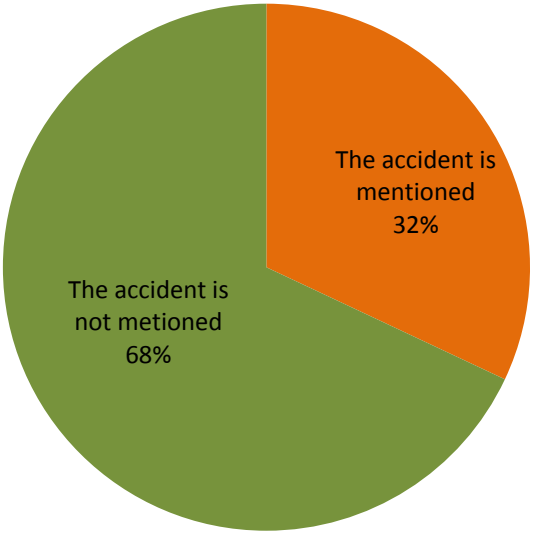


Figure 12. *Percentage of fusion related articles referring to the nuclear accident in Fukushima from January 2008–July 2012 (v.8; % of articles; n= 166)*

Are the articles mentioning the Fukushima accident different from those not mentioning it? Articles on fusion that refer to the Fukushima accident are slightly different from the whole sample of articles. They tend to focus more on energy policy issues. And, significantly, they tend to be more positive towards fusion energy that the average of articles (see table below). This seems to be due to the fact that articles mentioning the accident refer to fusion as a potential solution for future energy security and environmental problems.

	Fukushima is mentioned	**Fukushima is not mentioned**
Very positive	35%	15%
Mainly positive	29	38
Neutral	29	45
Mainly negative	6	1
Total	100% (17)	100% (147)

Table 2. *Valuation of nuclear fusion vs the mentioning of the Fukushima accident*

(v33; in % of fusion articles)

Only 5% of the articles with fusion-related content mention other accidents in the nuclear world (e.g. Chernobyl). Safety is a theme associated with nuclear fusion, but generally in positive terms, given that nuclear fusion is not generally discussed in articles dealing with risk management issues.

Regarding the differences in coverage of fusion energy, valuation and thematic content before and after the accident in Fukushima, the data shows that:

- There are no significant differences in the level of information about fusion provided in the articles before and after the Fukushima accident.
- There are minor differences between articles before and after the Fukushima accident in terms of general valuation attributed to fusion. The percentage of articles coded as very positive to fusion energy grows from 14% to 24% after the accident. As explained in the second section, articles after Fukushima tend to present nuclear fusion as a potential solution for nuclear energy related problems.

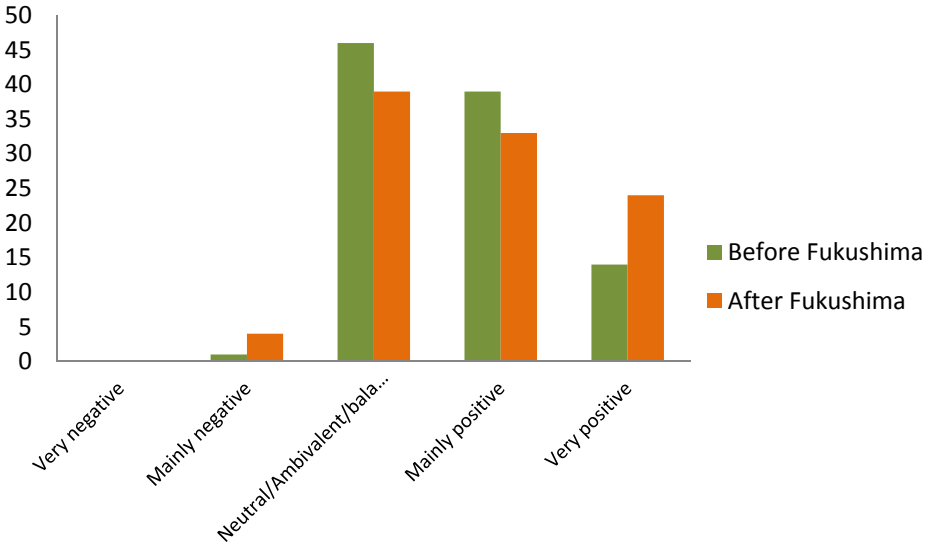


Figure 13. *Valuation of fusion energy before and after the accident in Fukushima from January 2008–July 2012 (v33; in % of fusion related articles; n= 166)*

- There are minor differences in the frequency of themes covered before and after Fukushima. The expensiveness of fusion research and the need of fusion to warranty the electricity supply are mentioned more frequently before Fukushima. The safety of fusion is significantly more frequently mentioned after the accident.

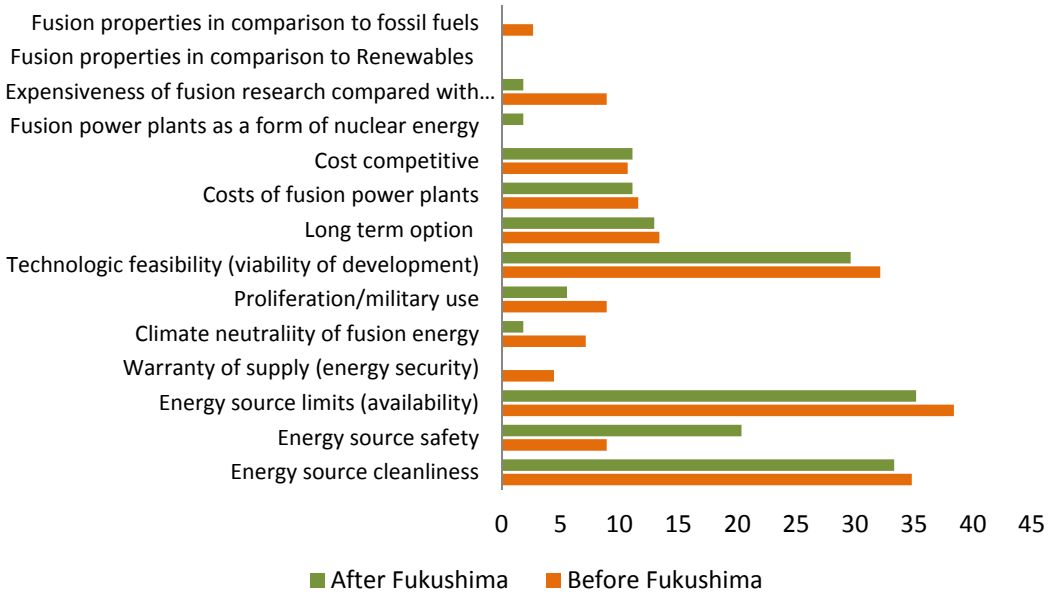


Figure 14. *Average evaluation for the various themes on nuclear fusion (1- Very negative; 5- very positive) before and after Fukushima (v35; in % of articles; n= 166)*

The average valuation associated to the statements is from neutral to positive (3.5 in a 1 to 5 scale). On average, themes portray positive evaluations (e.g. fusion is an unlimited resource), but also neutral evaluations ("technology feasibility"). If we consider the statements per year, we find minor differences in the average valuation. 2010 seems to be the year registering lower valuations of nuclear fusion costs and benefits. This could be related to an increase in news articles covering the costs of funding ITER. But even in this year, the average valuation is above 3.

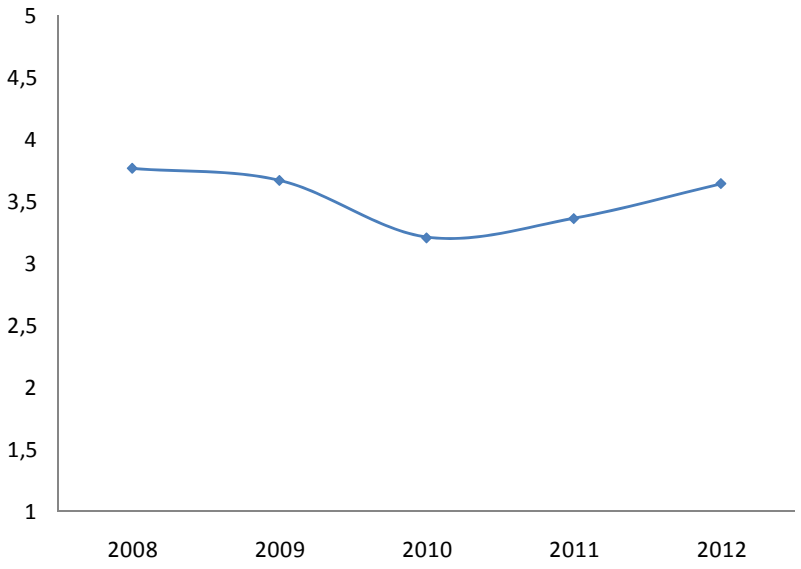


Figure 15. *Evolution of the average evaluation of the various themes related to nuclear fusion from 2008 to 2012 (1-very negative; 5-very positive) (v35; average value)*

Qualitative thematic analysis of the public discourse on fusion

As described in the methodological section, a qualitative thematic analysis was carried out to understand print media presentation of nuclear fusion. A template in the form of codes was developed and applied to a sample of 28 articles with fusion-related content.

In the following pages, the main results of the analysis are summarized. The analysis is structured following the coding structure previously developed. The main ideas and sub-codes in each of the thematic codes are presented in bullet points.

Characterization of fusion (all articles)

The content analysis showed that nuclear fusion is mainly linked to scientific events and research projects and, second, to energy policy. But what is the characterization of fusion? What are the ideas and words first associated to fusion? The analysis of the text shows the relevance of three main associations:

- Nuclear fusion as a source of energy. Nuclear fusion is framed as a potential source of energy for the future. This is the main characterization of nuclear fusion. In this frame, nuclear fusion is linked to very positive ideas, such as an unlimited and clean character. Of special importance is the Sun metaphor that stresses the idea that fusion energy is the energy produced by the Sun and other stars. As defined in one of the articles:

  A clean alternative to the other energies…fusion is the process of imitation of the Sun (art. 104)

- Nuclear fusion as a product of ITER. Fusion is also first mentioned in terms of a product of ITER. ITER is the main topic of the article and fusion is defined in order to explain the main objectives of ITER. Fusion is framed in terms of energy generation, but has a subsidiary role in the article. The following textual units show this idea:

  ITER is an international project aimed at producing in the Earth the process generated in the Sun, which would produce an unlimited source of energy (art. 82)

  This project (ITER) is building a prototype reactor of fusion energy… (art. 181)

- Nuclear fusion as a scientific challenge. Besides being a source of energy for the future, nuclear fusion is presented as a scientific endeavor. In some articles, nuclear fusion is first portrayed as one of the main challenges in science.

Energy source environmental impacts (information found in 17 articles of 25)

There is a clear representation of fusion energy as a clean source of energy. Articles precisely refer to the “clean” character of fusion. Some of the articles do not go further into this issue and just mention

the idea of cleanliness. Some others (11) provide more details regarding the environmental impacts of fusion energy. The description of fusion as a clean energy is based on two elements:

- Low to zero production of (short lived) radioactive waste (mentioned in 12 of 25 articles). Some articles mention that fusion energy will not produce long lived radioactive wastes. The risk of contamination by fusion energy is clearly minimized in these articles. Some articles state that fusion "is almost harmless" (29). Linked to this code is the relation between fusion energy and nuclear fission. Three articles establish a comparison between fusion and fission regarding environmental contamination. This idea is clearly mentioned in the following unit:

  Present nuclear power plants generate wastes that stay active for hundreds of years. In comparison, fusion is almost innocuous… (art. 14)

- No CO_2 emission (mentioned in 7 of 25 articles). No CO_2 production is the other environmental benefit (as it is associated with positive effects) mentioned in the articles. These articles just mention that fusion energy will not produce CO_2. It is interesting that these articles do not discuss fusion energy in the broader context of climate change mitigation. One article shows this benefit:

  (fusion) allows producing huge quantities of electricity without emitting CO_2*, which make us thinking that this will be a very interesting issue in the medium term*. (art. 51)

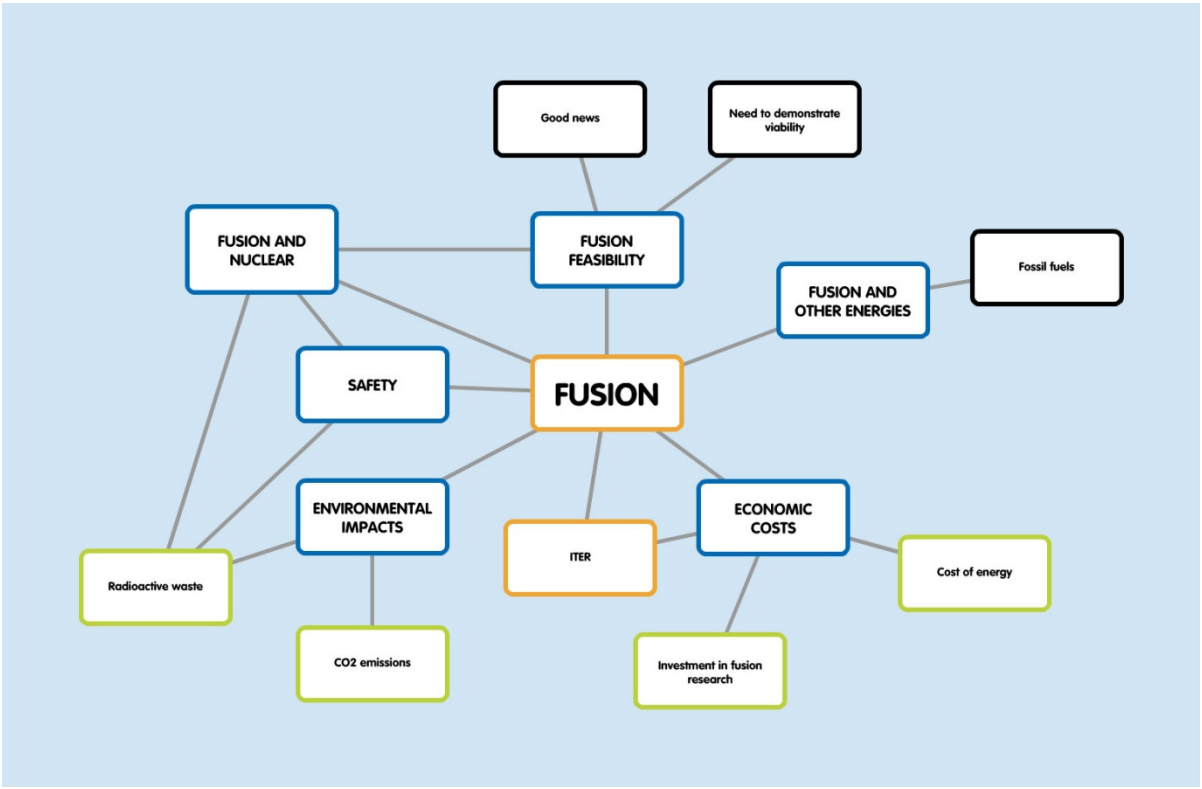


Figure 13. Visual representation of the discourse around fusion energy in the print media

Safety issues (found in 7 articles)

The safety of nuclear fusion is less developed than other thematic dimensions. When the word safety is mentioned, it is just to define fusion energy as a safe source of energy. We find various evidences of this:

> *Fusion is safe* (art. 85)
>
> *A safe and clean energy* (art. 29)

Some of these articles (3 in our sample of 18) provide an explanation of why fusion energy is a safe source of energy. These articles state that fusion reactors are easily stopped with almost zero risk. When comparisons with nuclear fission are established in this code, it is to show that the probability of accidents like those produced in nuclear reactors is zero in future fusion reactors.

> *Regarding safety, a fission reactor out of control becomes an atomic bomb. However, in order to control one of fusion, you just need to switch it off* (art. 104)

Energy source limits (in 12 articles)

Fusion energy is depicted as an endless, unlimited and abundant energy in some articles. Articles mention this as one of the main advantages of promoting fusion energy, but do not discuss this idea in the context of energy security problems. These articles neither explain why fusion energy is a never ending source of energy. Only two articles provide some level of explanation: one based on the fact that fusion reactors use unlimited resources such as water isotopes and the other based on the idea that the fusion reaction does not need external inputs.

The role of fusion energy in guaranteeing future energy supplies is not sufficiently developed in fusion-related stories. Only two ideas regarding the energy security were found. Both argue in the sense that fusion energy could be a potential solution to current and future energy problems:

> *It is a step forward to solve the energy problem* (art. 102)

Technology feasibility (found in 19 articles)

This is the most substantial thematic area in the articles on nuclear fusion. While other codes are poorly developed in the majority of articles, the feasibility of fusion generates more textual units. The first idea in the articles is the *need of fusion to demonstrate viability*. This is not necessarily portrayed as a negative issue, and most of the times this idea is neutrally portrayed, linked to the objective of ITER. But still some articles consider this as the main drawback of fusion energy:

> *The problem of fusion is to demonstrate its feasibility* (art. 104)

Linked to the feasibility of fusion is the idea that *fusion energy it is too far in the future*. Mentioned in some of the articles (6 of 18), this is negatively associated to fusion, as showed by the use of expression such as: it is “too far in the future” or it is a “long term reality”.

The feasibility of fusion is also framed in positive terms in the articles. Some of the articles (5 of 18) clearly state that *there are good news* regarding fusion research. Textual units in this code emphasize that fusion research has come to reality by presenting new scientific achievements. These textual units are clearly linked to articles dealing with scientific achievements and research projects. In this frame, scientists supporting fusion research play a key role. Some of the following textual units demonstrate this positive frame:

> *"Fusion works"* (art. 85)
>
> *"Fusion is not a dream anymore"* (art. 89)
>
> *It seems that the day has come* (art. 51)

Economic costs (in 14 articles)

Regarding the costs of fusion energy, there are two main ideas in the articles included in the sample:

- The costs of investment in fusion research (in 10 articles). This is the main topic regarding the economics costs of fusion. Textual units dealing with this idea usually refer to ITER and its associated funding problems. Words in this code indicate a negative evaluation: "shortfall", "deficit", "increase in cost", and "the cost is out of control". One of the articles mention this idea:

  > *The costs of this overambitious plan are out of control* (art. 85)

  This does not mean that articles suggest that investments in ITER should be cancelled or postponed. In fact, we have found very few articles mentioning the need to stop investments in fusion research. But articles tend to emphasize the difficulties of governments (and specially the European Commission) to defray the costs of ITER.

- The costs of fusion energy. Textual units in this code provide a different evaluation (mainly positive) for fusion energy than those dealing with the investment costs. Fusion energy is defined (in 5 articles) as *cheap.* But only one of the articles provides an explanation of this evaluation, referring to the low cost of the raw materials for fusion energy (water from oceans). The other articles simply do not develop the idea of fusion as s cheap source of energy.

Fusion and nuclear fission (found in 12 articles)

Some of the articles in our sample not only mention fusion and fission, but compare nuclear fusion properties to nuclear fission. The main objective of these textual units is to clearly differentiate between fusion and fission for the public. Some articles state that fusion "has nothing to do with nuclear fission" or that fusion has many advantages as compared to fission. The idea is that fusion is a new technology different from fission.

What elements are elicited by the articles to show the differences between fusion and fission? There are two main issues: safety and the production of radioactive wastes. 4 of 9 articles state that fusion is, contrary to nuclear fission, a safe source of energy. 7 of 9 articles mention that fusion will not

produce as much as radioactive wastes as nuclear fission, being this idea the most clearly associated to the comparison of fusion and fission.

The textual analysis clearly shows that the "nuclear brand" is not associated with nuclear fusion in our sample of articles. No mentions were found to the idea that nuclear fusion has some of the disadvantages attributed to nuclear fission (negative resonances in terms of fear, stigma, etc.).

Articles on fusion energy that mention the accident in **Fukushima** have some peculiarities, and textual units in this category emphasize in a more depth the advantages of fusion energy compared to nuclear fission. Two of the articles included in the sample clearly make a comparison between fusion and fission. They basically refer to the environmental impacts and the safety of fusion:

> *There are too many advantages for fusion and too many drawbacks for fission* (art. 151)

In these articles, fusion is portrayed as a clean and safe source of energy, while nuclear fission is represented as a non stable and dirty source of energy. One of the articles clearly state that the accident may foster the development of fusion energy:

> *The tragic accident may encourage a faster development of fusion energy due to its safety* (art. 162)

Fusion energy and other energies (in 10 articles)

Some of the articles in our sample associate somehow nuclear fusion with other energy technologies (apart from nuclear fission). Oil, solar, wind and coal are mentioned in relation to fusion energy. The presentation of these energy sources in fusion-related articles seems to be associated with one of the following functions.

- Fusion as a complementary energy (in 4 articles). These articles point to the role of fusion in a mixed energy systems (mainly with renewable and fission energy). The evaluation of fusion seems to be more neutral in this category.
- Positive comparison (in 3 articles). Some articles clearly state that fusion energy could be a positive alternative to current energy technologies based on fossil fuels (oil and coal).
- Negative comparison (in 1 article). The comparison of nuclear fusion to other energy technologies can also be aimed at providing a negative evaluation of fusion. One article states that the costs of fusion energy should be used to promote solar and wind energies.

The Fukushima accident (5 articles)

Of the articles with fusion-related content that mention the Fukushima accident, very few directly link Fukushima with fusion. There are two main ideas:

- Fusion is a better option than fission after Fukushima. In 3 of the 5 articles, fusion is portrayed as a solution to the safety problems of nuclear energy after the accident. This is

consistent with the results obtained in the content analysis that showed that the valuation of fusion is more positive in the articles mentioning the Fukushima accident.

- Impact of Fukushima on ITER. One of the articles mentions the reevaluation of safety standards of ITER after Fukushima.

Other emergent codes

Among the codes that inductively emerged in the thematic analysis, two need a special mention.

- ITER. ITER could be considered a code in itself (funding, role in fusion, characteristics, etc.)
- Impacts in the Spanish economy. The potential benefits of fusion (mainly through Fusion for Energy Agency) on the Spanish industry and on job generation.

The main categories analyzed in the section on the statements on benefits and costs about fission energy appear very clearly represented in the thematic analysis. The qualitative analysis has allowed a deeper understanding of the media presentation of nuclear fusion. One first result is that the various themes regarding fusion energy are not extensively developed in the media articles. Fusion energy is mainly characterized in positive terms and linked to three main areas: a potential source of energy for the future, ITER and a scientific challenge.

Fusion is shaped as a clean, safe and unlimited source of energy. The positive brand of fusion in the print articles with nuclear- fusion related content is based on various thematic elements. First, articles argue about the potential environmental benefits of fusion, mainly no radioactive wastes and no CO_2 emission (although very few explicit links to climate change have been found). Second, fusion is portrayed as an unlimited source of energy and a potential solution to future energy problems. Third, fusion is linked to safety issues and portrayed as a safe source of energy, but this idea is not developed in depth in the articles. The feasibility of fusion is often associated to any description of fusion energy (in fact, this is the most mentioned category). But feasibility issues are not clearly represented as a drawback for fusion technology. Finally, the economic costs of fusion energy are associated to ITER research (with some negative associations) and to the potential costs of energy production (with positive associations). All these elements configure the media presentation of nuclear fusion.

Side effects of fusion technology (potential safety issues, environmental impacts) are not relevant factors in the presentation of fusion in the media. When nuclear fusion is linked to nuclear fission, it is often to emphasize the clean and safe character of fusion energy. This “new brand” (compared to the “nuclear brand”) of fusion technology seems to dominate the print media presentation of fusion.

	Not mentioning Fukushima accident	Mentioning Fukushima accident
Characterization of fusion	Nuclear Fusion is mainly characterized: • As a source of clean and unlimited energy • As a product of ITER • As a scientific challenge Not clear links are established to the nuclear frame	*Same as articles not mentioning the accident*
Energy source cleanliness	Fusion is considered a clean source of energy. This is based on two elements: • Low production of (short lived) radioactive waste • No CO_2 emission	*Same as articles not mentioning the accident*
Energy source safety	Fusion portrayed as a safe technology. Very limited development in the articles of this idea. When developed, two factors are mentioned: • Fusion reactors are easily stopped • The probability of accidents like those produced in nuclear reactors is zero in future fusion reactors	*Same as articles not mentioning the accident*
Energy source limits	Fusion energy is depicted as an endless, unlimited and abundant energy. Very low level of development of this idea	*Same as articles not mentioning the accident*
Technologic feasibility	This is the main code in the representation of fusion energy. Three main associated ideas are: • The need of fusion to demonstrate viability • Fusion energy it is too far in the future • There are good news regarding fusion research	*Same as articles not mentioning the accident*
Proliferation/military use	Idea not developed	*Same as articles not mentioning the accident*
Economic costs	Two main codes: • The costs of investment in fusion research. This code is mainly associated to the costs of ITER. There is a negative evaluation: “shortfall”, “deficit”, “increase in cost”, “the cost is out of control”.	*Same as articles not mentioning the accident*

	• The costs of fusion energy. Fusion energy is here defined as cheap.	
Fusion energy and nuclear	When fusion and fission are mentioned together, fusion is portrayed as having many advantages as compared to fission. This comparison is mainly based on two elements: safety and radioactive wastes. The nuclear brand is not associated with nuclear fusion in our sample of articles	The differences between nuclear fusion and nuclear fission are more strongly stated. Fusion portrayed as clean, safe and inexhaustible. Fission portrayed unsafe, producing radioactive wastes and exhaustible
Fusion energy and other energies	Fusion is linked to other energy technologies: • As a complementary energy. Fusion as a part in mixed energy systems. • Fusion as an alternative to current energy technologies based on limited fossil fuels (oil and coal). • Fusion as an obstacle to promoting solar and wind energies.	
The Fukushima accident		• Fusion is a better option than fission after Fukushima. Fusion as a solution to the safety problems of nuclear energy after the accident. • Impact of Fukushima on ITER.
ITER	• Funding issues, international relations • Role in fusion • Characteristics	
Impacts in the Spanish economy.	The potential benefits of fusion (mainly through Fusion for Energy Agency) on the Spanish industry and on job generation.	

Table 4. Key elements in the thematic codes

3.2. Nuclear fission energy

General characterization of articles

Figure 1 depicts the trend in news coverage of nuclear energy in three print newspapers. In 2010, the data show a slight decrease in the number of articles with nuclear content. The volume of news on nuclear fission is significantly high in January 2010, mostly linked to the controversy on radioactive waste management in Spain, but decreases in the following months. The volume of nuclear energy content grows significantly from March 2011 to Juny 2011 as a result of the coverage of the Fukushima accident. The volume of content grows again in March 2012, one year after the accident, and returns to its previous volume.

In sum, media coverage of nuclear energy increased significantly one year after the Fukushima accident as compared to the situation one year before (937 articles against 421 articles). The Fukushima accident had a huge effect on the volume of nuclear content in the newspapers. The trend observed in the figure shows that this effect decreases two years after the accident.

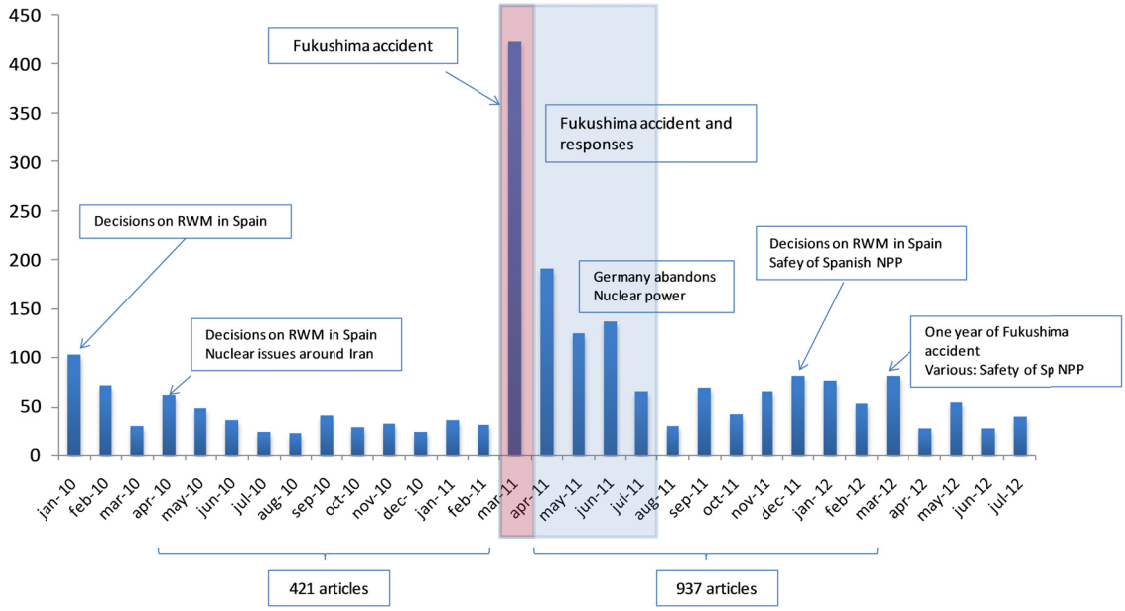


Figure 16. *Evolution of the number of articles with nuclear energy-related content (three newspapers) from January 2010-July 2012*

Compared to the coverage of nuclear fusion, in the majority of the articles in our sample, nuclear fission is the core subject. Around 80% of the articles in our sample have nuclear fission as a core subject. The percentage is higher in the period after Fukushima, where almost 90% of the articles are focused on nuclear fission. Before Fukushima, more articles (30%) cover nuclear as a subsidiary context (eg. international relations, general energy policy, etc.),

meaning that they are not focused on nuclear. In both periods, less than 3% of the articles cover fission as a marginal subject, whereas for fusion this percentage was around 30%.

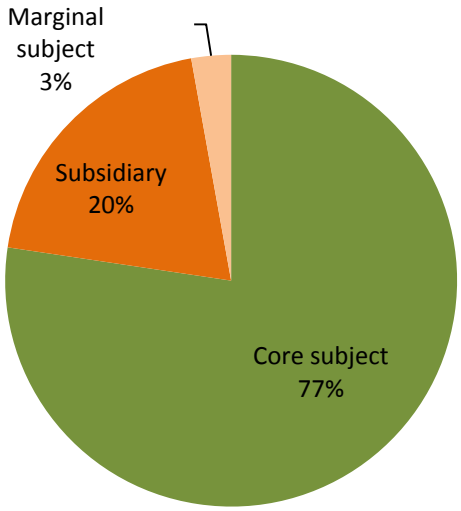


Figure 17. *Role of nuclear energy in the nuclear related articles from January 2010-July 2012 (v16; % of articles; n= 486)*

Thematic content

Energy policy and safety related issues are the main thematic frames associated with the nuclear-related content in the Spanish newspapers. General discussions about the role of nuclear energy in the energy system of Spain and other countries (mainly Germany, Japan and United States, but also France, Brasil, Chile, Argentina) account for 31% of the articles in the sample. This includes the debates about nuclear energy, the end of the nuclear program in Germany, the building of new nuclear power plants or the debates around the revision of existing power plants in Spain.

The Fukushima accident is the central topic of 20% of the articles in our sample (published after the accident in March 2011). Risk management, accidents and emergencies account for 13% of the articles, showing a clear focus in the media coverage on safety and emergency issues.

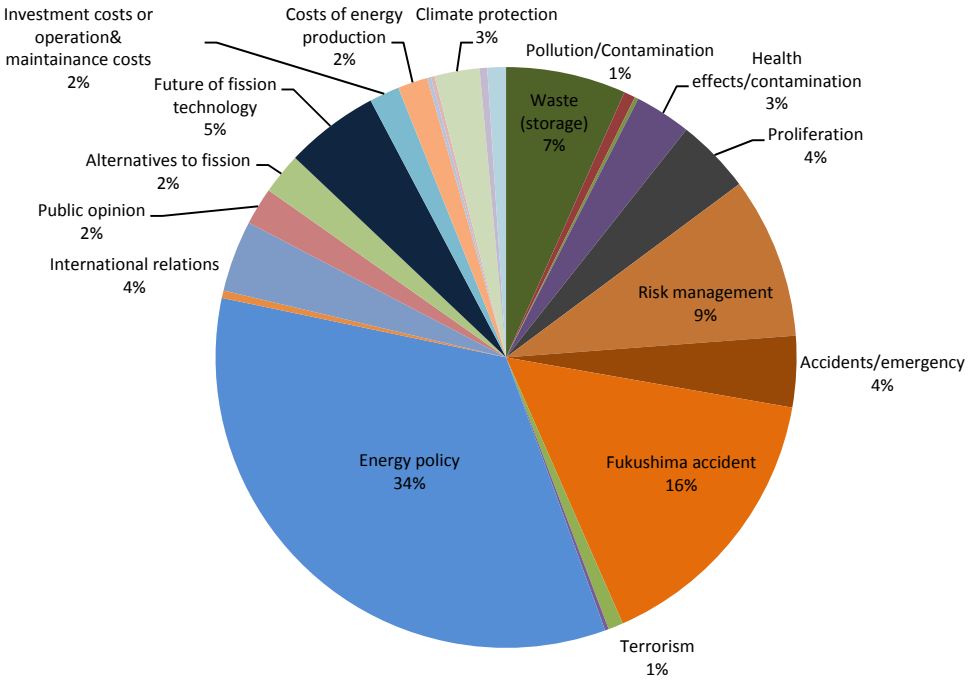


Figure 18. *Thematic content in print media articles on nuclear from January 2010-July 2012 (v22 & v23; % of articles; n= 486)*

The storage of radioactive waste is a topic in itself in the Spanish media, accounting for a 7% of the articles. This has been a central topic of debate in the last four years, given the proposals for a nuclear waste repository in various regions in Spain. The final decision was taken at the beginnings of 2012. The future of fission technology (5%), military proliferation (4%) and international relations (4%) are other significant central topics in the studied articles. Of special importance is the link between nuclear and proliferation in Iran and North Korea.

Actors

Figure 17 depicts the main actors referred in the nuclear-related articles. Foreign politicians (e.g. Merkel, Obama, foreign ministers etc.) are the most frequent actors in the articles. This clearly shows the international character of the nuclear debate. Environmental groups and organizations are the second most important actor and represent 16% of the actors mentioned. National and international environmental groups are a prominent actor in the nuclear debate. This shows a significant difference as compared to nuclear fusion. The other actors most frequently referred in the articles are the national politicians (14%), followed by representatives of the industry (10%), regional politicians (7%) and consumers and citizens (7%). National and regional politicians are clearly linked to the national debate on nuclear energy.

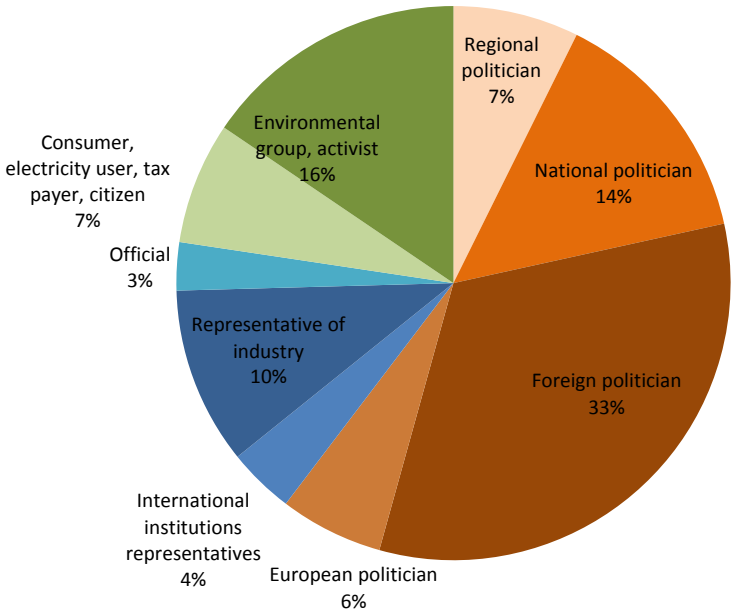


Figure 19. *Main actors in nuclear fission related articles from January 2010-July 2012 (v27; % of actors; n= 513)*

The position of the actors represented in the nuclear-related content is almost balanced between a negative position (44% of the actors) and a positive position (38%). A 18% of the actors is portrayed as neutral or ambivalent towards nuclear fission.

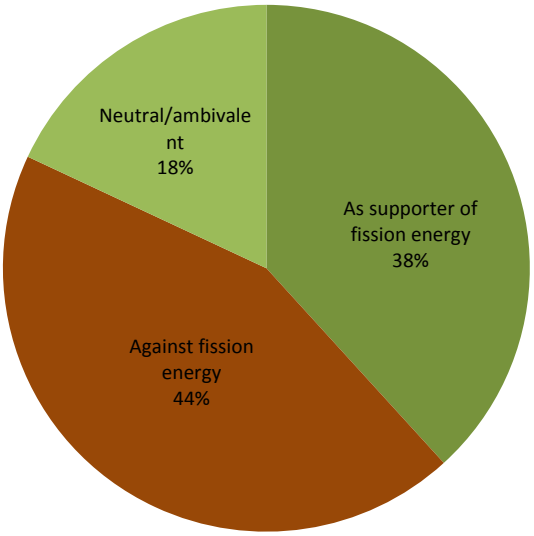


Figure 20. *The position of the main actors in nuclear fission related articles from January 2010-July 2012 (v28; % of actors; n= 513)*

There are strong differences in the presentation of the various actors in the articles. While environmental groups and groups of citizens and consumers are almost always portrayed as negative towards nuclear energy, representatives of the industry are usually positive about nuclear. Politicians show more variation in terms of valuation. Around 50% of the politicians (national and international) in the articles are positive about nuclear fission and around 30% of them are negative. Regional politicians are more negative about nuclear, mainly due to opposition to nuclear power plants and radioactive waste facilities. Scientists are the actor represented as less concentrated on one category. Almost 40% of the scientists is represented as neutral or ambivalent towards nuclear.

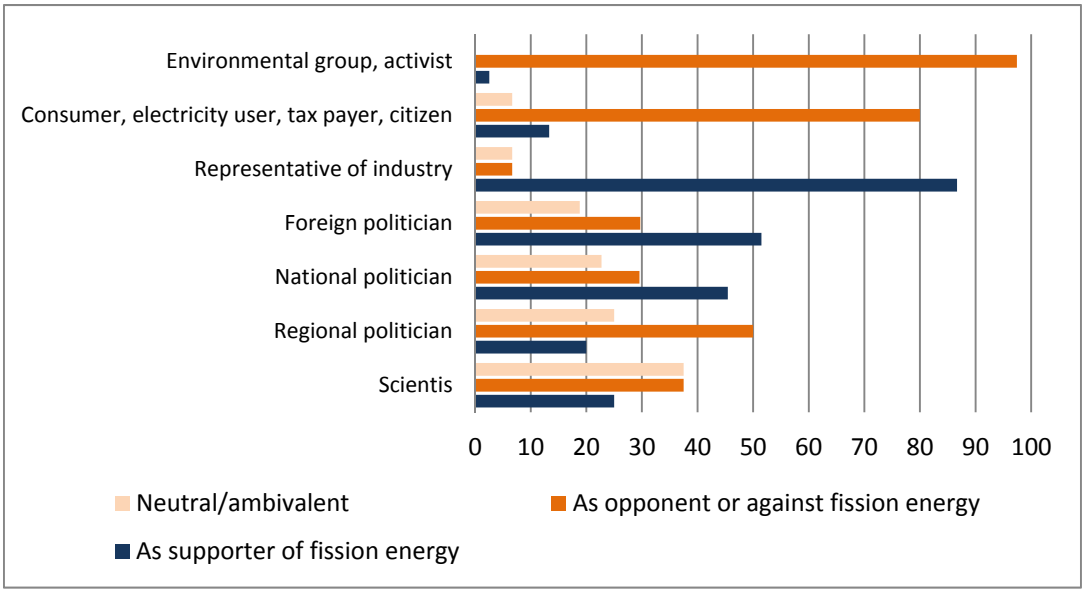


Figure 21. *The position of the main actors in nuclear related articles from January 2010-July 2012 (v27 vs v28; % of actors; n= 513)*

Valuation of nuclear fission

In general terms, the content of nuclear-related articles is associated with negative events (the accident at Fukushima, demonstrations, policy decisions against nuclear energy). Figure 20[2] shows that around 60% of the articles with nuclear- related content are associated with a negative valuation. A significant 20% of these articles are neutral. Another 20% of the articles link nuclear with a positive content (the planning of new nuclear power plants, policy actors in favor of nuclear energy, etc.). Only 3% of the articles could be considered as promoting nuclear energy.

[2] In order to give a general evaluation of the article, we considered as negative those articles linking nuclear with negative events, and not only those providing clear arguments against nuclear energy.

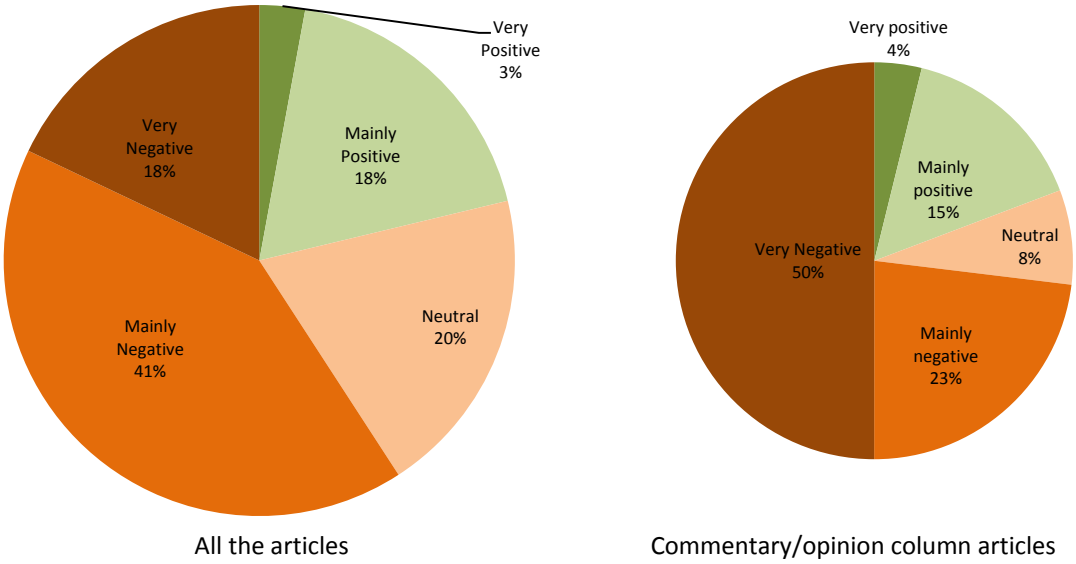


Figure 22. *General valuation of nuclear fission vs type of article from January 2010-July 2012 (v34; % of articles; n= 486)*

The picture is different if we consider opinion articles. These articles are of special interest, as they often take a clear position towards nuclear and provide arguments in favor or against nuclear. The figure in the right side shows that 50% of these articles are very negative about nuclear energy and 23% of them mainly negative. Only 8% of commentary articles are neutral and 19% of them are positive. The data clearly show that those articles in our sample providing a deeper evaluation of nuclear energy tend to provide a position contrary to nuclear energy.

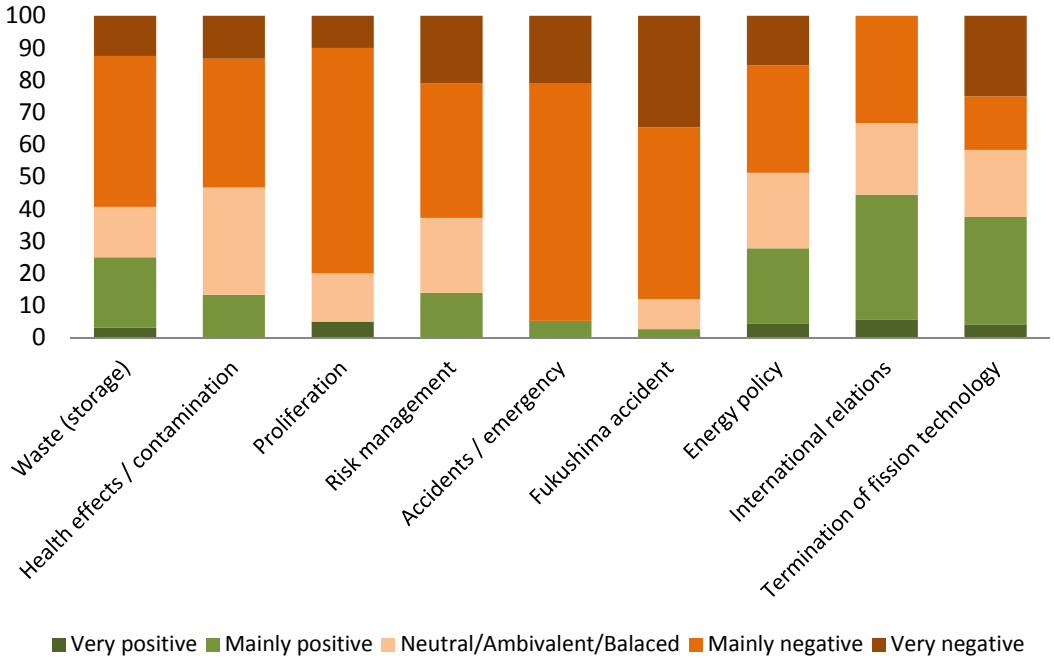


Figure 23. *Valuation of nuclear fission in the various themes from January 2010-July 2012 (v34 vs v22; % of nuclear fission articles; n= 486)*

As depicted in the figure 21, the general valuation towards nuclear energy differs among the various thematic frames. Articles dealing with accidents, risk management and the Fukushima accident provide a more negative representation of nuclear energy. Interestingly, articles on energy policy are more neutral about fission. Also articles on waste management, international relations and those about the future of fission technology are, on average, less negative about nuclear energy than articles in other topics.

Statements on benefits and costs about fission energy

The majority of the articles (around 50%) with nuclear fission content mention one statement (cost/benefit) about nuclear fission. Around 20% of the articles do not mention any benefit or cost associated with fission. The other 30% of the articles have more than one statement about fission.

The most frequent cost/benefit found in the articles is the safety of nuclear. Around 45% of the articles refer to this issue. This can be explained by the coverage of the Fukushima accident. Before the accident, only 20% of the articles refer to safety of nuclear. This percentage grows to 60% after the accident. Articles arguing about safety tend to provide a negative evaluation of this dimension. The average valuation attributed to this statement is mainly negative (2.4 in a 1 to 5 scale) (figure 24). This is the lowest value among the various statements. Nuclear safety tends to be presented in negative terms.

The environmental impacts of nuclear ("energy use cleanliness") are the second most frequent statement associated with nuclear. Also associated with a negative valuation (2.4), around 20% of the articles mention this idea. Fission energy is linked to contamination and radiation, and is usually portrayed as a dirty energy with associated risks to the environment. A proportion of these articles (around 10%) even literally mention that "nuclear energy is not a clean source of energy".

The links of nuclear fission to proliferation, the costs of nuclear energy and the warranty of supply are the other main ideas in the articles. The risks of proliferation are mentioned in 19% of the articles. This percentage is significantly higher in the articles before the accident (26%). This is explained by the fact that a significant amount of the articles deal with the nuclear program in Iran and North Korea. This risk is evaluated, on average, in neutral to negative terms.

The costs of nuclear energy are frequently mentioned in the articles about nuclear. More than 20% of the articles refer to the idea that nuclear energy is cost competitive or to the costs of fission power plants. The costs of nuclear are more frequently mentioned before Fukushima. As seen in the graph, the idea of cost competitive is generally portrayed as a neutral characteristic of nuclear energy (value 3), while the costs of nuclear power plant (mainly the building of new nuclear power plants) is regarded as a cost (mainly negative evaluation).

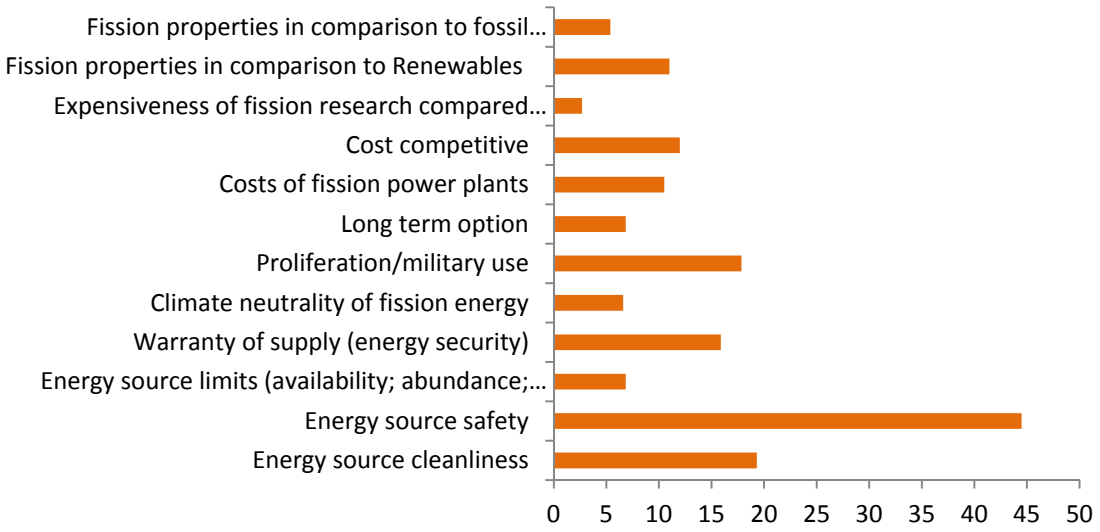


Figure 24. *Percentage of articles mentioning various nuclear fission-related statements from January 2010-July 2012 (v36; % of articles; n= 486)*

The benefits or nuclear energy in terms of warranty of supply are mentioned in 15% of the articles. Actors in favor of nuclear energy tend to mention this idea (nuclear energy contributes to the warranty of supply). Also commentary columns and news in brief present this theme. As depicted in the figure, this is a frequent idea in the media articles before and after Fukushima. This statement is portrayed, on average, as mainly positive.

Finally, the comparison between fission energy and renewable energy plays also a role in the media coverage of nuclear fission. 10% of the articles establish a comparison between nuclear and renewable. When this idea is mentioned, is often to suggest that renewable energy is a better option than nuclear (as seen in the negative evaluation of this item).

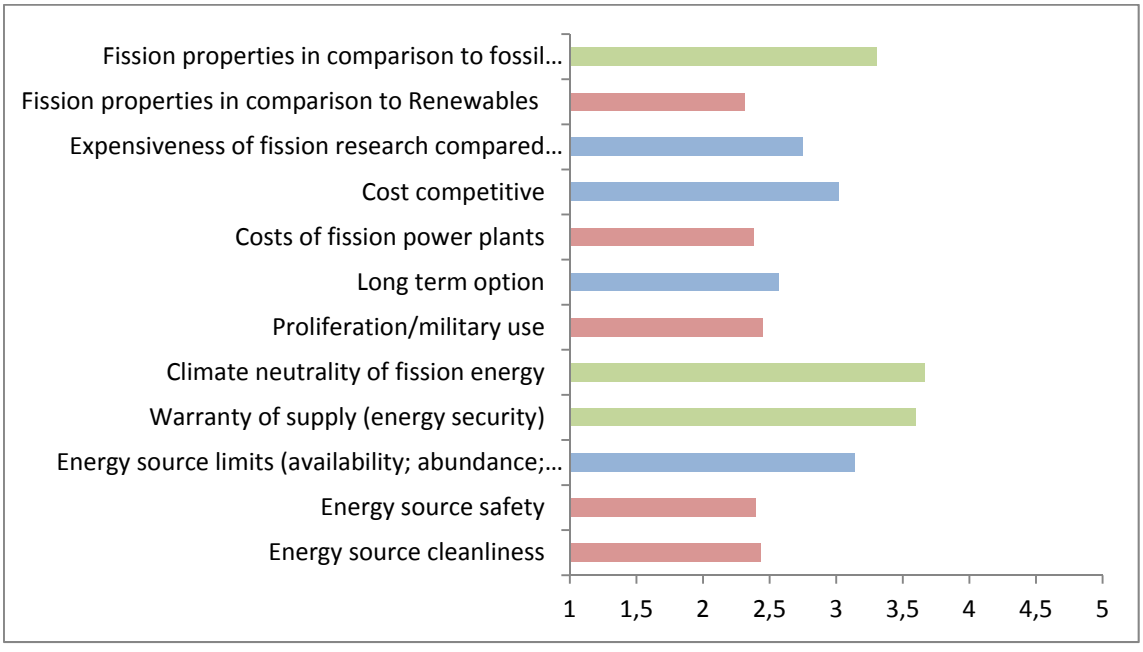


Figure 25. *Average evaluation of the various statements regarding nuclear fission from January 2010-July 2012 (1- Very negative; 5- very positive) (v36; average value per item; n= 486)*

New nuclear framing

The links between nuclear energy and climate change mitigation are less frequently mentioned in the articles than expected. Only 7% of the news articles in our sample mention the idea that nuclear fission is necessary for climate change mitigation. As expected, the percentage of articles presenting the climate benefits of nuclear is higher before Fukushima (10%) than after the accident (6%). But this difference cannot be considered as a significant difference. The same result is found if we consider the frequency of articles mentioning the benefits of nuclear in terms of CO_2 emissions reductions. Only 6% of the articles present this benefit as associated with nuclear. On the other hand, the idea of nuclear as an energy source guaranteeing security of future energy supplies is more frequently mentioned in the articles. Around 15% of the articles mention this idea.

The effect of Fukushima

The nuclear-related content in the Spanish newspapers is clearly linked to the accident in Fukushima. In the whole sample after March 2011, 74% of the articles mention the accident. And a 16% of the articles are completely focused on the accident.

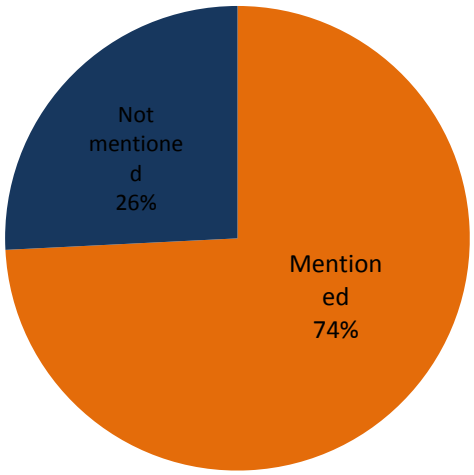


Figure 26. *Percentage of the articles with nuclear content mentioning the Fukushima accident (v8; % of nuclear related articles published after March 2011; n= 486)*

Other accidents like Chernobyl or Three Mile Island are also linked to the nuclear content in the studied newspapers. 18% of the articles mention a nuclear accident different from the one

in Fukushima. The links of nuclear fission with nuclear accidents was limited before March 2011, and less than 10% of the articles in the sample mentioned other nuclear accident. The percentage grows in 2011 and 2012, and around 25% of the articles after Fukushima mention other nuclear accidents (mainly Chernobyl).

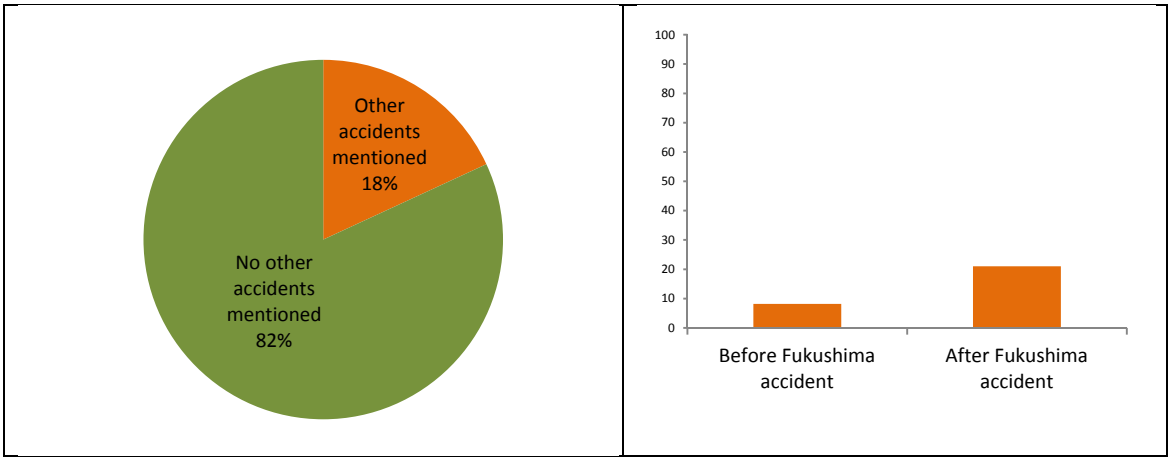


Figure 27. *Percentage of nuclear related articles mentioning other nuclear accidents, from January 2010-July 2012 (v9; % of articles; n= 486)*

In the following figure we have graphed the percentage of articles mentioning the Fukushima accident or any other nuclear accident from January 2010 to July 2012. The prevalence of the Fukushima accident (orange line) is of almost 100% in the months around the accident and decreases during 2011 to its lowest level in the last months of the year. The percentage of articles mentioning the accident grows again in March 2012, as a result of the anniversary of the accident, and declines again in the following months. The prevalence of other accidents in the media articles remains in a very low level in 2010, increases significantly (to almost 40%) in March 2011, and remains again in a low level (but slightly higher than 2010) in the following months.

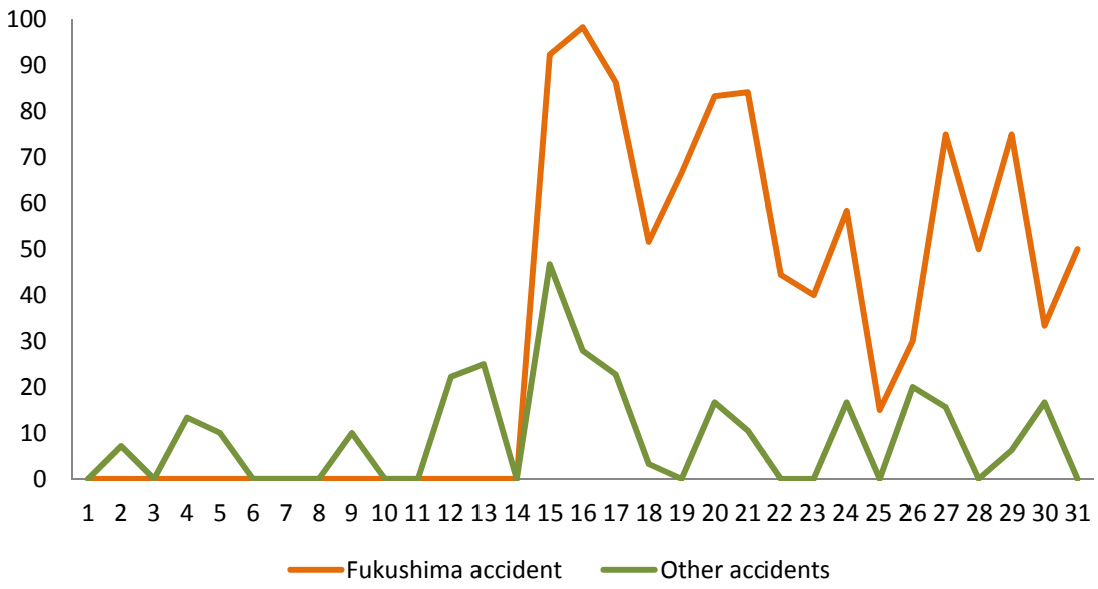


Figure 28. *Percentage of articles mentioning the Fukushima accident and other nuclear accidents from 2010-2012 (month 1 to 31) (v8 & v9; in % of nuclear related articles; n= 486)*

Regarding the effect of the Fukushima accident, as compared to nuclear fusion, the data also show that the role of nuclear fission in the articles becomes more relevant after Fukushima, and in almost 90% of the articles, nuclear is the core subject. Before Fukushima, more articles (30%) cover nuclear as a subsidiary context (eg. international relations, general energy policy, etc.), meaning that they are not focused on nuclear.

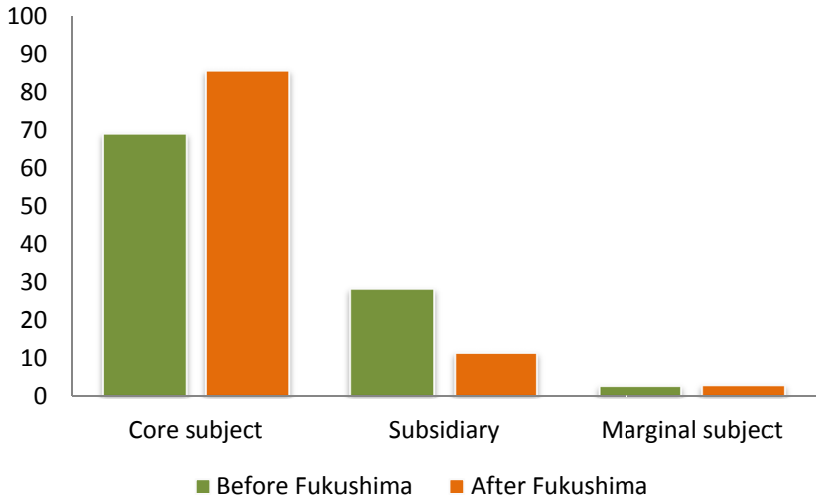


Figure 29. *Role of nuclear energy in the print articles from January 2010-July 2012, before and after the accident in Fukushima (v16.1 vs v7, % of articles)*

Articles before Fukushima are, on average, more positive to nuclear than those published after the accident. If we analyze only the articles before Fukushima, we find that these articles are more polarized, and almost 40% of them are negative and 40% of them are positive. After the accident, more than 65% of the articles are negative. These differences are mainly due to the coverage of the consequences of the accident in the months following the accident. Even when we compare specific types of articles (such as opinion columns and interviews), articles after the accident are generally more negative (provide negative valuations) towards nuclear energy than accidents before Fukushima. Related themes, arguments and valuations are generally more negative after the accident than before.

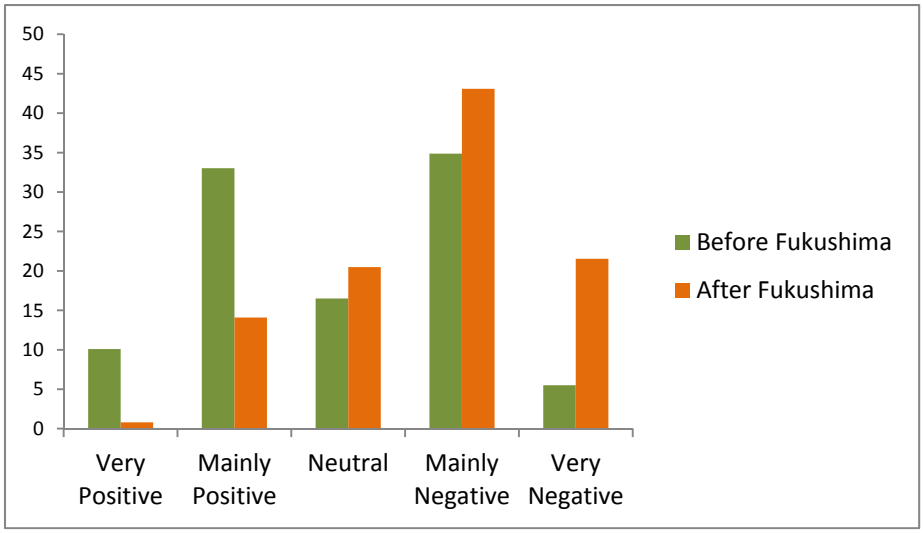


Figure 30. *General valuation of nuclear fission in the articles before and after the accident in Fukushima, from January 2010-July 2012 (v34 vs v7; % of articles)*

Although safety is a main argument in the debate around nuclear fission in all the period under study, there are some significant differences in the nuclear coverage before and after Fukushima. Before Fukushima, ideas and arguments about nuclear fission are more focused on the costs of nuclear and proliferation. After Fukushima, safety becomes the main topic. The environmental impacts of nuclear and energy security also remain as important arguments in all the period.

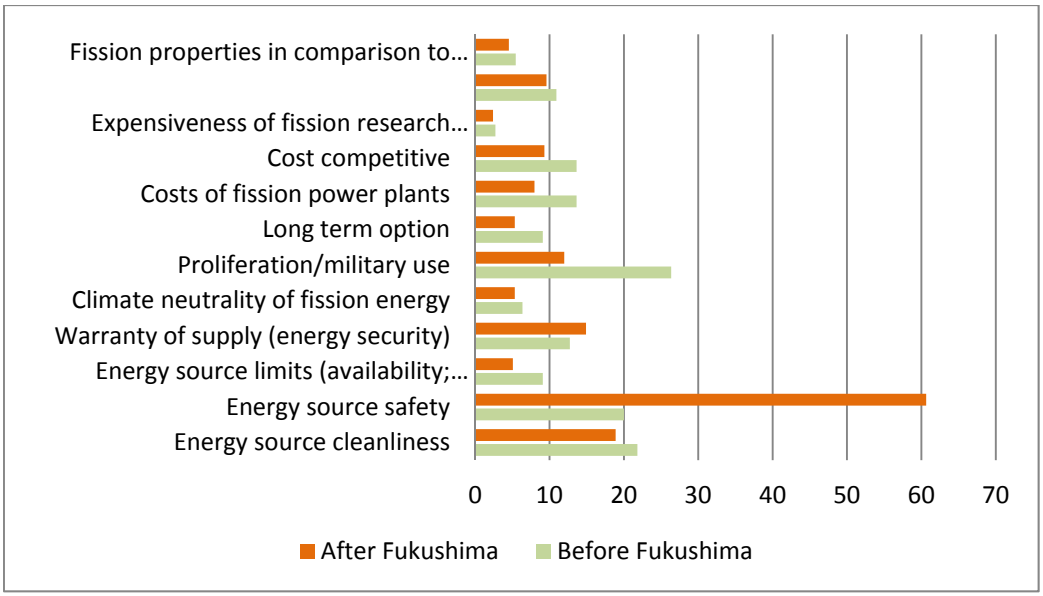


Figure 31. *Percentage of articles mentioning various nuclear fission-related statements from January 2010-July 2012 (costs/benefits) (v36 vs v7; % of articles; n= 486)*

Finally, if we consider the evolution of the average evaluation of all the themes related to nuclear fission, the figure depicts a slight fluctuation over the trimesters around a neutral to negative valuation. Only two trimesters (2 and 3) have a value higher than 3, showing an average neutral to positive evaluation of the arguments in this period. Trimester 6 and 9 show the lowest average valuation, mainly related to the coverage of the accident of Fukushima.

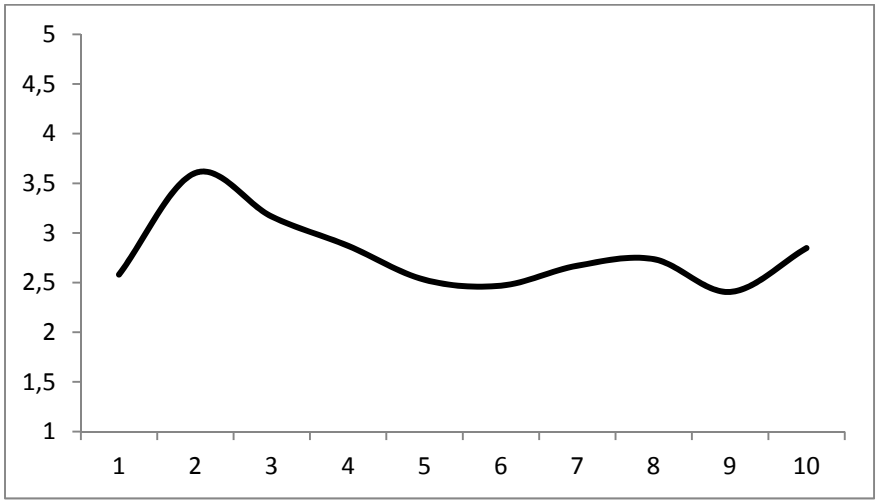


Figure 32. *Evolution of the average evaluation of the various themes related to nuclear fission from trimester one to trimester ten (January 2010-July 2012) (1-very negative; 5-very positive). (v36; average value; n= 398)*

The accident in Fukushima had a clear impact on the volume of coverage, thematic content and valuation of nuclear energy.

3.3. Relationship between fusion and fission

The evolution of the number of articles clearly differs between nuclear fusion and fission. While nuclear fission- related articles are strongly linked to the accident in Fukushima, fusion related articles show a different pattern. The figure below depicts the evolution from January 2010 to July 2012 of the articles with fusion-related content and with fission-related content (in percentages to allow comparisons). The data show that both technologies are not associated in terms of media coverage frequency. While the number of articles for nuclear significantly increases after the accident and one year after the accident, the number of articles with fusion-related content follows a different pattern, as explained in the previous sections.

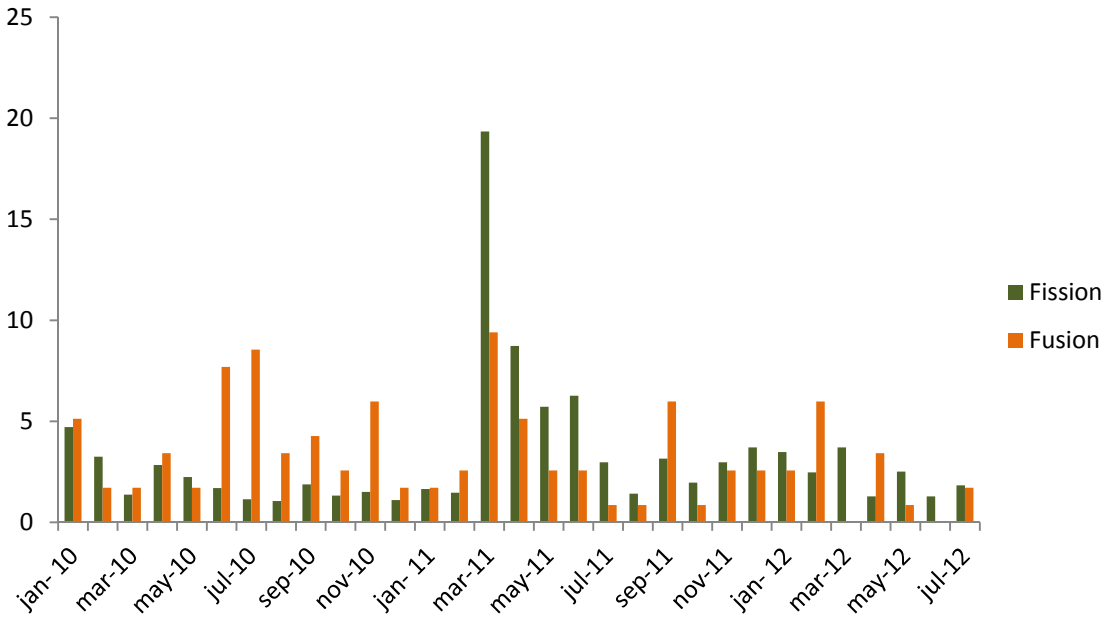


Figure 32. *Evolution of the percentage of articles with fusion and fission energy-related content from 2010–2012*.

It is also clear that nuclear is a more salient topic in the print media than fusion. In the studied articles, fission is often the core subject of the article, while fusion is often a marginal subject or a subsidiary subject in other context. News articles mentioning nuclear energy extensively report nuclear-related issues and this is especially true after the accident. In all the considered period, less than 3% of the articles cover fission as a marginal subject, whereas for fusion this percentage is around 30%.

In terms of thematic frame, there are also significant differences between fusion and fission. Fusion energy is mainly linked to scientific and research achievements, with a strongly positive evaluation, while nuclear fission-related content is mainly linked to energy policy decisions (with neutral to negative evaluation) and the Fukushima accident, as well as to risk and waste

management. In this sense, nuclear fission is generally portrayed in a more controversial and negative context than fusion energy.

The valuation attributed to fusion and fission also differs significantly in the print media. As the following figure shows, while the majority of the articles with fusion-related content provide a neutral to mainly positive valuation of fusion energy, the majority of the nuclear-related articles provide a negative valuation of fission energy.

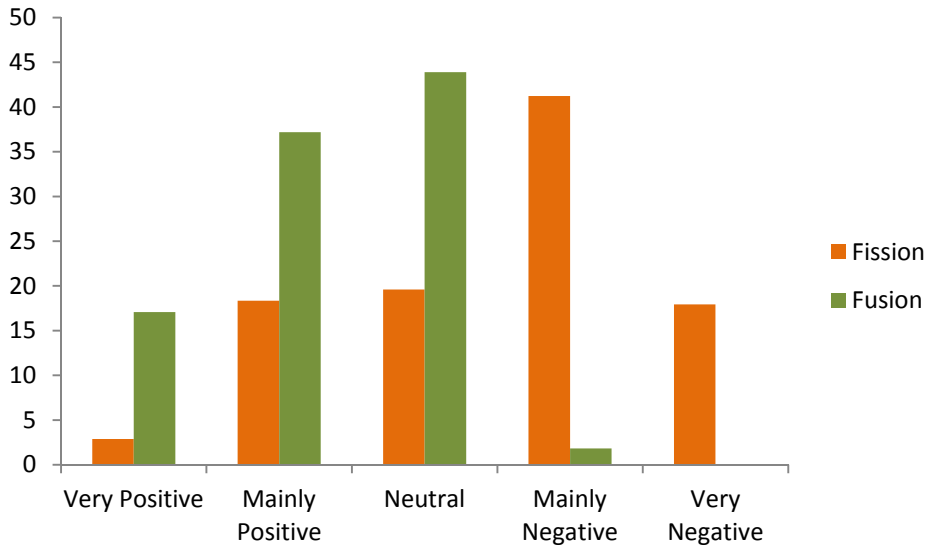


Figure 33. *General valuation towards fusion and fission from January 2010-July 2012 (v33 & v34; % of all articles; n= 652)*

It is interesting that if we consider the valuation towards fission obtained in the articles that mention both nuclear fission and nuclear fusion, we find that nuclear fission receives a more positive valuation in the context of fusion than in the fission-related articles. Fusion- related articles provide a more neutral view of nuclear fission. One explanation is the negative associations to nuclear in the nuclear-related articles derived of the Fukushima context.

No confusion between nuclear fusion and fission has been found in the articles. Only 35% of the articles mentioning fusion mention also fission.

The figure below represents the evolution of the average evaluation of all the themes (benefits and costs) related to nuclear fission and nuclear fusion in the studied articles. While the data for nuclear fission shows a slight fluctuation over the months around a neutral to negative valuation, the data for fusion show a fluctuation around mainly positive and very positive values. For nuclear fission, only four months provide a positive valuation (values lower than 3 in the graph), while for fusion energy there is no month with a negative valuation. The valuation of nuclear fission and nuclear fusion significantly differ in the months around the Fukushima accident, as well as one year after the accident, when nuclear fission receives the lowest average valuation, differently from nuclear fusion.

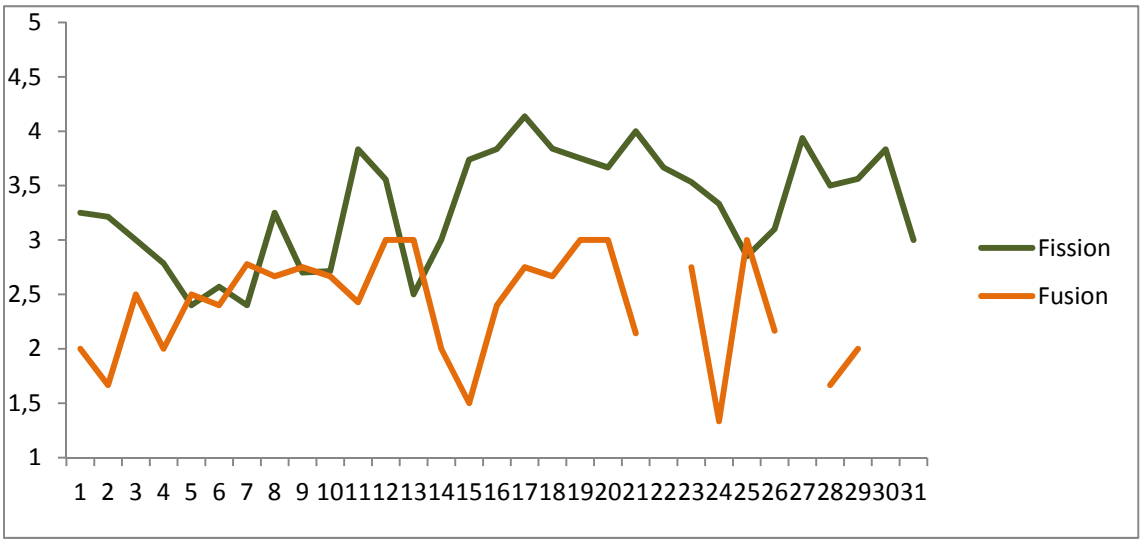


Figure 34. General valuation towards fusion and fission per month (1= very positive; 5=very negative) (v33 & v34; average value; all the articles; n= 652)

The position of the actors is also significantly different in fusion and fission related articles. While a large majority of actors in fusion articles are supporters of fusion energy (77%), the majority of actors in fission-related articles are against nuclear fission (44%). Fusion stories are mainly dominated by representatives of ITER and scientists. On the contrary, nuclear fission stories are dominated by a range of actors, mainly politicians (from local to European) and members of environmental organizations.

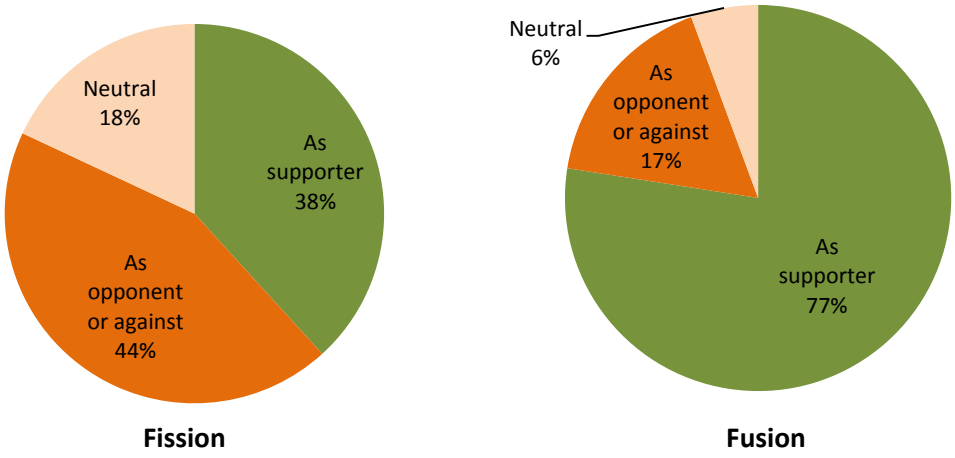


Figure 35. *The position of the actors in nuclear fission and nuclear fusion-related articles from January 2010-July 2012 (v28; in % of actors; n= 619)*

More differences between the media presentation of fusion and fission and the effects of the Fukushima accident will be summarised in the final section.

4. Summary of findings

Regarding the coverage of nuclear fusion and nuclear fission, the study has shown the existence of significant differences between the media coverage of nuclear fusion and fission. Specifically, we can conclude that:

- The volume of fusion-related content in the print media is limited and linked to special events and new technological achievements. Although the coverage shows a regular tendency around two articles per month, the coverage is clearly irregular (from 3 to 7 articles per year) if we consider each of the newspapers, and mainly linked to special events. This seems a limited number to stimulate the attention of the public.
- The volume of nuclear-related content in the Spanish print media is significant and consistent over time. The volume of content is strongly linked to the Fukushima accident during 2011 and 2012, as well as to other events or issues such as waste management decision, nuclear policy issues in Spain and abroad and nuclear proliferation.
- There is some evidence of a formation of media frames about nuclear fusion. The presentation of nuclear fusion in the media is generally positive. Fusion is shaped as a new technology producing clean and endless energy and as a potential solution to energy problems. Fusion is characterized as a new source of energy, as a subsidiary product of ITER and as a scientific challenge. There is no evidence of a "nuclear brand" (negative resonances in terms of fear, stigma, etc.) in the media presentation of fusion. In fact, 65% of the articles with fusion-related content do not mention nuclear fission
- The general valuation of fusion energy in the print media is positive. Fusion is mainly presented in terms of an unlimited and clean source of energy. Articles dealing with research projects are, on average, more positive towards fusion than those dealing with energy policy or investment costs. When linked to safety issues, nuclear fusion is positively presented. Nuclear fusion is poorly associated with climate protection, but also to risk management or accidents.
- Nuclear-related articles are mainly negative about nuclear. Nuclear is mainly linked to the Fukushima accident, to problems in nuclear safety, military proliferation, controversial policy debates, demonstrations, etc. Interestingly, articles dealing with energy policy issues are more neutral about fission. Commentary articles are often the most negative about nuclear energy, portraying it as a not clean and costly source of energy. The new nuclear framing seems to have a minor presence in the print media.
- The thematic content of fusion and fission coverage significantly differs. Specifically, fusion energy is mainly linked to scientific and research achievements, with a strongly positive evaluation, while nuclear fission-related content is mainly linked to energy policy decisions (neutral to negative evaluation) and the Fukushima accident, as well as risk and waste management. Fission is generally portrayed in a more negative way.
- In the studied articles, fission is often the core subject of the article, while fusion is often a marginal subject or a subsidiary subject in other context. Nuclear fission is a significant topic in the print media, and news articles mentioning nuclear energy extensively report nuclear-related issues. This is especially true after the accident.

- The presentation of actors clearly differs between the articles on nuclear and the articles on fusion. The most frequent actors associated with nuclear fusion-related content are operative directors (mainly linked to ITER) and scientists, both usually positive about fusion. Foreign politicians, environmental groups and national politicians are the actors more frequently associated with nuclear-related content. These actors are more negative than positive about nuclear, showing a clear controversy not present in the fusion context.

Regarding the changes in the coverage of nuclear fusion and nuclear fission after the accident we can conclude that:

- Nuclear fusion is poorly associated to the accident in Fukushima. On the contrary, the accident plays a key role in the coverage of nuclear fission in 2011 and 2012, where more than 70% of the articles with nuclear related content mention the accident. The number of articles with nuclear-related content increases nine times in March 2011 as compared to the months before the accident. The number of articles with fusion-related content grows in the month of the accident, but this is not only attributable to the accident. Only 30% of the articles with fusion-related content mention the accident
- The effect of the Fukushima accident on thematic content and valuation clearly differs between nuclear fusion and nuclear fission. In the fusion-related articles, those articles mentioning the accident tend to be more positive towards fusion than those articles not mentioning the accident. There are not significant differences in thematic content before and after Fukushima for fusion energy.
- In the nuclear fission-related content, the effect of the accident is more significant. After Fukushima, nuclear fission becomes a more central subject in the articles. Specifically, the Fukushima accident is the main theme in 20% of the articles and more than 80% mention the accident. There is also an increase in the articles dealing with risk management, accidents and emergencies issues after the accident. The general valuation of nuclear fission becomes more negative after the accident, mainly due to the change in thematic content, focused now more on risk management issues. The Fukushima accident also produces an increase in the percentage of articles mentioning other nuclear accidents such as Chernobyl or Three Mile Islands. The evolution of the average evaluation of the various costs/benefits related to nuclear fission also shows a more negative tendency in the months during and after the accident.

The data provides some evidence to the hypothesis of the 'issue-attention cycle' whereby coverage of technologies is positive in the early stages and grows increasingly more negative and conflict-driven over time (Cacciatore et al., 2012; Nisbet and Huge, 2006). Fusion, compared to nuclear fission, is still in an early stage of development, mostly linked to basic science, so media presentation of fusion is clearly more positive and less controversy oriented than the media presentation of fission.

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