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Portuguese media discourse on nuclear energy before and after Fukushima

Prepared for the EFDA Workprogramme 2012 WP12-SER-ACIF-1

Luísa Schmidt (coord.)
Ana Horta, Sérgio Pereira, Carla Oliveira

Association Euratom-IST

INSTITUTO DE CIÊNCIAS SOCIAIS

UNIVERSIDADE DE LISBOA

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Introduction

This report presents the results of the analysis of nuclear related content in Portuguese print media. The report is submitted to the first step of the research task untitled *Public Discourse about Nuclear Fusion before and after the Fukushima accident*, as part of the Socio-Economic Research on Fusion under the general coordination of EFDA Workprogramme 2012.

From the EFDA point of view, in order to understand the public discourse about fusion as an alternative nuclear technology, it is also important to have an analytical insight into the discourse about conventional nuclear power or nuclear fission. This analysis provides a fundamental tool to understand the social construction of nuclear power imagery in contemporary societies.

The general hypothesis conducting this research is that the accident at the Fukushima Daiichi nuclear power plant in Japan on March 11 2011 contributed to the enhancement of public discourse about nuclear energy, focusing on risks and perils, thus contributing to diminish the public acceptability of this source of energy. In addition, we propose two other hypotheses in our study of the Portuguese case: i) the accident in Fukushima didn't have any significant effect on the constructed image of fusion energy in Portuguese print media. We assume that the image of fusion energy remains unaltered and is independently built regardless of the focus given to nuclear accidents by the media; ii) the accident in Fukushima brought forth the debate on fission energy in Portuguese print media contributing for a **clearly negative** image of this technology.

Context of the Portuguese print media discourse on nuclear energy

Portugal does not have any nuclear power plant or even plans to build one. Since the expressive public demonstrations against the construction of a nuclear power plant in the small town of Ferrel, on March 1976, up to now, nuclear energy has been almost consensually dismissed in our country¹. In 2004 the public debate on nuclear energy re-emerged, assuming a more solid ground for a broad discussion in 2006, following a conference untitled *Nuclear Energy – the necessary debate*, organized by the Order of Engineers. This debate was supported by the idea that nuclear power is a viable alternative in the present energy scenario, characterized by overconfidence on renewables and the absence of a straightforward substitute to fossil fuels. The accident at the Fukushima Daiichi power plant does not presuppose any change in the political decision-making regarding nuclear energy, since its rejection is prior to that event. However, it can

¹ The existence of nuclear power plants in Spain, especially in Almaraz, 100 km away from the Portuguese border, is an external element to our political and economic context and falls under the category of foreign policy in national media agenda. Nevertheless, it represents a risk factor for the Portuguese population. This was one of the arguments stated by the Portuguese environmentalist organization Quercus, for a joint demonstration with their Spanish counterparts, on September 17, 2011, claiming for the shutting down of that nuclear power plant. It should be noted that the demonstration took place six days after the nuclear accident in Fukushima.

contribute to the closing of the public debate on this subject, which has regained some support in recent years.

The coverage of nuclear energy in Portuguese media focus mainly on foreign issues, as shown in analysis of television news from 1957 to 1995 (Schmidt, 2003) and in 2006 (Horta, 2007). Proliferation and military use of nuclear energy are two clear examples of this trend. Commonly associated with non-Western countries, particularly Iran and South Korea, proliferation and military use are seen as external problems from our country's point of view. Nevertheless, international responses to these problems fall under the category of globalized political issues, to which Portuguese media often attends and therefore require our analytical attention.

Due to their particular characteristics like the destructive potential, persistency, and indirect contamination effects (such as the contamination of food products commercialized on the global market), nuclear accidents are not circumscribed to their space-time coordinates. They are perceived as global problems, with implications over future generations. The social construction of globalized risks also plays an important role in the public assessment of nuclear power advantages and disadvantages. In this sense, the Fukushima incident is a benchmark for the framing of public discourses that should be also considered in analysing Portuguese print media.

Media coverage and risk perception of nuclear energy after Fukushima

Nuclear energy has been, to some extent, a consistent option in some countries. Recent data on nuclear energy production register a total of 437 nuclear power reactors operable around the world and 63 nuclear power reactors under construction. In the EU context, France takes the lead in the production market, with 58 operating reactors. In the aftermath of the Japanese nuclear accident, the EU announced the intention to submit to stress tests all 143 nuclear power reactors operable by mid-March 2011. Countries such as France and the United Kingdom have adopted these measures but remain committed to nuclear power. Germany announced the immediately shut down of all nuclear reactors that were operating since before 1980 and a step-by-step closure of all its nuclear reactors by 2022².

The nuclear accident in Fukushima constitutes a key moment for the assessment of nuclear energy from the social, political and economic perspectives. The media play a very important role in placing emphasis on an issue such as this one, and in communicating and drawing some guidelines for public debates over this technology in light of its potentialities but also of its hazards.

It did not take much time after the accident in Japan for some researchers to start analysing the ways how the media dealt with it. Perko et al (2011) presented one of the first studies. The authors depart from content and discourse analysis of two Belgian newspapers (*Le Soir* and *De Standaard*), to analyse the role of the media in presenting public views about the accident that occurred in Fukushima, but also in communicating

² This data refers to February 2012. For more details on this subject see: World Energy Council (2012), *World Energy Perspective: Nuclear Energy One Year After Fukushima*. London: Regency House. ISBN: 978 0 946121 16 8.

about risks associated with nuclear power. The authors argue that media “form a link between the emergency actors and the risk perception among the population” (Perko et al, 2011: 10).

In a research that addresses the social dimensions of nuclear power after the event in Fukushima, Butler et al (2011), identify a set of ‘interpretative packages’ that illustrate the media coverage of the accident. The role of media is considered to be a crucial one in the relationship between government and public, mainly in the shared construction of cultural meanings, risk perception and risk communication of nuclear power.

Another study that immediately followed the accident is the one conducted by Sharon Friedman (2011). This study compares the coverage of the accident in Fukushima with two other nuclear events - Chernobyl, on April 26 1986 and Three Mile Island, on March 26 1979. Ultimately, what distinguishes the media coverage of the accident in Japan from the previous ones are the volume, speed and quality of information flowing in various media. Accessibility of the public and interactive processes between public and journalists, channelled by the Internet, were also identified as distinctive features.

Media coverage of fusion energy

We have no data on Portuguese media coverage of fusion energy until now. In fact, since fusion is not yet a technical standard or an economic reality, it does not capture much of the attention of the general public and the media, unlike conventional nuclear power. Research made on public acceptability of fusion energy concludes that fusion is often confused with fission, which tends to produce a negative image towards it. Social rejection of fusion is based upon a “high perception of risks or a strong preference for other energy options”, while social acceptability is related either to a vague notion of energy abundance and environmental friendly features, or to a “positive association with “top” or pioneering scientific research”³.

Some studies that address the coverage of fusion energy in the media have concluded that the focus given to this subject is not constant over long periods of time. Media attention to fusion is enhanced whenever a technologic breakthrough is reported (Borrelli, 2004).

Framing of fusion-related content in press media develops mainly around institutional, economic and technical aspects of fusion research programmes. Positions and evaluation towards fusion are strongly associated with technical features and therefore tend to be neutral. These studies give us also a clear picture of fusion’s ‘place’ in media agenda: it is not a constant subject of interest and much of the attention given to it depends strongly on general expectations created around issues like applications to host fusion research facilities on national territory, such as that of Vandellós, in Spain for the siting of the ITER research device (Prades et al, 2007).

³ EFDA during FP7 – Reinforced coordination of physics and technology in EU laboratories Part 7, available on:

<http://www.efda.org/newsletter/efda-during-fp7-%E2%80%93-reinforced-coordination-of-physics-and-technology-in-eu-laboratories-part-7-2/>

A great deal of the research on fusion has been supported by international scientific cooperation. The Joint European Torus (JET), operating since 1983 and the International Thermonuclear Experimental Reactor (ITER), in development since 2007, are two of the most notorious examples of such projects. Portugal is involved in ITER through the participation of the Instituto Superior Técnico (IST). This institutional linkage can be crucial for the framing of fusion related content in national media over time.

Methodology

a) Quantitative content analysis

i. *Method and analytical procedure*

In the first stage of our research we found appropriate to use quantitative content analysis. This method aims at the identification of meanings, associations and intentions present in verbal or written texts. Applied to media, content analysis provides a way to measure the frequency of issues or topics, messages and events presented in several types of media communications (Macnamara, 2005: 4).

The analytical procedure applied to the collection of articles was a mixed one – deductive and inductive. Firstly, a set of categories or variables was created in order to select and organize the relevant data according to our research goals. This set of categories constitutes our coding system or codebook. Secondly, we applied the coding system to a random sample of articles and then debated on some improvements required to strengthen it. A final version of this coding system was then established.

ii. *Sampling and sample description*

The collection of articles followed different procedures whether the main subject was nuclear fusion or nuclear fission. With regard to nuclear fusion, taking into account the predicted less amount of articles available, we decided to work upon a broader time frame - from January 1, 2008 to July 31, 2012; we decided as well to search from a larger list of publications - all newspapers and magazines that could contain some information on this subject.

For the collection of articles on fission, given that these are published more frequently, we decided to work upon a shorter period, determined by the need to gather sufficient information about the circumstances and effects of the nuclear accident in Fukushima. Accordingly, the collection of articles covered a period that extends from January 1 2010 to July 31 2012. In order to deal with the large amount of articles available, we decided to apply a sampling technique for the search and collecting process. Thus, we only selected articles published by mainstream newspapers in the first fifteen days of each month, starting on a Monday.

The collection of articles for both subjects was attained from online catalogues of daily or weekly national publications. Regarding fusion, when necessary this was complemented with search on printed copies of some of the newspapers and magazines. When searching articles on fission we used the keyword “energy nuclear” (nuclear energy); when searching articles on fusion we used the keyword “fusão nuclear” (nuclear fusion).

The selected publications were grouped into the following categories: Quality newspapers/magazines (here included the dailies *Público*, *Diário de Notícias* and *I*, the weeklies *Expresso* and *Sol*, and the weekly magazine *Visão*); popular newspapers (the dailies *Jornal de Notícias*, *Correio da Manhã*, *Diário Digital* and *Destak*); Economic newspapers (the dailies *Diário Económico*, *Jornal de Negócios* and *OJE*) and scientific newspapers/magazines (*Ciência Hoje* and *Ciência PT*). Table 1 presents the distribution of

articles per type of newspaper. Scientific journals and Economic newspapers/magazines were searched only for fusion related articles.

Table 1. Articles by newspaper/magazine profile

Newspapers	n	%
Quality newspaper / magazine	609	65.2
Popular press	292	31.3
Scientific journal	24	2.6
Economic newspaper	9	1.0
Total	934	100.0

iii. Coding procedure

In the first stage of the working task we established a quantitative research tool aimed at operationalizing the concepts considered most important for the understanding of the media coverage of nuclear energy. Since this is an international project, we found necessary to ensure the comparability of results. The first step taken in this direction was to set a detailed encoding protocol (for more information see the codebook in Annex 1) for written press material so that all articles could be framed and classified with common criteria. The coding process was constantly submitted to an inter-coder agreement in order to tackle with subjective or biased categorization.

The following summarize some variables and dimensions of the codebook considered fundamental to our analytical purposes.

1. Variables for the general characterization of articles:

- Keyword – indicates the keyword used to find each specific article;
- Geographic scale - the country in which the collection was done and the publishing scale of newspapers/magazines;
- Chronological references – date of article; period of publication (before/after Fukushima accident);
- Reference to nuclear accidents (includes Fukushima and other accidents);
- Characterization of articles and publications - refers to the extent and accentuation of the article, the form of presentation or style of article, the type of newspaper, the category, provenance and background of author;
- Specificity of fusion – refers to technical/scientific content and institutional/organizational aspects concerning nuclear fusion, as well as the degree of scientific information on the subject;

2. Thematic framing variables

- General themes and specific themes – refers to macro-themes and specific themes associated with fusion, fission or both, and their order of importance in the context of the article;
- Focus – fusion or fission as core, secondary or marginal themes in the context of an article;

3. Actors involved

- Refers to all records of actor's discourses in active or passive voice, as well as simple references to individual or collective actions and decisions on any matter discussed in the article, provided that they are relevant for nuclear discourse analysis.
- Typology of actors (socio-occupational and gender categorization);
- Actor's attitudes towards fusion, fission or both;

4. Valuation of fusion or fission

- Valuation grade attributed to each one of these subjects, style and degree in which these valuations are expressed;
- Valuation grade of arguments stated regarding fusion or fission.

iv. Analysis procedure

The data was submitted to statistical analysis in SPSS (Statistical Package for the Social Sciences). This involved univariate analysis with frequency distribution of single variables and bivariate analysis with cross-tabulations and contingency tables. The bivariate analysis was aimed at identifying the relationship between independent and dependent variables. For example, crossing the period of publication of the article (independent variable) with valuation grade attributed to fusion (dependent variable) indicates possible variations of assessments made towards fusion from the period before to the period after the accident in Fukushima.

To better understand the evaluation made both for fission and fusion, we built a variable called Image. Image is a variable that aggregates all arguments stated towards a particular subject. In creating this variable, we intend to present a more comprehensive and accurate understanding on how a particular subject is approached from the normative point of view.

b) Qualitative content analysis

An exploratory qualitative analysis was designed with the objective of increasing knowledge about the journalistic coverage of nuclear fusion through in-depth analysis of a sample of significant articles. This analysis followed a template developed for all case

studies and based in the description of codes associated to fusion and portraying its characteristics.

The selected articles correspond to a strategic or purposive sampling, in an attempt to cover as best as possible the diversity of journalistic coverage of fusion. 20 articles were selected among the initial universe of 105 articles, according to the following distribution:

Table2. Purposive sample (n=20)

	Core subject	Not core subject
Scientific events and research projects	6 articles	2 articles
Other themes	5 articles	5 articles
Articles mentioning Fukushima	-	2 articles

As there were no articles with fusion as core subject that simultaneously mentioned the Fukushima accident, it was impossible to fulfill the share of articles mentioning Fukushima.

The selection of the sample was developed in three moments:

1. First, we excluded articles which the thematic “fusion” was a marginal subject in the article;
2. Second, we excluded the articles which the form of presentation is “news in brief” ;
3. Third, we chose the articles that better satisfy each of the items mentioned at the table above.

The preset template of codes was applied to selected articles in an attempt to find patterns and connections between and within them.

The table containing sample may be consulted in Annex 2.

Presentation of main results

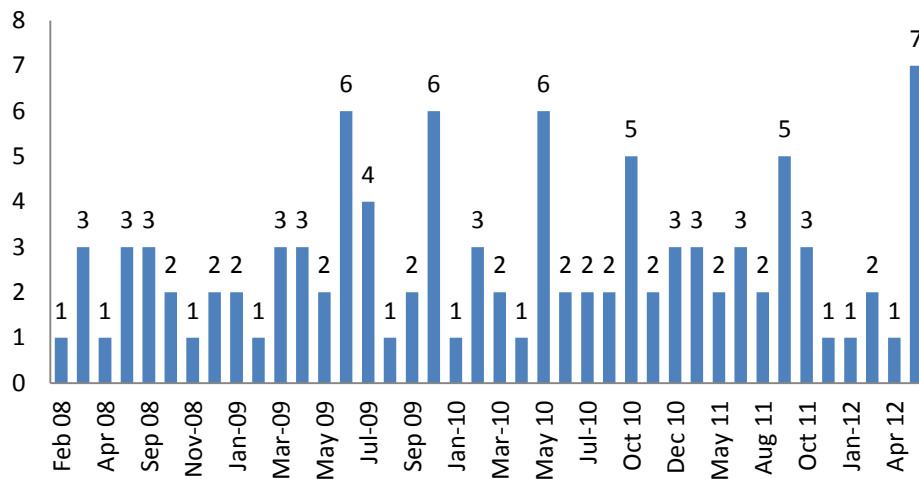
Fusion

General characterization of articles

The major trend to be reported is an almost persistent low number of articles with fusion-related content published during the whole period of analysis (Figure 1). This has to do with the fact that fusion itself is not an issue commonly covered in our national media. There are, however, occasional fluctuations within each year, except for 2008, which shows slight variations in the monthly time span. Nevertheless, these fluctuations are not always related to a specific event or sequence of events. For example, in May 2012 we find the highest number of articles published in that same year and over the whole period of analysis, but only two of those articles relate to the same issue – the achievements and aspirations of a remarkable young student with a personnel interest in nuclear technologies.

Other peaks in the evolution of articles can be attributed to occasional prominent and co-related issues in print media agenda. Those concern the funding and collaboration activities of IST in ITER project (3 out of 6 articles in June 2009 and 4 out of 6 articles in October 2009), the National Ignition Facility inauguration ceremony and prospective developments (3 out of 6 articles also in June 2009), and the attainment of nuclear fusion announced by North Korea officials (5 out of 6 articles in May 2010).

Figure1. Evolution of the number of articles with fusion energy related content (2008/2012)



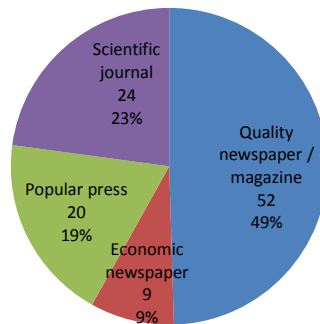
N=105 articles.

The evolution of articles on fusion is largely independent from the accident in Fukushima Daiichi nuclear power plant. This statement is supported by the short number of articles published since the day of the event and over the period that immediately followed. The coverage of fusion energy in Portuguese print media evolves mainly around organizational

issues and prospects related to fusion research and to personal or collective achievements in the development of this technology.

The publication of articles on fusion energy occurred mainly in Quality newspapers/magazines, which represent almost half of the sample (52 articles of a total of 105). This number is significantly higher than the two succeeding types of newspapers/magazines – Scientific journals and Popular press (Figure 2). Given the fact that fusion energy is not a regular feature in the Portuguese media context, it is not surprising that fusion is covered more frequently by newspapers or magazines aimed at an selected audience (Quality press), than by popular press publications, which tend to construct their agendas around the general public main interests and expectations.

Figure2. Type of newspaper/magazine presenting articles with fusion energy related content (2008/2012)



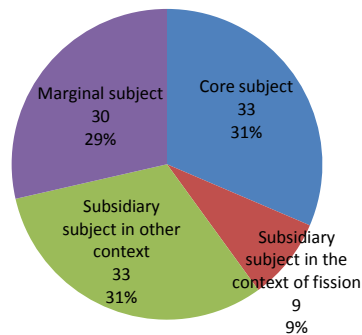
N=105 articles.

Scientific journals have an even more limited public. Nevertheless, in comparison to Quality press, they do not stand out in the coverage of fusion energy. Portuguese science press does not contribute much to public understanding of fusion energy.

With regard to Economic newspapers, there are very few articles published over the period of analysis. Economic newspapers approach fusion energy mainly from the point of view of private enterprise participation in Research and Development. The expectations on competitive advantages of fusion in comparison to other sources of energy (particularly to fossil fuels) are also a matter of interest.

The focus on fusion energy varies frequently between Core subject and Subsidiary subject in other context or even, to a lower degree, to Marginal subject. In fact, there is no difference in the number of articles that present fusion as the main subject and the number of articles that present it as a secondary subject in other contexts. These other contexts are mainly reported to organizational and institutional processes that take place within fusion research scope. As a Subsidiary subject in the context of fission, fusion energy only appears in nine articles. This means that in the framing of nuclear technologies and issues alike, fusion is not often overlapped by fission (Figure 3).

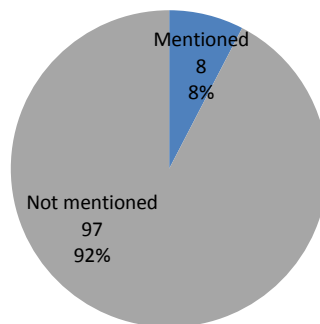
Figure3. Role of fusion in the fusion related articles (2008/2012)



N=105 articles.

Magnetic Confinement Fusion (MCF) along with Inertial Confinement Fusion (ICF) is considered to be a crucial pathway to attain fusion energy in a secure manner and at high levels. The ITER device is based solely on MCF. This is the only process referred to in our collection of articles, and it's strongly linked to the work in progress within ITER research developments. Nevertheless, as we can see in Figure 4, records of MCF in our sample of articles are very few, which reflect the scarcity of specific info concerning fusion research and corresponding technical futures or procedures.

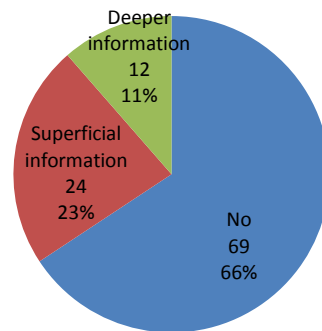
Figure4. References to Magnetic Confinement Fusion (MCF) in the articles with fusion energy related content (2008/2012)



N=105 articles.

Basic science information is absent in more than half of the reports (Figure 5). When provided, it is mainly in a superficial manner. More in-depth information is available in only 12 out of 105 articles, that is to say, in half of the articles that explain the basic science behind fusion in a superficial way. If we consider this as an underlying tendency in Portuguese print media, we can say that public knowledge and public discourse on fusion is, thus, more likely to be constructed out of narrow explanations and vague information than out of comprehensive insights about this technology.

Figure5. Depth of information provided about basic science behind fusion energy in the articles with fusion energy related content (2008/2012)

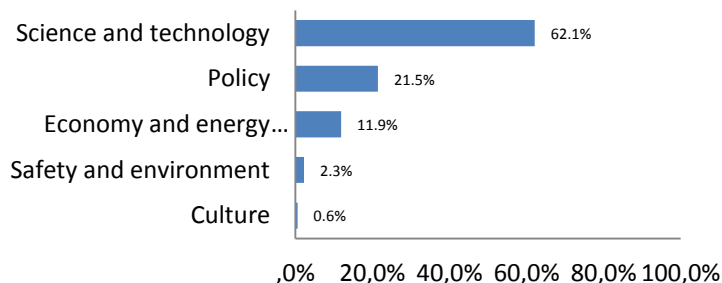


N=105 articles.

Thematic content

Science and technology is the top thematic category in the framing of reports on fusion energy, representing more than half of the records in the sample (Figure 6). Policy is the second most frequent category. The distance between these two to higher ranked categories is 41%. Economy and energy comes in third place with 12% of articles covering it and at a substantial distance from the remaining general themes.

Figure6. General themes aggregated in articles with fusion energy related content (2008/2012)



N=177 Identified themes.

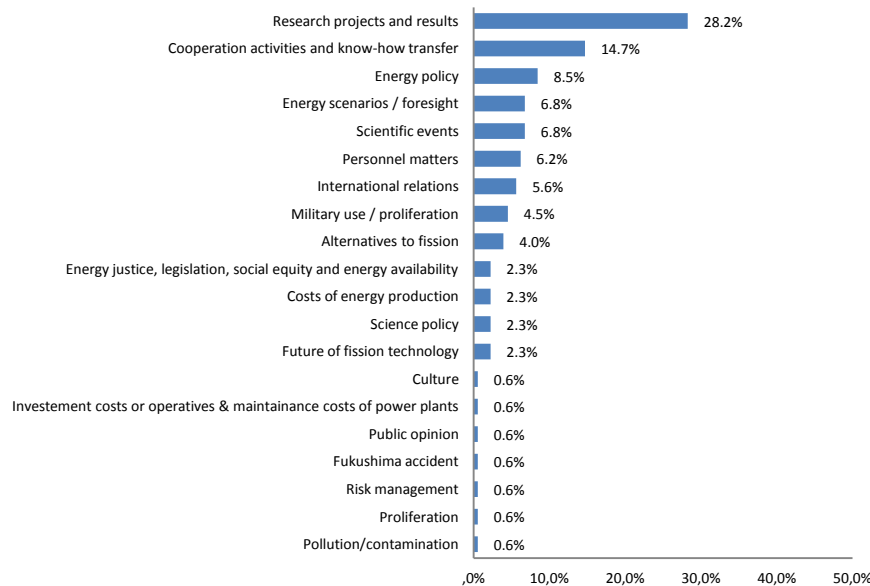
The grading shown on Figure 6 reflects the status of fusion energy in diverse contexts of public understanding and discourse construction. Fusion energy is for the time being a scientific project sustained by upgraded technical apparatus and not yet a standard process in providing high levels of energy for commercialization. Therefore, it stands mainly on the ground of scientific research and discovery rather than on the grounds of political decision-making or economic exploitation. Nevertheless, as we will see more

accurately later in this section, policy and economy have a significant role to play in fusion research scenarios.

Safety and environment, along with culture, is a residual theme in the construction of media discourse on fusion energy. Given the fact that experiences on fusion energy are not accessible to common citizens and its processes are not incorporated by environmental dynamics, safety issues and environment control of fusion are not yet questions to be addressed frequently to by the media.

The grading in Figure 7 gives us a more accurate insight on what are the particular themes more frequently treated in the reports and their relation to the general thematic level. As we can see, there are two top categories of themes that relate directly to Science and technology – Research projects and results, with 28.2% of records and Cooperation activities and know how transfer, with 14.7% of records. Research project and results as well as scientific events are in most cases framed in a descriptive manner, rather than in an explanatory one, with a strong emphasis both on the prospective changes that they imply and on the institutional aspects involved.

Figure7. Themes aggregated content in articles with fusion energy related content (2008/2012)



N=177 Identified themes.

Cooperation activities and know-how transfer are treated from the point of view of the network of relations established both by research institutions and national governments. At a lower degree, records on the theme Alternatives to fission (4%) indicate that fusion can also be framed as a subject of interest in the discussion of present and future scenarios for nuclear energy in general.

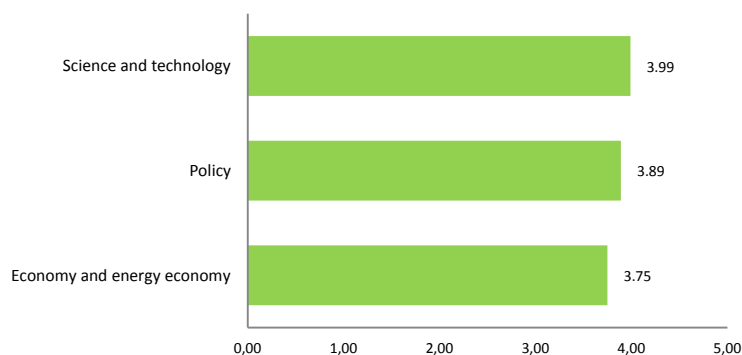
Energy policy (8.5%) and International relations (5.6%) are the two Policy related themes that appear more often in the articles. Fusion energy is, to some extent, presented as a potential alternative to fossil fuels dependency and a forthcoming option to satisfy the

growing needs of energy in our societies. Energy policy decision makers, advisers and experts do have some perspectives on fusion energy, notwithstanding the uncertainties that some cautiously mention about its feasibility and commercial prospects. As to International relations, we can say that is strongly related to negotiation processes, at an official level, for cooperative activities and protocols that involve public research institutions in international projects like ITER.

In what concerns Economy and energy economy, the most significant thematic reference in this aggregate is Energy scenarios/foresights (6.8%). Here again, fusion is seen as a forthcoming technology that can help societies cope with the escalating need for energy in present and future scenarios, but also with the absence of powerful alternatives to a sustainable exploitation of energy resources.

As shown in Figure 8, all general themes are positively evaluated, with records above 3.5 (regarding a scale from 1, meaning “very negative”, to 5, “very positive”). Science and technology shows the highest score, without distancing that much from other general themes such as policy and economy. Overall, this indicates that perceptions and valuations associated with fusion are regularly positive and to some extent independent from the main thematic references presented in the articles.

Figure8. Average of valuation grade by primary general theme in print media with fusion energy related content (2008/2012)

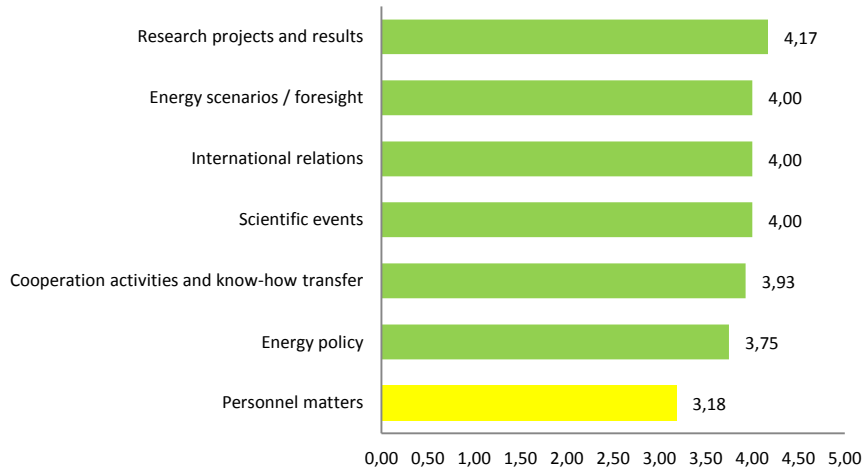


N=105 articles.

(Scale from 1 – Very negative to 5 – Very positive)

Figure 9 illustrates more specifically the topics considered in the main general themes covered. Research projects and results stand out in the average of valuation attributed to fusion. Confronting this score with the one depicted in Figure 8, we can say that Research projects and results is the most representative theme in positive evaluation of Science and technology related issues.

Figure9. Average of valuation grade by primary theme in print media with fusion energy related content (2008/2012)



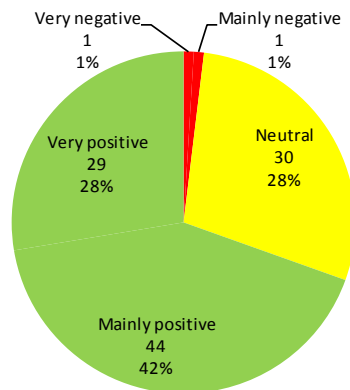
N=105 articles
(Scale from 1 – Very negative to 5 – Very positive)

Some themes show equal valuation scores at a median level. These are related to Science and technology or Policy, which in fact corresponds to the ranking showed in Figure 8.

Personal matters is the only theme that has an average of valuation below the positive standard value (3.5), making it also the only one associated with neutral perspectives on fusion energy.

Fusion is a technology highly valued in Portuguese print media (Figure 10). In almost half of the records the valuation grade is mainly positive. Very positive and neutral valuations show equal percentages, while the percentages of Very negative and Negative valuations grades are insignificant. If we disregard the neutral valuation grade, we can conclude that fusion is assessed almost exclusively in a positive way.

Figure10. General valuation of fusion energy in print media with fusion energy related content (2008/2012)



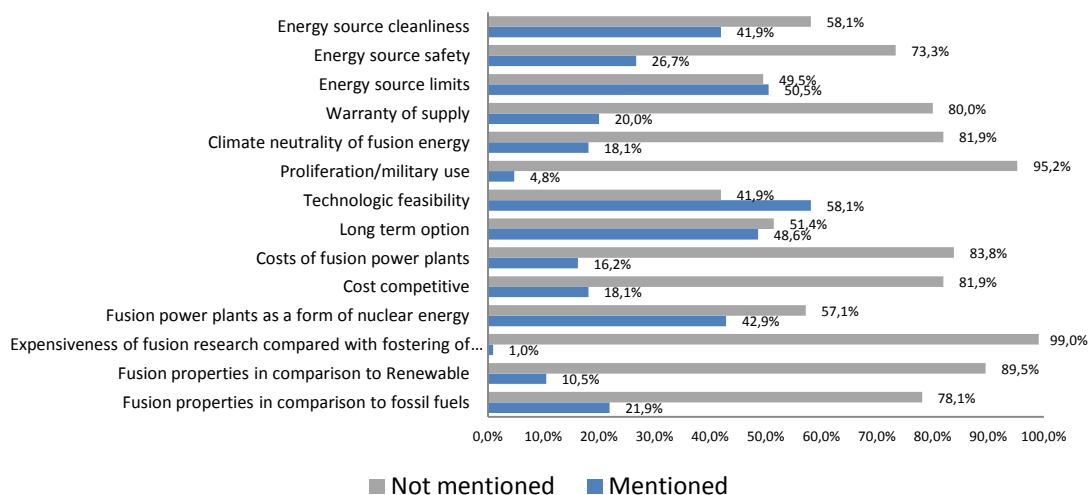
N=105 articles.

A possible explanation for these results seems to be related with the focus on scientific research and the positive valuation of technological development in Portuguese culture.

Statements on benefits and costs

An analysis of the statements on benefits and costs mentioned by the press help to clarify what are the predominant dimensions of evaluation in the framing of fusion energy. Figure 11 shows that Technologic feasibility and Energy source limits are the statements that prevail when it comes to evaluate costs and benefits of fusion. Technologic feasibility is associated with present and future technical conditions required for the development of fusion energy at high standards, thus, it is a subject frequently debated by scientific experts as well as decision makers. Energy source limits of fusion technology also constitute an item strongly addressed to, for it is considered to be one of its most distinctive characteristics.

Figure11. References to various fusion-related costs/benefits in print media with fusion energy related content (2008/2012)



N=105 articles.

Fusion is also considered by many as a clean and safe way to produce energy. Nevertheless, Energy source cleanliness and Energy source safety are debated to a lesser extent than the two issues mentioned above. As for the frequency of mentions to Long-term option statement, this may indicate that public discourses are beginning to address fusion as an option for broad energy production and commercialization, rather than just an experiment within the boundaries of scientific research.

Evaluation on fusion energy is positive for most of the dimensions depicted in Figure 12. The lowest average of evaluation refers to the Cost of fusion power plants, slightly above 2.50. In fact, fusion power plants are, for the time being, experimental devices and not energy generation facilities for supplying public consumption. Thus, the assessments and debates on costs of fusion power plants are mostly concerned with current costs of research programs involved, rather than with eventual socioeconomic aspects of those costs, which are more likely to be strongly evaluated.

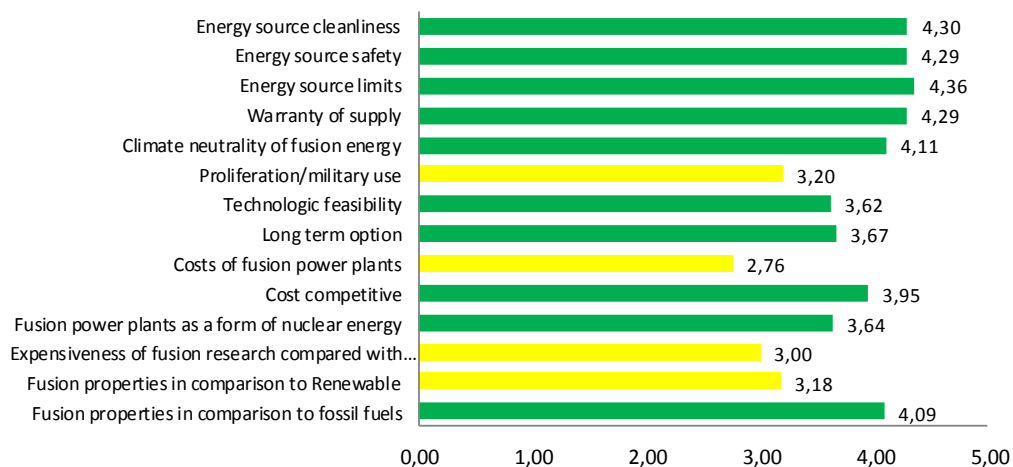
Energy source limits, Energy source cleanliness and Energy source safety have the highest averages of evaluation in the sample. These types of statements constitute a recurrent triad in media discourse on fusion, in the sense that they often appear linked to each other whenever fusion energy is to be explained or described to the general public. In fact, fusion is frequently reputed as a *clean, safe and almost unlimited source of energy* in many articles, and this typified discourse is common to almost all newspaper and magazines analysed. This also helps to explain why there are not significant differences in the averages of evaluation between these three types of statements.

We find appropriate to pay some close attention to three other types of statements - Warranty of supply, Climate neutrality of fusion energy and Fusion properties in comparison to fossil fuels, which also have high averages of evaluation. Warranty of supply is related to the predicted capability of fusion to assure energy at high levels in the future. It is also associated with the positive evaluation given to the unlimited possibilities of fusion energy production. Positive evaluations on Climate neutrality and Fusion properties in comparison to fossil fuels are supported by the idea that fusion is a non-pollutant source of energy from the core generation processes. Fusion fuels like Deuterium and Tritium have proven to be clean and environmentally neutral, unlike fossil fuels that have a well-known impact on climate change.

The remaining types of statements have quite negative records. Among these, Proliferation/military use, Expensiveness of fusion research compared with fostering of renewable, and Fusion properties in comparison to Renewables, stand out as the least mentioned.

In conclusion, we can say that media discourses on benefits and costs of fusion energy are primarily framed around its technical possibilities and energy generation potentialities.

Figure12. Average evaluation attributed to various fusion-related costs/benefits in print media with fusion energy related content (2008/2012)

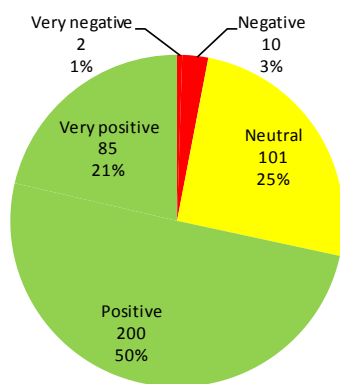


N=105 articles.

(Scale from 1 – Very negative to 5 – Very positive)

Thus, not surprisingly, Figure 13 shows that fusion is generally portrayed as a positive source of energy. It also shows that in 25% of cases (neutral) there is no constructed image of it, which represents no more than a ¼ of the overall records. There aren't many records of a negative image in our sample and much less of a very negative one.

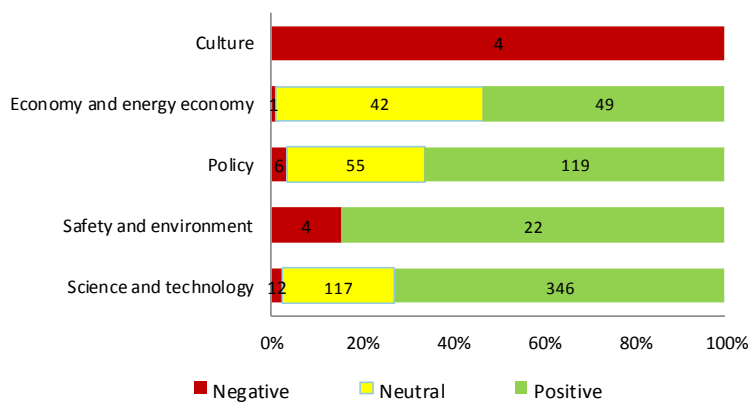
Figure13. Image of fusion based on various fusion-related costs/benefits in print media with fusion energy related content (2008/2012)



N= 398 references.

Figure 14 allows examining how the image of fusion is distributed by the general themes covered. Except for Culture, that has a very low number of articles associated, the image of fusion is mainly positive for each general thematic category. Science and technology is the general theme that has more positive aggregated records, making it the most representative in the construction of a favourable image of fusion energy. When confronted with economic related issues, public discourse on fusion tends to be more balanced, although maintaining a positive constructed image towards it.

Figure14. Image of fusion based on various fusion-related costs/benefits crossed by general themes aggregated in print media with fusion energy related content (2008/2012)

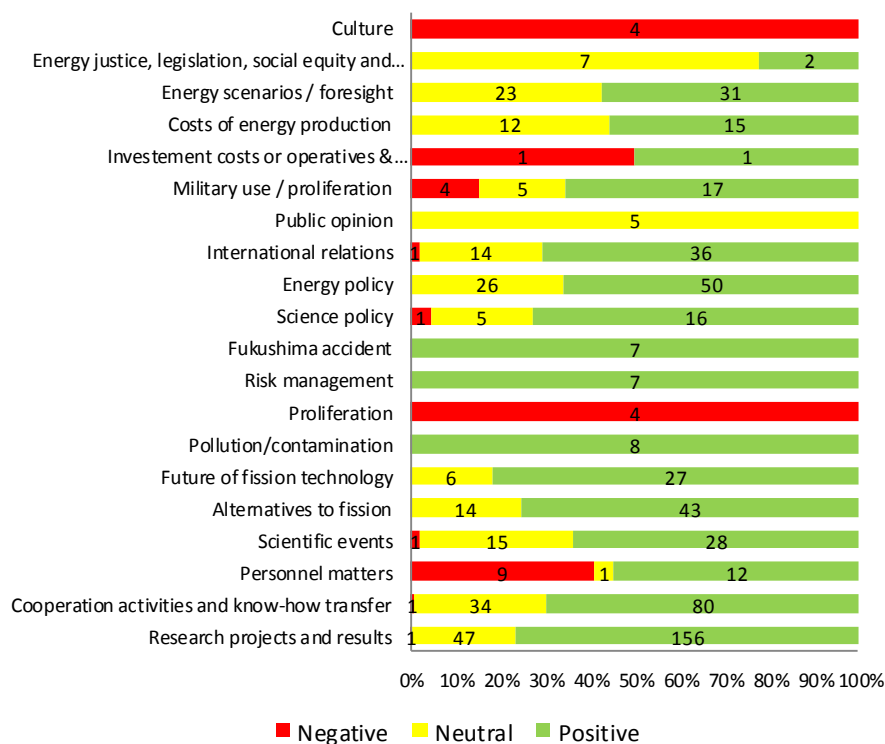


N=782 crossed references.

It is also interesting to see that there are no neutral perceptions or evaluations on fusion energy when addressing safety and environmental themes. They are either positive or negative, but positive records prevail, contributing to construct a favourable image of fusion in this particular context.

Looking at the specific themes covered in the news (Figure 15), we can see that the constructed image of fusion energy is clearly negative only with relation to culture and proliferation themes. Nevertheless, the number of articles written about both themes is so few that do not count much as to invalidate the general positive image of fusion energy.

Figure15. Image of fusion based on various fusion-related costs/benefits crossed by themes aggregated in print media with fusion energy related content (2008/2012)



N=782 crossed references.

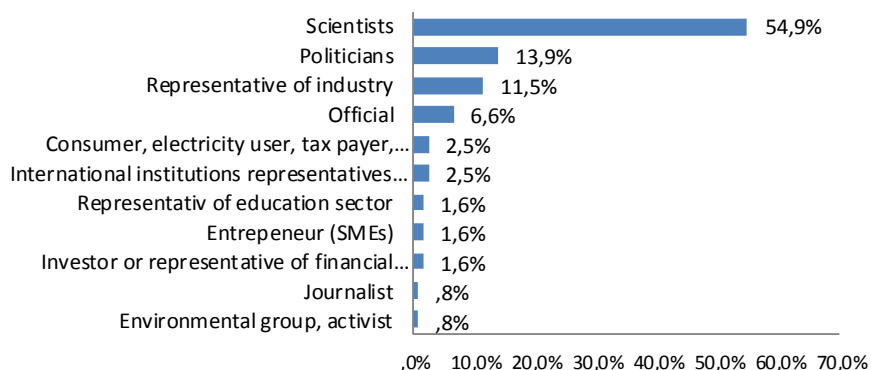
In articles about Fukushima accident, Risk management and Pollution/contamination, fusion is exclusively evaluated in a positive sense. Positive valuations associated with these themes are strongly co-related. In fact, assessments made upon risk management and pollution link directly to the coverage of Fukushima accident, which contributes to draw a very positive image of fusion in the context of safety and environmental issues.

The positive valuations made over fusion occur at a greater level when Research projects and results, Cooperation activities and know-how transfer or Energy policy emerge as primary themes. Alternatives to fission also show a great record of positive valuations. In this particular case, the positive image of fusion is constructed in comparison to fission on the grounds of nuclear technology development and enhancements.

Actors

Scientists constitute the top category of actors involved in the articles, representing over half of records of the sample (Figure 16). Politicians, Representatives of industry, and Officials also have distinctive records but are far behind from the top category. The remaining categories have similar but very low records.

Figure16. Main actors in print media articles with fusion energy related content (2008/2012)



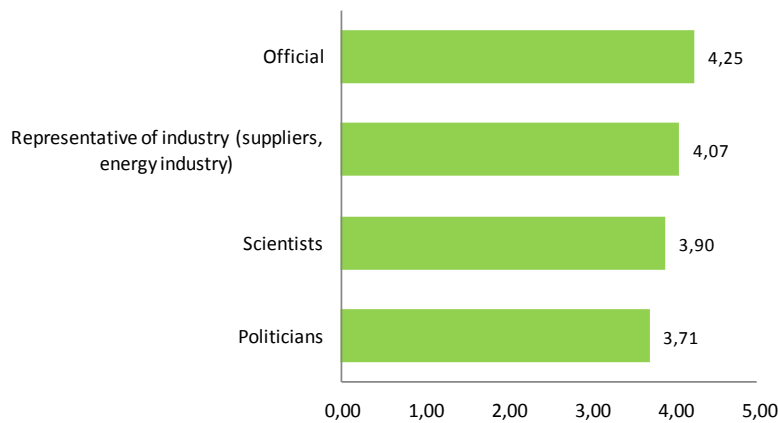
N=122 actors.

This result is in line with the general thematic framing previously described (Figure 6). In fact, print media discourse on fusion is constructed mainly around Science and technology issues, so it is not surprising that scientist's opinions and insights have an outstanding presence in the reports. Politicians and Representatives of industry also have a role to play in the construction of media discourse. As we also saw before, political issues surpass industrial or economic ones in the framing of fusion related content, a trend that is projected onto the more significant presence of politicians in comparison to representatives of industry in this aggregate.

Figure 16 also shows that Consumers, electricity users, taxpayers as well as Environmental group, activists, are not main actors in the construction of media discourses on fusion. This may be understood as an indicator that fusion energy is still restricted to some social and intellectual segments; in other words, fusion has not been yet incorporated in the systems of values, expectations and cognitive experiences of larger segments of society, especially those that have an important role to play as non-political actors of social change.

Figure 17 shows that it is not possible to establish a link between the average of valuation grade and the frequency in which various categories of actors are mentioned in the reports. Contrasting with the grading described previously, scientists who are the actors more often referred to in the articles, are precisely the ones that state their positions towards fusion energy at a lower degree. We can assume that scientific discourses tend to be more neutral or logically based rather than normative. Politicians also tend to be more neutral towards fusion energy. In contrast, Officials, whose activities are to some extent associated with political processes and decision-making, have a high evaluation record on fusion energy.

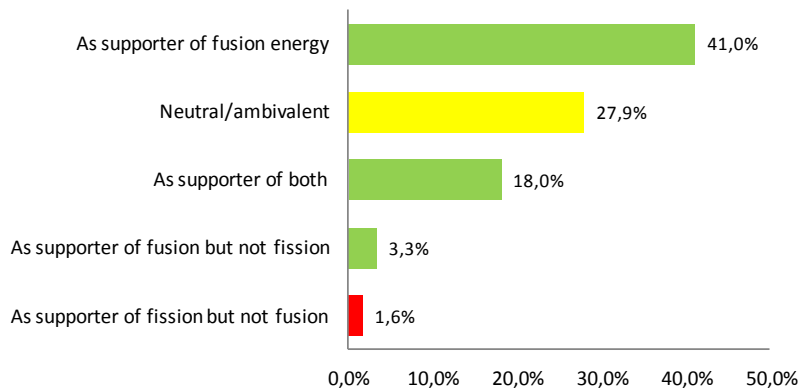
Figure17. Average evaluation attributed to various fusion-related costs/benefits in print media with fusion energy related content crossed by main actors (2008/2012)



N=105 articles

(Scale from 1 – Very negative to 5 – Very positive)

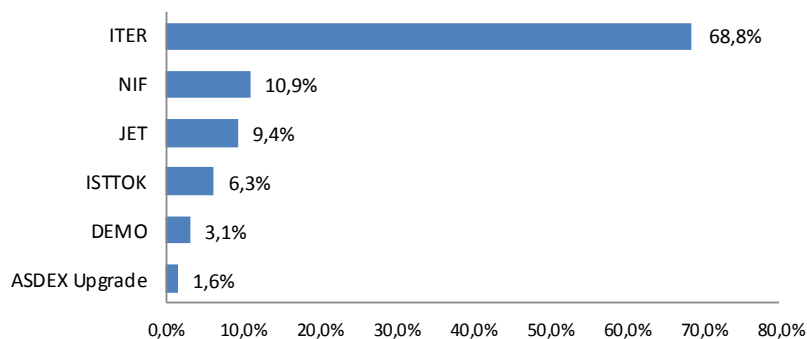
Figure18. Position manifested by actors about fusion in print media articles with fusion energy related content (2008/2012)



N=122 actors.

As we can see in Figure 19, ITER is the more frequently mentioned research device, with a percentage high above NIF, the second research device appearing in this aggregate. ITER has been the centre of attention in fusion news published by Portuguese print media over the whole period of analysis. In every year between 2008 and 2012 at least 2 articles mentioned ITER as the main research device. This focus on ITER is closely related to Portugal participation in ITER.

Figure19. Main research devices focused or mentioned in the articles with fusion related content (2008/2012)

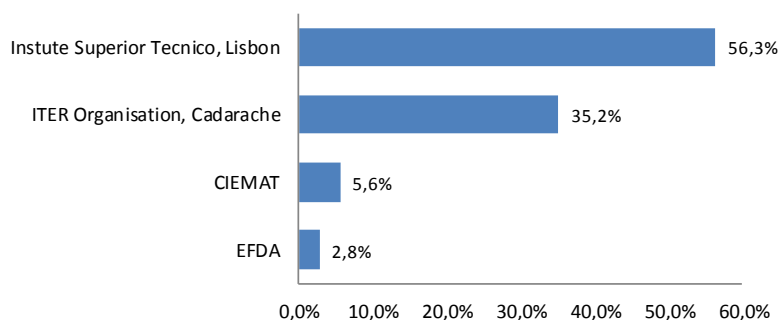


N= 64 research devices.

NIF is also referred to in some articles, but almost strictly in the period immediately after its inauguration and debut. We must also keep in mind that NIF was created by and is confined to USA research programs in fusion energy, a fact that does not captures so much of the attention of Portuguese print media. JET is the third research device in this aggregate. In the roadmap towards fusion energy, JET was the predecessor of ITER and for a considerable period the world's largest fusion research device operating. DEMO, with few references in our articles similarly to other research devices, also takes part in this roadmap and is expected to be the first fusion power plant to be connected to the grid.

The Instituto Superior Técnico leads the Portuguese participation in ITER. For this reason, it is the most frequently mentioned laboratory in our articles with more than half of the records (Figure 20). References to Instituto Superior Técnico are often coupled with references to ITER Organization, the second in the grading shown above. This linkage is mainly based upon reports on I&D activities and other agreements signed by both institutions.

Figure20. Main laboratories focused or mentioned in the articles with fusion related content (2008/2012)



N=71 laboratories

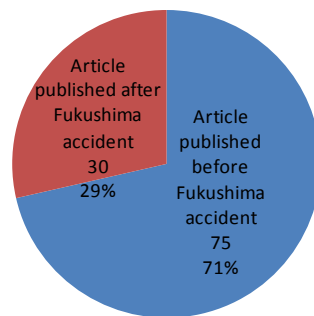
CIEMAT, the Spanish research centre, also participates in ITER but references to it are not so frequent in our articles. The few references to EFDA, the organization behind EU

contribution to fusion energy research and development, are made upon international or European protocols that involve ITER and its partners or collaborators.

Effect of Fukushima

The number of articles published before the accident in Fukushima is much superior to the number of articles published after that event (Figure 21). These differences can be partly explained by the wider period covered before the accident, which permitted to include more articles in the sample. Nevertheless, we have reasons to state that Fukushima's nuclear accident didn't produce a considerable effect on the publication of articles with fusion related content.

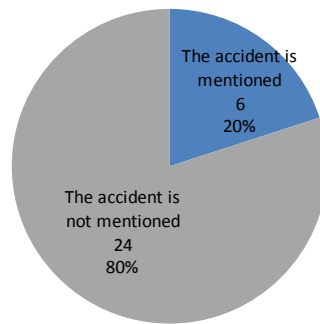
Figure21. Percentage of articles with fusion related content published before and after Fukushima accident (2008/2012)



N= 105 articles

Of the 30 articles published after the Fukushima accident only six (20%) mention it, against 24 (80%) that do not (Figure 22). Thus, we can say that the framing of fusion energy related content in Portuguese print media was not driven by the coverage of the accident in Fukushima. The few references to the accident are made in articles that cover fusion as a subsidiary subject in the context of fission and are mostly concerned with the safety problems and contamination effects commonly associated with fission technology. Most of these articles also compare fusion and fission over safety and environmental issues, with a positive assessment towards fusion and a negative one towards fission.

Figure22. References to Fukushima accident in the articles with fusion related content (2008/2012)

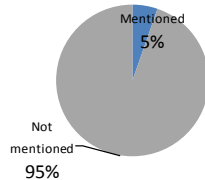


n= 30 articles published after Fukushima accident.

As shown in Figure 23, only 5% of the articles mention other accidents before the event in Fukushima. After it, this percentage reaches 10%. We can perceive in this numbers a slight increase of the impact that Fukushima's nuclear accident had over the framing of fusion related content. References to other nuclear accidents include Chernobyl and Three Miles Island and are made in the aftermath of Fukushima's nuclear event as a reminder of safety problems associated with fission power plants.

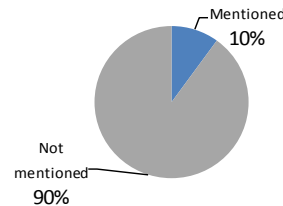
Figure23. References to other nuclear accidents in the articles with fusion related content (2008/2012)

Before Fukushima



n= 75 articles

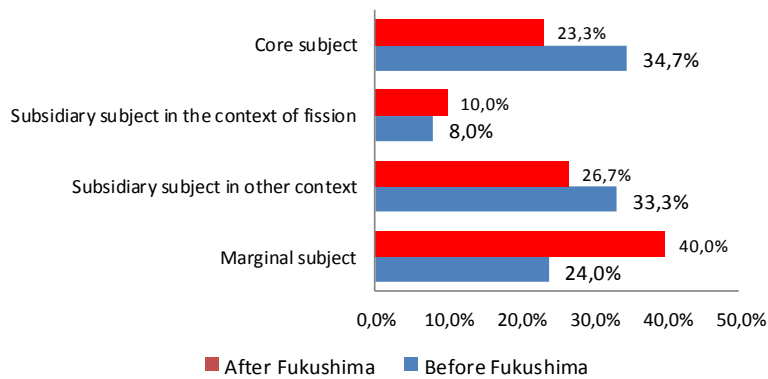
After Fukushima



n=30 articles

Before the Fukushima accident, fusion is mainly the core subject or subsidiary subject in other context (Figure 24). The difference between these two types of focus is almost insignificant (only 1.4%). Still in the period before the accident, fusion is the subsidiary subject in the context of fission in only 8% of the articles and marginal subject in 24% of theme.

Figure24. Role of fusion in the articles with fusion related content published before and after Fukushima accident (2008/2012)



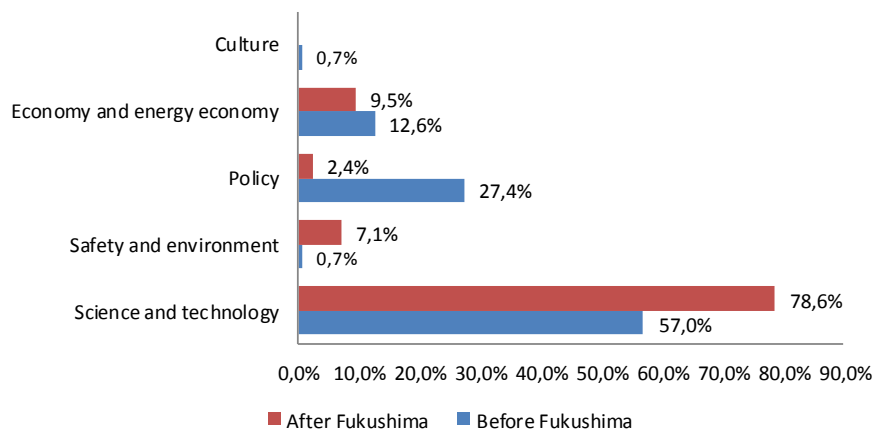
N=105 articles

After the accident, there is a strong increase in the number of articles where fusion is a marginal subject as well as a slight increase in the number of articles where fusion is presented as a subsidiary subject in the context of fission. Correspondingly, there is a decrease in the number of articles that present fusion as core subject as well as subsidiary subject in other context.

After the accident in Fukushima, fusion energy became more of a marginal subject than a core one in media discourse; it also became more often presented as a subsidiary subject in the context of fission and less in other context. Thus, it's clear that Fukushima nuclear accident has had a moderate effect in the type of focus given to fusion energy.

In comparing the period before with the period after Fukushima's nuclear accident, we can perceive some changes in the general thematic framing of fusion energy (Figure 25). First of all, articles written about Policy diminish to a point that takes this general thematic category from second in order of importance, before the accident, to a much lower position afterwards. Articles that focus on Economy and energy economy also decrease but in a moderate proportion. In contrast, there is a strong increase of articles written about Safety and environment as well as Science and technology thematic areas. As to Culture related themes no changes occur.

Figure25. General themes aggregated in articles with fusion related content published before and after Fukushima accident (2008/2012)



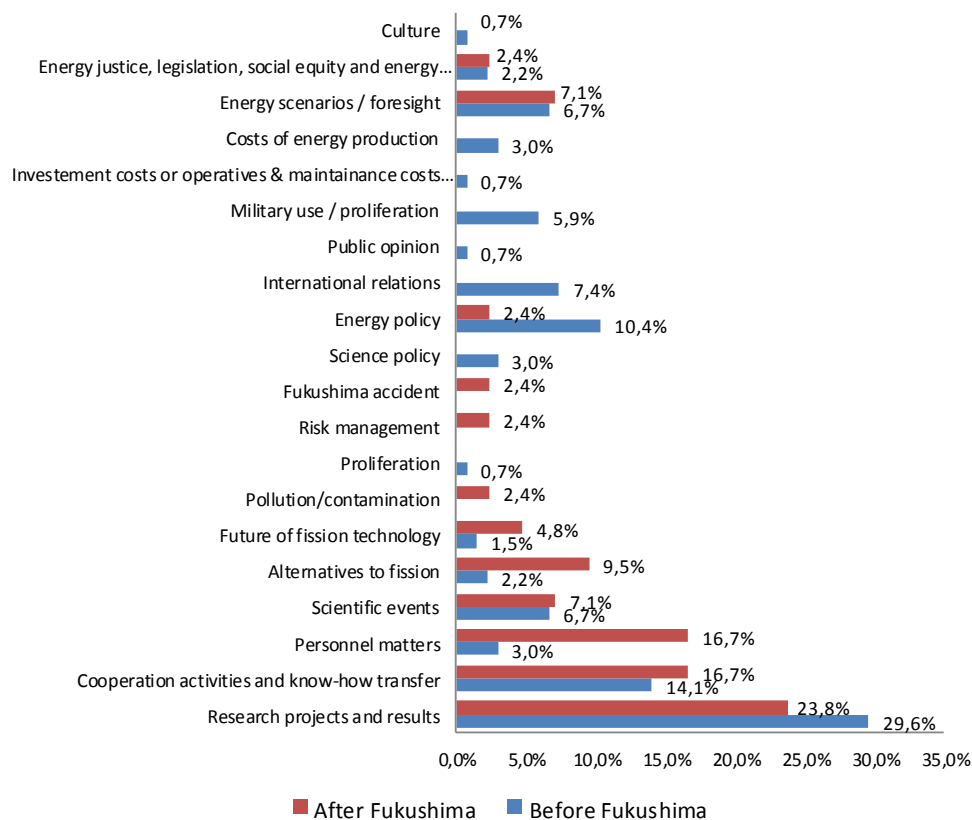
N=174 themes.

There is a clear switch in media focus from economic and political themes to safety and environmental ones after the accident in Fukushima. The accident in Fukushima impacted on the media agenda in the sense that enhanced the debate on risks and perils associated with conventional nuclear power and also brought forward some discussions on expected advantages of fusion over fission technology with respect to safety and environmental issues.

There is a moderate effect of Fukushima's accident in the increase of articles about Science and technology. This increase results mainly from random reports on scientific developments and events associated exclusively with fusion research, although some articles confront the limits and potentialities of fusion in comparison to fission technologies.

Figure 26 displays some significant outcomes in the post-Fukushima period. It's obvious that all articles about Fukushima accident only appear at this particular moment regardless its low proportion. Fukushima accident, Pollution/contamination and Risk management are all connected by the same event and display exactly the same record. This is the major effect of Fukushima's nuclear accident in the thematic structuring of fusion related content.

Figure26. Themes aggregated in articles with fusion related content published before and after Fukushima accident (2008/2012)



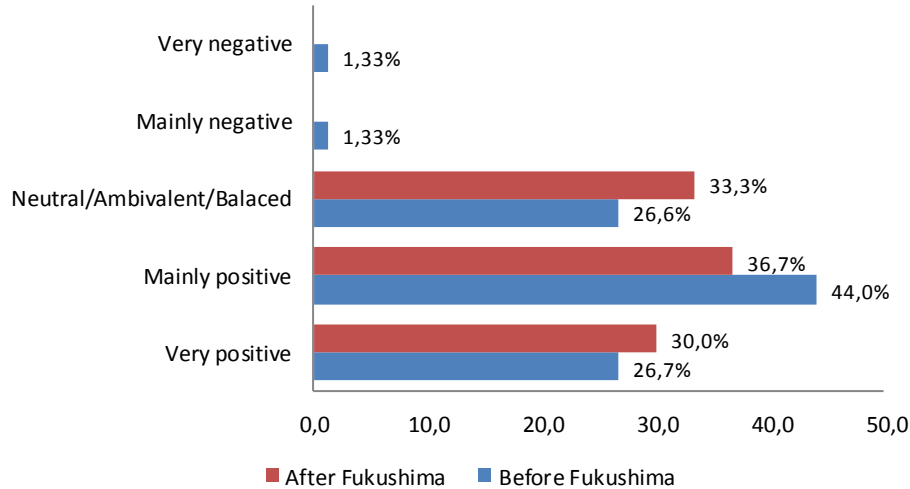
N=174 themes.

The increase of articles written about Future of fission technology and Alternatives to fission is also driven by the accident in Fukushima. Emerging debates about the causes and consequences of the accident in Fukushima have submitted this particular technology to public judgment in terms of its limits, expected improves on safety features, discussions over termination or proposals to alternatives considered more safe and environmental friendly, which is the case of fusion energy.

There is also an increase in the number of articles written about Energy justice..., and Energy scenarios/foresights, but it is not associated with the accident in Fukushima. Some themes show no record after the accident in Fukushima, especially those related to Economy and energy economy or Policy. These results reinforce the idea that media discourse on fusion energy changed focus from economic and political issues to safety and environmental ones after the accident in Fukushima.

After Fukushima, negative evaluations are absent from media discourse on fusion (Figure 27). Neutral, ambivalent or balanced evaluations increase slightly but there is no evidence that this is associated with Fukushima nuclear accident or its aftermath.

Figure27. General valuation of fusion energy in print media with fusion energy related content published before and after Fukushima accident (2008/2012)

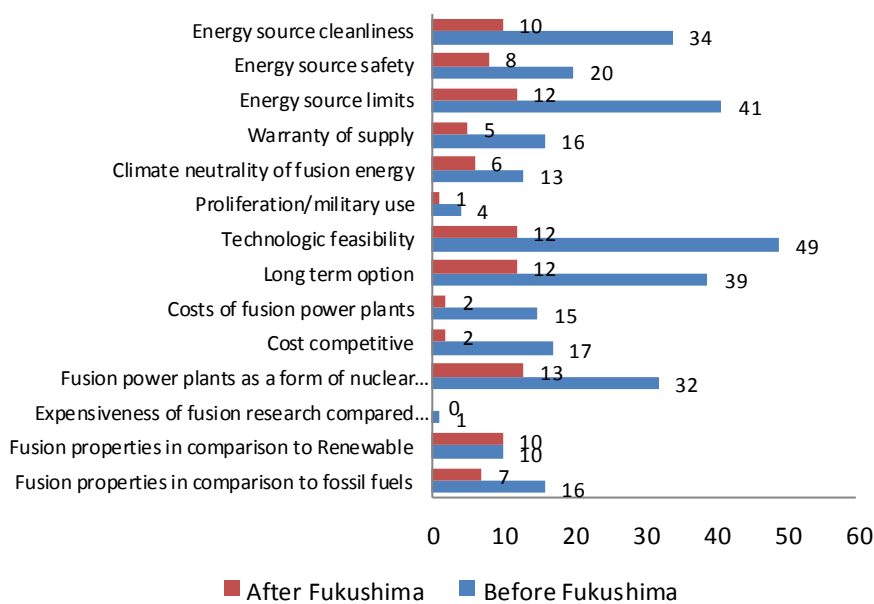


N=105 articles.

There are also more records of very positive and less records of mainly positive evaluation on fusion energy after the accident in Fukushima. It seems that this two different trends are co-related. Assessments made upon Fukushima nuclear accident contributed to emphasize positive evaluations already associated with fusion energy, in the sense that articles presenting very positive evaluations do so by underlying safety and environmental advantages of fusion in comparison to fission technology. Six of these articles mention Fukushima nuclear accident. It is also important to say that these articles were published by Quality newspapers/magazines and Scientific newspapers. Any contribution to build a more favourable opinion about fusion energy would only reach a narrow segment of the public.

All statements associated with fusion are mentioned more often before than after the accident in Fukushima (Figure 28). The expensiveness of fusion research compared with fostering of renewable energy is the only statement that appears only in articles published before the accident. Technologic feasibility, Long-term option, Costs of fusion power plants, Cost competitive and Fusion properties in comparison to Renewables, show equal records in both periods. However, this is not related to the accident in Fukushima.

Figure28. References to various fusion-related costs/benefits in print media with fusion energy related content published before and after Fukushima accident (2008/2012)

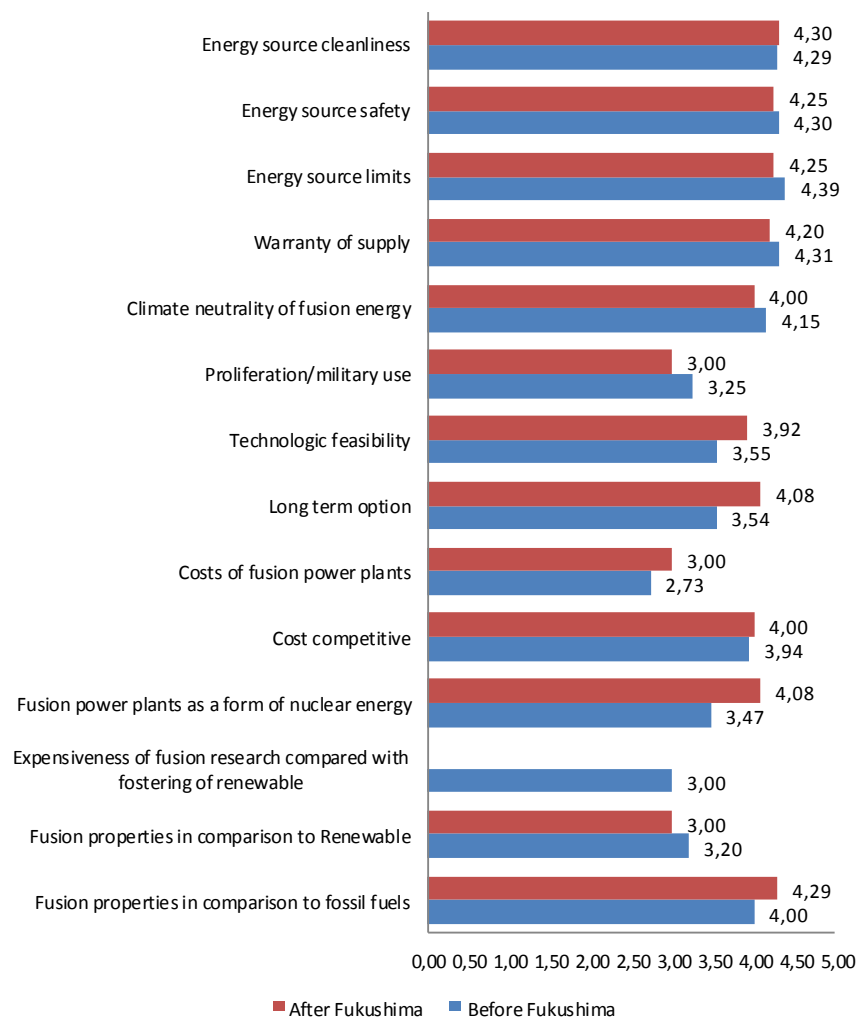


N=105 articles

As we can see in Figure 28, there is a strong decrease in statements from the period before to the period after the accident. This downward trend is partially explainable by the lower number of articles published after Fukushima's nuclear event. Records on Energy source cleanliness, Energy source safety and Energy source limits are very similar after the accident. We can perceive in this trend a stronger co-relation between these three statements, which is associated with the enhancement of fusion's comparative advantages over fission technology.

In what concerns the evaluation of statements related to fusion mentioned in the news, we can see (Figure 29) that all statements show values above 2.5 in both periods, which means that they are always positive. Some statements are very close to the highest average score, like Energy source cleanliness, Energy source safety, Energy source limits and Fusion properties in comparison to Renewables.

Figure29. Average evaluation attributed to various fusion-related costs/benefits in print media with fusion energy related content published before and after Fukushima accident (2008/2012)



N=105 articles
(Scale from 1 – Very negative to 5 – Very positive)

The first three statements are often presented together in some articles, contributing to shape a specific kind of discourse in which fusion is reputed as a standard for environmental friendly, safe and powerful source of energy. Warranty of supply also shows a high and almost constant score. This statement is associated with the predicted capability of fusion technology to provide energy for public consumption when future fusion power plants connect to the grid.

The most notable variations in average scores from the period before to the period after Fukushima accident, concern statements such as Long term option, Fusion properties in comparison to fossil fuels and Fusion power plants as a form of nuclear energy. With respect to the first two statements, there is no identifiable effect of Fukushima accident in this variation. As for Fusion power plants as a form of nuclear energy, it is quite clear that in spite of non-existing fusion power plants as energy supplying facilities up until now,

prospects over their construction are kept in mind for future generations. After the accident in Fukushima, we have 11 articles that present a positive evaluation over this statement. There is no negative assessment towards it. Three out of those eleven articles mention the accident in Fukushima.

Qualitative analysis

The exploratory qualitative analysis here presented is based in 20 articles that were selected according to the criteria mentioned at the methodology. Emphasis was put on statements about costs and benefits of nuclear fusion. The Fukushima accident is not a frequent theme when fusion is the main subject of the article. It is only present in two articles, and in both articles fusion is a subsidiary theme.

First of all, we will present the general definition given to fusion, and then we will focus on each of the dimensions or statements related to fusion mentioned in the articles.

Characterization of fusion

Generically, nuclear fusion is presented in the Portuguese press as a potential form of energy production. This status as technology still under development is emphasized and the fact that this achievement will only happen in the coming decades is highlighted.

"Nuclear fusion has been one of the biggest hopes in the world to get unlimited and cleaner energy." (Público; 2009/05/29)

"Besides renewable energy, there is the possibility, as yet remote, of nuclear fusion."(Visão; 2009/01/01)

The analyzed media tends to characterize fusion energy as clean, safe and unlimited. This repetition of words, in this order, appears with some regularity in the analyzed articles, constituting an established conceptual frame.

"The objective is to recreate the energy of the stars, clean, safe and inexhaustible."(Diário Económico; 2008/10/14)

"(...) the nuclear fusion technology, clean and safe." (Jornal de Notícias; 2010/04/08)

Another frame regularity conveyed by the media is the explanation of nuclear fusion as a reproduction of a natural, grand and mighty process, highlighting the similarity to what occurs inside stars, stressing mainly the Sun. This frame rests upon the notion of "technological sublime" (Nye, 1994). By stating that this man-made technology is identical to a natural sublime it is suggested that fusion may be considered a dream, an achievement of future greatness.

"(...) we imitate on earth the process that occurs inside the sun – nuclear fusion."(Sol; 2010/09/20)

'(...) the reproduction in Earth of energy production of the universe, where all the energy is generated or fusion reactions.' (Ciência Hoje; 2008/07/16)

Several articles are dedicated to explain what the project ITER is, who participates and what are its costs.

"F4E is an institution created by decision of the Council of Ministers of the European Union with three key objectives that pass 'by the European contribution to Tokomak/ ITER construction - an international project that aims to demonstrate nuclear fusion as a viable and sustainable energy source.'" (Ciência Hoje; 2011/08/04)

Issues such as military use and proliferation had never been mentioned in none of the articles of this sample.

Fusion cleanliness

Cleanliness is one of the most used adjectives when fusion is the subject. The emphasis on that feature passes through all the analyses.

The fact that this technology allows the production of nuclear energy with almost no toxic waste is also often referred. As well as the fact that it is not responsible for CO² emissions to the atmosphere.

"fusion (...) produces virtually no radioactive wastes."(Ciência Hoje; 2008/07/16)

"(...) much safer, cleaner and producing no CO." (Ciência Hoje; 2012/01/03)

The emphasis given to this feature is certainly related to the widespread public awareness and concern about climate change.

Fusion safety

Safety is another issue that people care about when it comes to nuclear energy. Regarding fusion, articles always emphasize its safety, especially when compared with the traditional nuclear energy.

"The fusion is still safer than fission." (Ciência Hoje; 2008/07/16)

Scientists interviewed in some of these articles explain something about the science that underlies fusion technology, in order to stress its safety.

"While a fission reactor works under pressure, like a pressure cooker that if something malfunction explode, the fusion works in a vacuum. If something malfunctions it implodes, goes inside." (Ciência Hoje; 2011/03/28)

"Another advantage is that in a fission reactor the fuel must be put inside at the beginning of the operation, while in the fusion fuels are entering as they are burned. In case of a malfunction the only thing one has to do is to close a gas intake valve and stop the reactions." (Ciência Hoje; 2011/03/28)

Fusion limits and warranty of supply

The fact that fusion allows to produce almost unlimited amounts of energy is often referred to in Portuguese newspapers.

"According to experts, one kilogram of fusion fuel will produce energy equivalent to 10 million liters of oil."(*Ciência Hoje*; 2008/07/16)

In one article the exposition goes further and explains what distinguishes fusion and allows it to be almost unlimited.

"In 20 years, when we manage to have power plants with these lasers, I think is a very good solution. With 500 liters of water - which is to say five baths - we will be able to create the amount of energy a person uses all his life." (I; 2001/03/16)

This unlimitedness may be associated to some kind of energy supply security. This characteristic is pointed out as opposed to the current situation where there is an energetic dependence of countries which are sometimes politically unstable.

"(...) it is not sensitive to geopolitical" (*Público*; 2009/05/29)

Fusion technologic feasibility

Technological feasibility is the topic with more frequent references. Many times ITER appears as the most innovative project and it's Tokomak as the most modern device.

"The main objective of ITER is to demonstrate the scientific feasibility of producing electrical energy from nuclear fusion. Tokamak / ITER is an international mega project to build the world's largest reactor capable of producing nuclear fusion." (*Ciência Hoje*; 2012/01/03)

But technological feasibility is also the only topic related to fusion with pointed weaknesses.

"The ignition might even be possible. But there is still much to learn." (*Público*; 2009/05/29)

"There are technological difficulties to cope with such large volumes of plasma." (*Expresso*; 2008/04/05)

Remote forecasts are provided for the commercialization of energy produced by nuclear fusion.

"Fusion will not come until 2050 or 2075." (*Expresso*; 2009/04/10)

"It is hoped that over a period of four to five years, ITER will demonstrate the scientific and technical feasibility of fusion energy, pointing to the beginning of commercial production of energy in 40 to 60 years, depending on the political will."(Ciência Hoje; 2008/07/16)

Fusion costs

The costs of scientific research on fusion presented by Portuguese newspapers are mainly related to the ITER project. Sometimes comparisons are made with other projects to make clear the amount of money involved.

"Experimental nuclear fusion reactor, ITER, is being built in southern France. Rated 4750 million euro over 10 years, will be funded by Euratom in 50%." (Diário Económico; 2008/10/14)

"There are 12 billion (the equivalent of 10 bridges Chelas-Barreiro) to build a functional prototype up to 2027." (Expresso; 2008/04/05)

The other focus given to this question has to do with the economic viability of this energy source.

"The energy of the future, according to scientists, will be even nuclear fusion, and we may be at a distance of 30 to 40 years for it to be economically viable." (Jornal de Negócios; 2011/06/02)

"The economic studies suggest that a fusion reactor is only viable with a gain of energy application in the order of 40." (Ciência Hoje; 2011/03/28)

Fusion energy and nuclear energy

Almost every articles analyzed establishes a link among fusion and fission. The majority sets a parallel between nuclear energy flaws and fusion potential. In most cases this comparison is related with cleanliness, waste, safety, limits and warranty of supply.

"The radioactive wastes are of short duration (one hundred years), unlike those of nuclear fission of uranium, some of which are 'hot' for thousands of years, which raises the problem of its long-term storage." (Expresso; 2008/04/05)

"Nuclear power is based on conventional fission of atoms requires unstable feedstock (such as uranium) and produces radioactive waste. Fusion enables unlimited and clean energy." (Diário de Notícias; 2009/06/18)

"Comparing an experimental fusion power plant to a nuclear power plant having a power of classical 1.5GW, the ratio of cost should be from five to three 'but will tend to lower as that manufacturing becomes more frequent.'" (Expresso; 2008/04/05)

Fusion energy and other energies

Fusion is displayed as being a good complement to the renewable energy and as the best alternative to non-renewable energies.

"Besides renewable energy, there is the possibility, as yet remote, of nuclear fusion."
(Visão; 2009/01/01)

"With the depletion of non-renewable resource there are only two ways to meet our energy requirements: or extended the use of renewable energy, benefiting from the Sun power by distance, or imitating on Earth the process that occurs inside the sun - the nuclear fusion." (Sol; 2010/09/20)

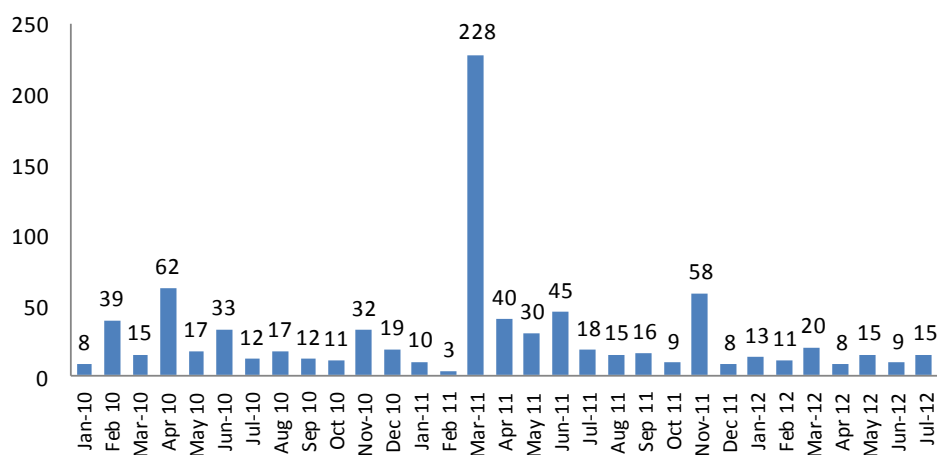
Fission

General characterization of articles

The evolution of articles about fission is very irregular within each year and over the whole period of analysis (Figure 30). The month of March 2011, when the accident in Fukushima occurred, stands out as the one with the highest number of articles. Of the 228 articles published in this month, 211 set the accident at Fukushima nuclear power plant as the primary or secondary theme.

The months of April 2010 and November 2011 are, respectively, the second and third with the highest number of articles published. Proliferation and military use, international relations and, to a lesser extent, energy policy are frequently the primary and secondary themes in these articles.

Figure30. Evolution of the number of articles with nuclear energy related content (2010/2012)



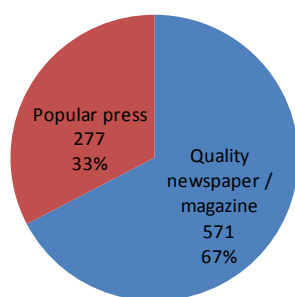
n=848 articles.

It is interesting to see that except for April 2010 and until the month of the accident in Fukushima, articles written about fission are very few, with some sporadic increases occurring at a very inconstant rate. February 2011, which immediately preceded the moment of the accident, is the month with fewer articles published. From April 2011 onwards, there is a progressive decrease in the number of articles published. Framing of fission energy in this post-accident period is initially related to assessments and insights on the nuclear accident in Fukushima, but tend to be progressively more concerned with proliferation and military use of nuclear energy or even with some random issues.

As we can see in Figure 31, more than half of the articles written about fission were published by Quality newspapers or magazines. These numbers are partially explained by

the fact that in the collecting process we searched only in two popular newspapers against six quality newspapers/magazines.

Figure31. Type of newspaper/magazine presenting articles with nuclear energy related content (2010/2012)

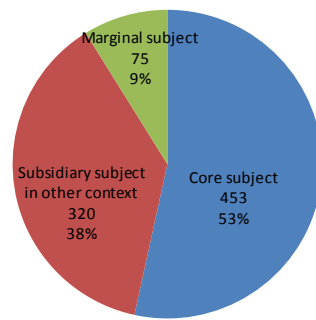


n=848 articles

There are no significant differences between popular and quality press publications in the thematic framing of fission energy. Frames are mostly constructed around themes such as military use and proliferation, accidents (especially Fukushima) or energy policy. Quality newspapers and magazines pay a little more attention to scientific content related to fission energy but not as much to distinguish themselves from popular press publications.

Fission is the core subject in more than half of reports (Figure 32). As a marginal subject, fission is present at an almost insignificant proportion and as subsidiary subject in other contexts at a median one. There is no distinct thematic structuring in media coverage either fission is presented as the core, subsidiary or marginal subject. That is, a specific theme can be focused differently at any specific context.

Figure32. Role of nuclear energy in the nuclear energy related articles (2010/2012)



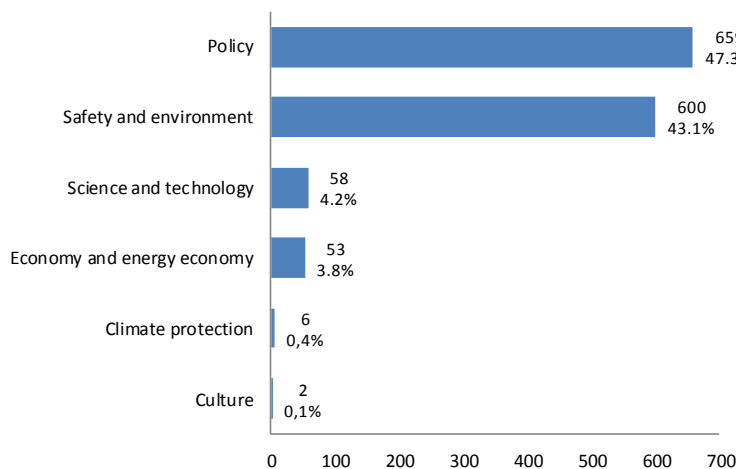
n=848 articles

Variations from core to subsidiary or marginal subject are associated with the time line of some events in general media coverage. For example, fission was more often presented as the core subject when reports addressed the Fukushima accident during the first three or four months following it, than afterwards.

Thematic content

According to the grading depicted in Figure 33, Policy and Safety and environment are the top references in the framing of fission energy, showing a remarkable distance from the lower ranked general themes. Fission is, therefore, more likely to be set in media agenda whenever political and safety or environmental issues emerge, than whenever other sorts of issues do.

Figure33. General themes aggregated in articles with nuclear energy related content (2010/2012)

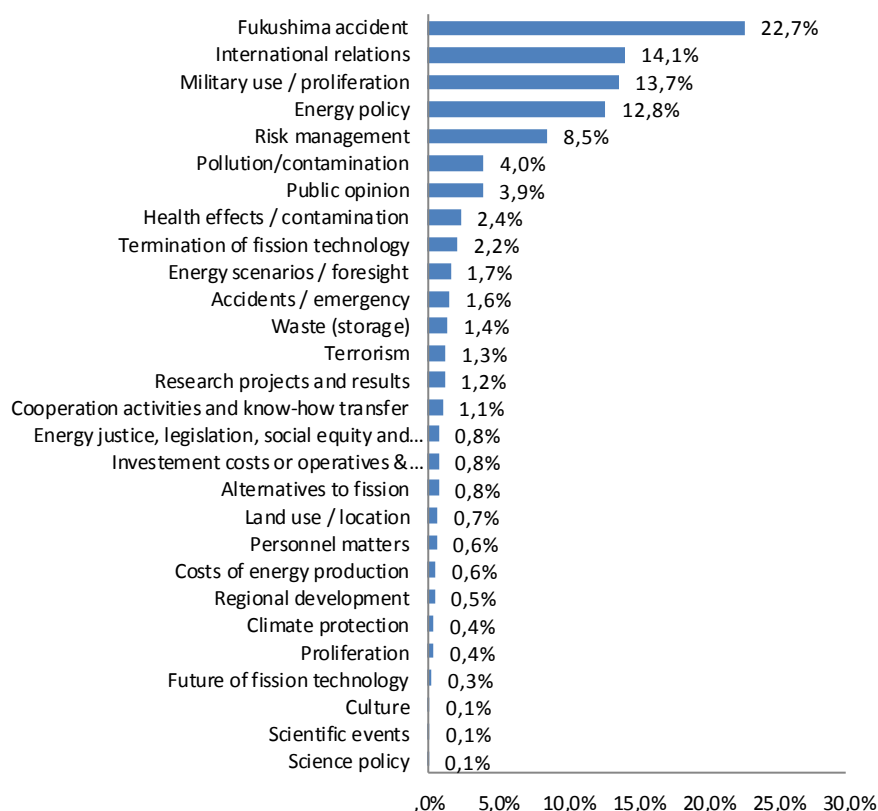


n=1393 Identified themes

Science and technology or Economy and energy economy are represented at a much lower level, but still show a significant proportion of records in comparison with the remnant general themes (Other, Climate protection and Culture).

As we can see in Figure 34, the Fukushima accident is the most common theme in the coverage of fission energy during the period of analysis. International relations, Military use/proliferation and Energy policy are also addressed to in a significant number of articles. If the Fukushima accident stands alone in the top ranked themes, since it is the only one associated with Safety and environment, International relations, Military use/proliferation and Energy policy are clustered as thematic references of the same kind, that is, all associated with Policy.

***Figure34. Themes aggregated in articles with nuclear energy related content
(2010/2012)***



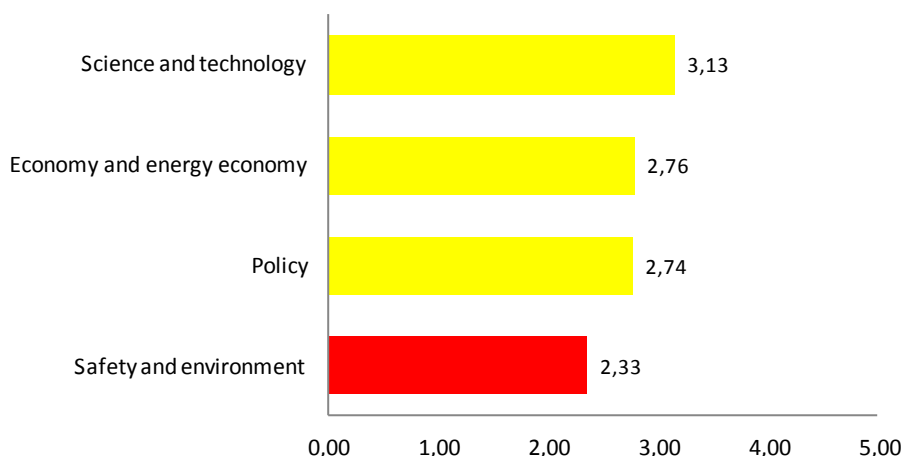
n=1393 Identified themes

In comparing the results for general themes and primary theme, we can say that the Fukushima accident redirected the attention of media to safety and environmental issues associated with fission energy in a decisive way. This kind of relation is unique when analysing the thematic structuring of fission energy in overall.

Themes associated with Science and technology or Economy and energy economy are randomly distributed in the grading depicted above. The coverage of fission energy in Portuguese print media tends to present scientific content and economic issues in an unstructured and superficial way. It also disregards climate protection and cultural aspects of the subject.

As shown in Figure 35, nuclear energy is not reported in a positive way. Except for Safety and environment, which shows a negative average of valuation, all general themes are neutrally evaluated.

Figure35. Average of valuation grade by primary general theme in print media with nuclear energy related content (2010/2012)



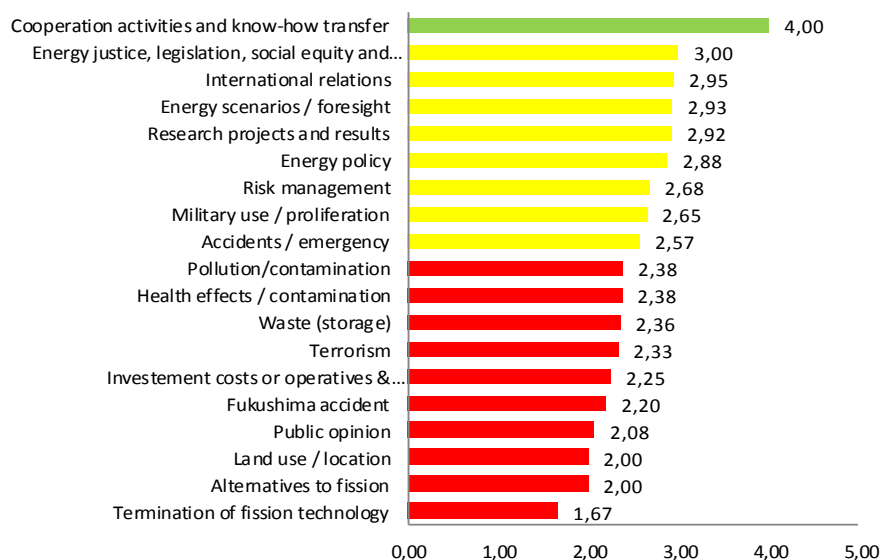
n=848 articles

(Scale from 1 – Very negative to 5 – Very positive)

Safety and environment is a thematic category related to issues such as nuclear accidents and its effects. This concurs with the strong emphasis given to the accident in Fukushima and its aftermath. When approached from the scientific or technological point of view, neutral valuations made on fission are very close to a positive grade.

Cooperation activities and know-how transfer is the only primary theme that shows a positive average of valuation (Figure 36). For the remaining themes, the averages of valuation range from positive to neutral degrees. We find appropriate to highlight the very similar scores of negative valuations associated with themes such as Pollution/contamination, Health effects/contamination and Waste. This suggests that these themes are commonly co-related in various articles and contribute to depict a strong negative image of fission in these particular contexts.

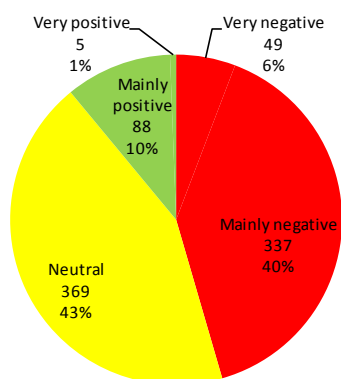
Figure36. Average of valuation grade by primary theme in print media with nuclear energy related content (2010/2012)



n=848 articles
(Scale from 1 – Very negative to 5 – Very positive)

Figure 37 shows the general valuation of nuclear energy conveyed in Portuguese press.

Figure37. General valuation of nuclear energy in print media with nuclear energy related content (2010/2012)

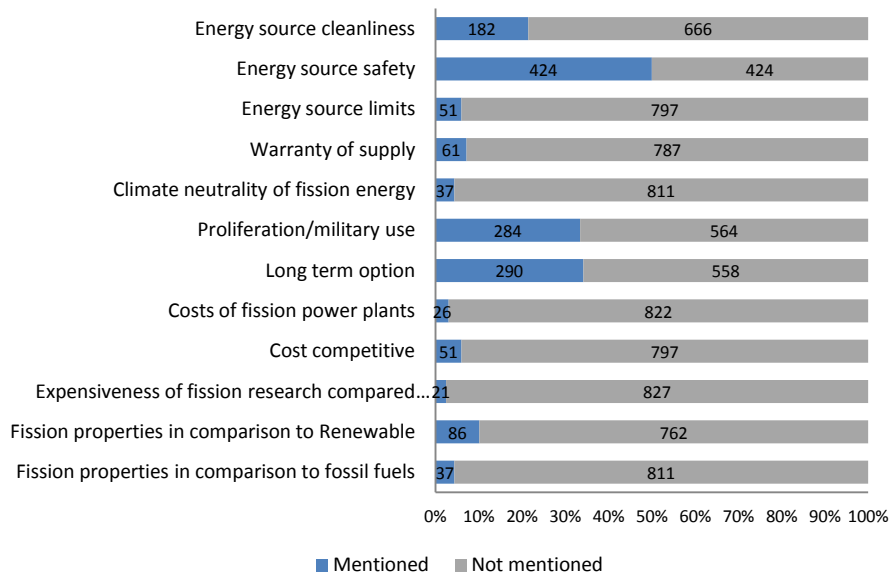


n=848 articles

Statements on benefits and costs

Figure 38 shows that only four statements are frequently mentioned with respect to the costs and benefits of fission energy. These are: Energy source safety, Long-term option, Proliferation/military use and Energy source cleanliness. The emphasis given to these statements is associated with the prevailing themes that frame media discourse on fission energy.

Figure38. References to various fission-related costs/benefits in print media with nuclear energy related content (2010/2012)



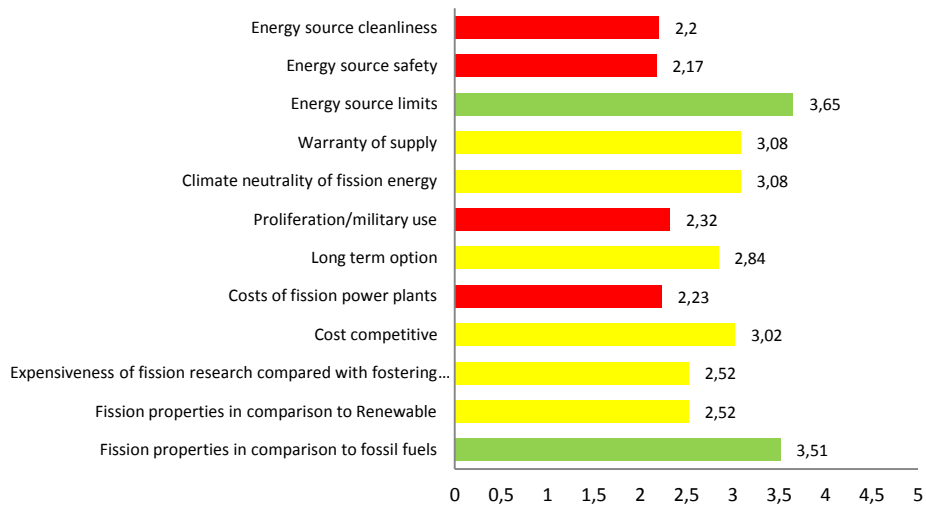
n=848 articles

A clear example of this linkage refers to Energy source safety (the statement more often present in the balance of costs and benefits), which is closely related to the nuclear accident in Fukushima and its aftermath. Energy source cleanliness can also be related to this event or theme, but to a minor degree, a fact that indicates that cleanliness was a secondary issue in comparison to security of fission energy within the context of Fukushima nuclear incident. Another example refers to Proliferation/military use. This statement also designates a specific theme and one that is commonly addressed to in Portuguese print media. There are some articles about the Fukushima accident that mention the Long-term option statement, but this occurs less frequently since the context of debate and assessments on this particular issue are more extended in time and less dependent of specific events.

All other statements are mentioned at a very low level, also following the lesser importance given to the contexts and themes from which they emerge in the construction of Portuguese media discourse on fission energy.

Overall, the averages of valuation of the various dimensions on nuclear fission range from neutral to negative (Figure 39). Positive valuations are associated with only two dimensions – Fission properties in comparison to fossil fuels and Energy source limits. In the first case, positive evaluations are linked either to the more moderate impact of nuclear energy based on fission technology over the environment in comparison to fossil fuels or to the possibility to face fossil fuels dependency in some developed countries. In the second case, positive valuations are related to the high standard of energy production generated by fission technology.

Figure39. Average evaluation attributed to various fission-related costs/benefits in print media with nuclear energy related content (2010/2012)



n=848 articles

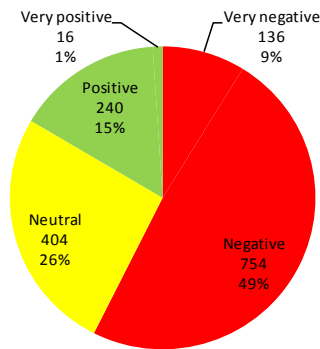
(Scale from 1 – Very negative to 5 – Very positive)

Climate neutrality of fission energy, in the first case and Warranty of supply, in the second one, which show records of neutral valuations very close to a positive degree, help to confirm a more favourable assessment made upon fission energy in both contexts of evaluation.

Fission properties in comparison to renewables, Cost of fission power plants, Military use, Energy source safety and Energy source cleanliness are negatively evaluated. Energy source safety and Energy source cleanliness show very similar records. Safety and environmental issues tend to be negatively co-related. Although some opinions favour the continuity of nuclear energy in the context of environmental protection (mainly climate change mitigation), the predominant views of nuclear energy do not convey with a clean and environmental friendly source of energy. Safety, on the other hand, is a major dimension of fission technology evaluation, moreover when debates over accidents, risks and unwanted outcomes of fission energy emerge in the public opinion (e.g. the accident in Fukushima).

Thus, in accordance with previous data, fission is generally portrayed negatively by Portuguese press. There are some positive references in the construction of fission's image, but they stand at a much lower degree in comparison to negative or even neutral ones. In addition, very negative assessments have a greater weight than very positive ones in this context.

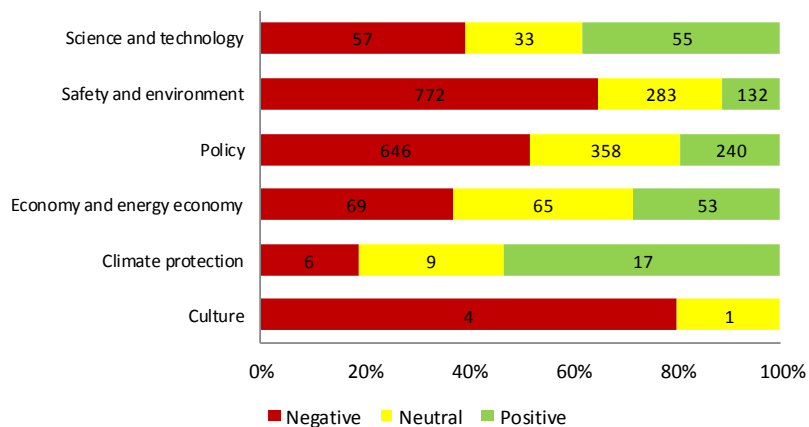
Figure40. Image of nuclear energy based on various fission-related costs/benefits in print media with nuclear energy related content (2010/2012)



n= 1550 references

Negative records of valuations made upon fission prevail in most of the general thematic categories (Figure 41). This draws a negative image of fission in overall. Fission is perceived positively as a source of energy only with respect to Climate protection. The argument behind this singular fact is that fission technology does not produce greenhouse gases that are known for their impact in global climate change.

Figure41. Image of nuclear energy based on various fission-related costs/benefits crossed by general themes aggregated in print media with nuclear energy related content (2010/2012)

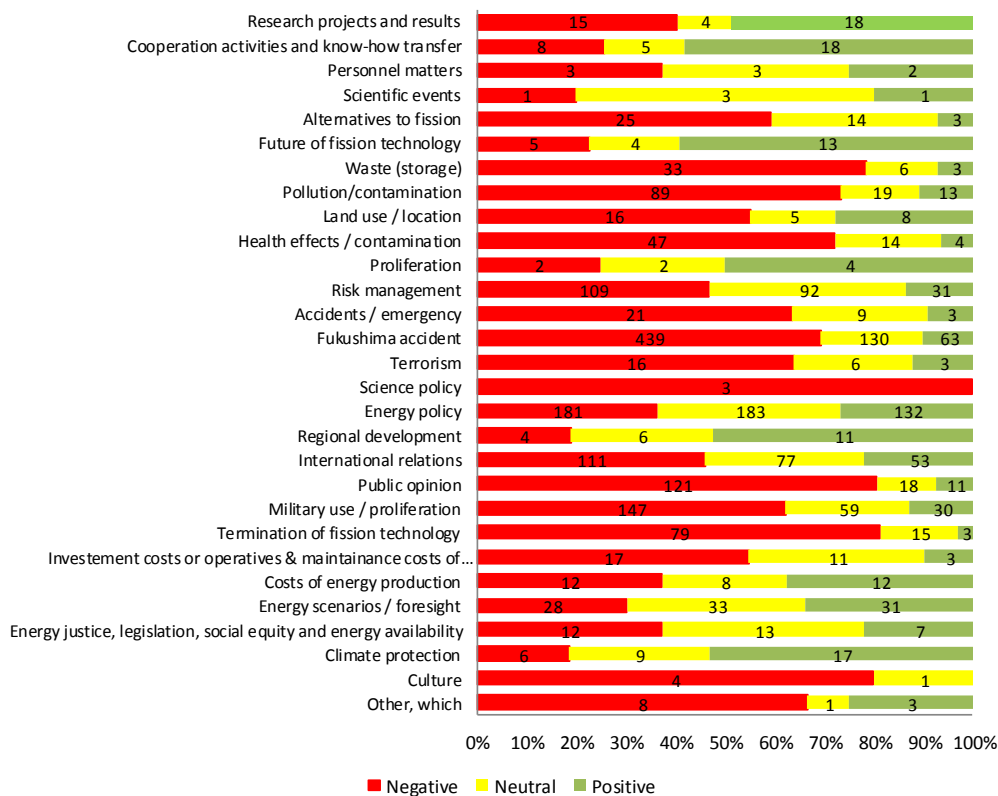


n= 1550 references

The negative image of fission is clearly outlined whenever issues that fall under the general thematic categories such as Safety and environment, Policy or Science and technology are addressed to in the articles.

The image of fission is clearly negative when Science policy is the primary theme of the articles (Figure 42). Negative valuations concerning the primary thematic references – Fukushima accident and Military use/proliferation are quite evident. We find some positive or neutral valuations associated with these thematic contexts, but they are very few to draw a more favourable picture of fission energy.

Figure42. Image of nuclear energy based on various fission-related costs/benefits crossed by themes aggregated in print media with nuclear energy related content (2010/2012)



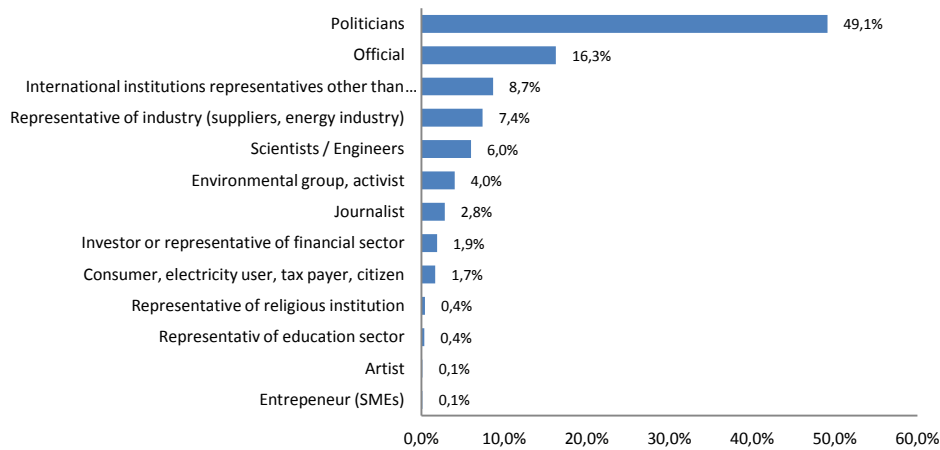
n=848 articles

There are some balanced valuations for themes such as Personal matters (neutral/negative), Scientific events and Costs of energy production (negative/positive) and Proliferation (neutral/negative). Positive valuations overcome negative ones when the primary themes of the articles are Research projects and results, Cooperation activities and know how transfer, Proliferation, Regional development, Energy scenarios and foresights and Climate protection. As we saw before, these are not major references in the thematic framing of fission energy. In an overall analysis, they do not counterbalance the overweight of negative valuations associated with the defining axis (themes) of media discourse. The negative image of fission is, thus, clearly drawn.

Actors

Politicians are the actors more often mentioned in the articles written about fission (Figure 43). In second place we find Officials, who have a close relation with political processes and political structures. International institutions, the third category of actors in order of importance, also have a role to play in the political sphere when relating to debates and assessments over nuclear energy.

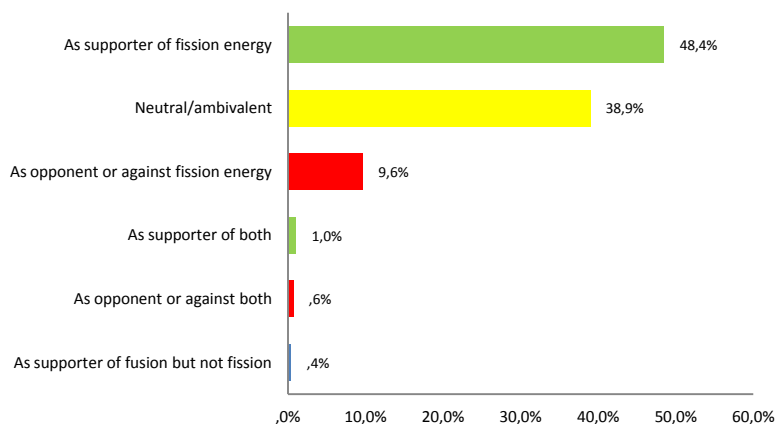
Figure43. Main actors in print media articles with nuclear energy related content (2010/2012)



n=1419 actors

Representatives of the education sector and Entrepreneurs are the actors that have a clearer evaluative position towards fission energy. All other actors tend to abstain from taking normative positions, notwithstanding their remarkable participation in the construction of media discourse on nuclear energy. This is particularly the case of Politicians and Officials.

Figure44. Position manifested by actors about nuclear energy in print media articles with nuclear energy related content (2010/2012)



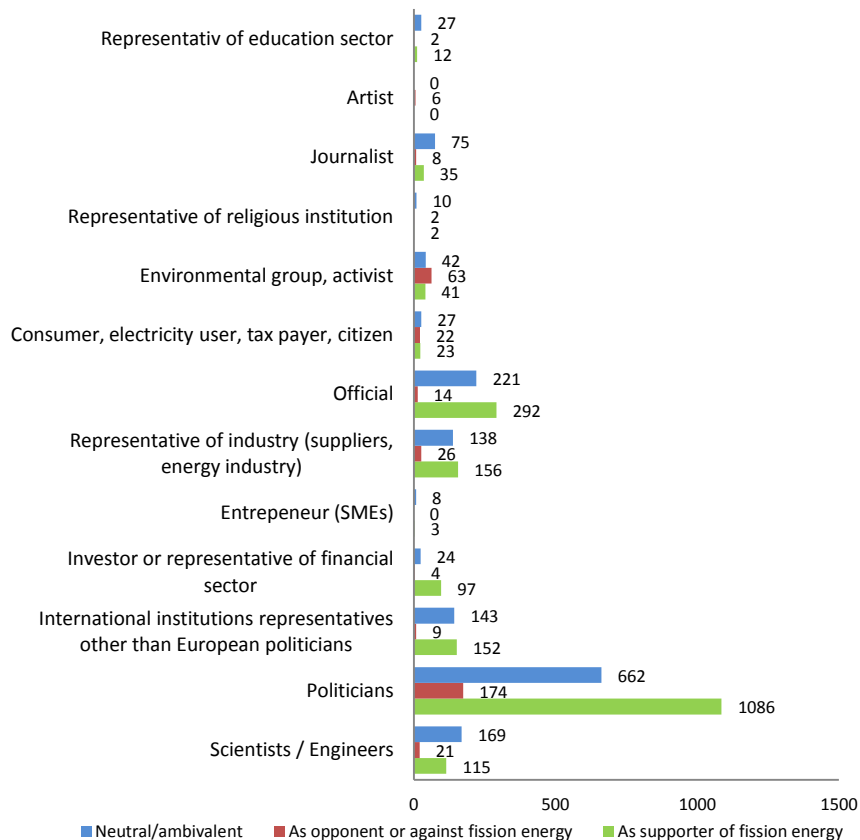
n=1419 actors

Supporters of fission energy are predominant in the articles, representing almost half of the records in this sample. Only 9.6% oppose fission and less than 0.1% opposes fusion and fission, a record that is very close to those that support both types of nuclear technology. There are very few references to supporters of fusion that oppose fission energy. Neutral positions towards fission are also very frequent.

Overall, actor's positions on fission energy tend to be either positive or neutral, and strongly dissociated from perspectives on fusion energy.

Politicians are the most relevant actors in the construction of media discourse on fission energy. Their positions vary from supporters to opponents or even neutral observers, with the greater number of representatives for each type of position (Figure 45). Within this category, supporters of fission overcome opponents in large numbers. This dichotomy is cut through by neutral positions, which show a relatively high record in the grading.

Figure45. Main actors position about nuclear energy in print media articles with nuclear energy related content (2010/2012)



n=1419 actors

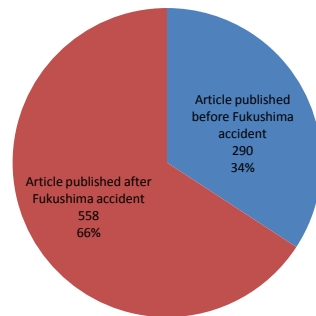
Official, Representatives of industry, International institutions and Investors show the same pattern of positioning: supporters are predominant, neutral individuals are in the middle rank and opponents are a minority.

Scientists and engineers tend to be more neutral. When called to take a specific position, the majority supports fission energy. It is also interesting to see that Environmental groups and activists form the only category of actors in which opponents overcome both supporters and neutral observers.

Effect of Fukushima

Figure 46 shows that more than half of the articles were published after the accident in Fukushima. As we had the opportunity to say in the section dedicated to the general characterization of articles about fission, Portuguese print media did not publish neither a great amount nor even a median amount of articles, in a regular basis, until the accident in Fukushima.

Figure 46. Percentage of article with nuclear energy related content published before and after Fukushima accident (2010/2012)

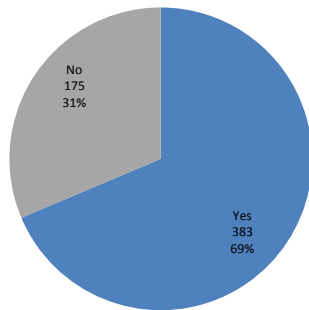


n= 848 articles

The accident did have a great impact on the amount of articles published about fission energy, but only during a limited time. A downward tendency in the publication of articles occurred only a few months after the exhaustive coverage of that nuclear event.

Figure 47 shows that 69% of the 558 articles published after the accident in Fukushima mention it, against 31% that do not. The Fukushima accident is largely the main thematic reference during this period. The articles that do not mention this nuclear incident address a great variety of themes, with a greater percentage focusing on Military use/proliferation and International relations.

Figure47. References to Fukushima accident in the articles with nuclear energy related content (2010/2012)

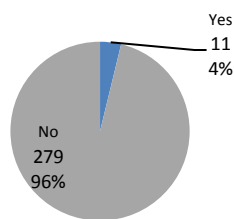


n= 558 articles published after Fukushima accident.

The references to other nuclear accidents increased after Fukushima (Figure 48). There is no doubt that the chain of events in the Japanese nuclear power plant drove the attention of the media towards other past nuclear accidents, especially Chernobyl and Three Mile Island. Media discourse presents these references as constant reminders of the perils associated with nuclear energy based on fission technology.

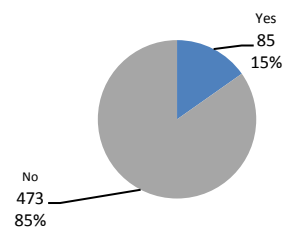
Figure48. References to other nuclear accidents in the articles with nuclear energy related content (2010/2012)

Before Fukushima



n= 290 articles

After Fukushima

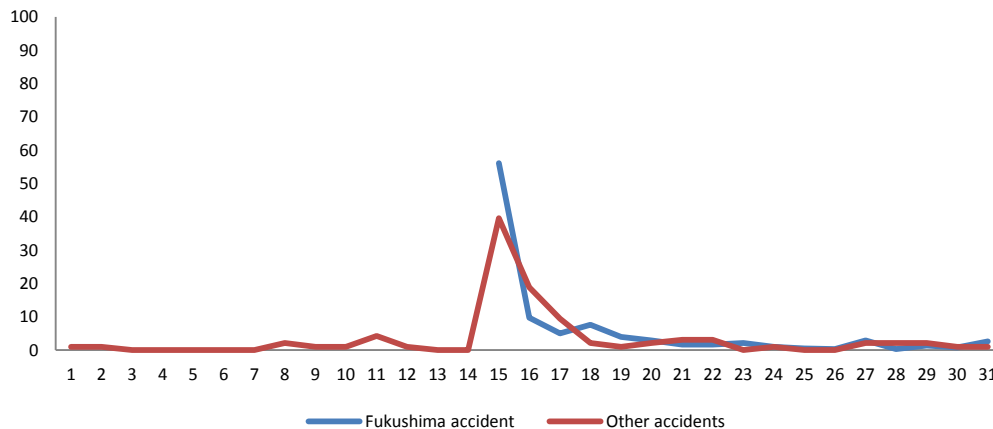


n=558 articles

The timeline represented in Figure 49 gives us more clear perception of the focus given to nuclear accidents during the period of analysis. It's remarkable how the Fukushima accident had a pull effect over the coverage of other similar nuclear events. In November 2010 (month 11), there are few references to other nuclear accidents, mainly associated with social protests over nuclear waste disposable methods. In March 2011, references to other nuclear accidents are almost always paired with references to Fukushima. In fact, a

considerable number of articles only mention other nuclear accidents in articles written about Fukushima and mainly with the intention of comparing the causes and consequences that each accident had over social, political and environmental dimensions.

Figure49. Percentage of articles mentioning the Fukushima accident and other nuclear accidents from 2010-2012 (month 1 to 31)

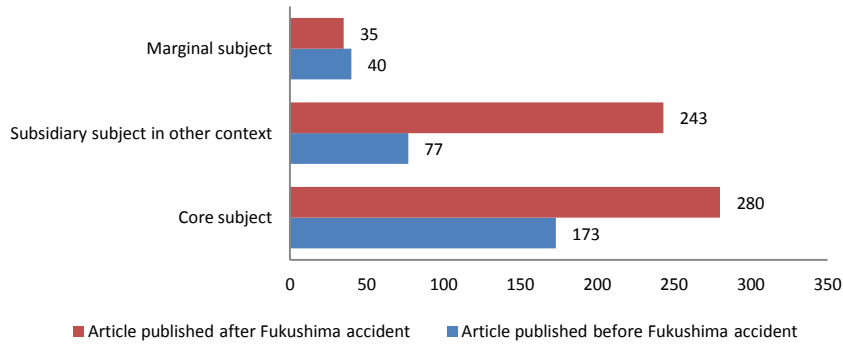


n= 848 articles

The decrease in the number of references to other nuclear accidents and the Fukushima accident occurred concomitantly from April 2011, reaching a very low and constant level until the end of the period of analysis. However, it's interesting to see that references to Fukushima drop down abruptly and references to other nuclear accidents decrease in a more moderate pace.

The focus on fission as a core subject is much more frequent after the accident in Fukushima than before (Figure 50). As a subsidiary subject, this relation follows the same pattern. It is also interesting to see that fission is more often treated as a marginal subject before the accident than after it. Thus, we can say that the accident in Fukushima had a great impact over the angle of approach to fission energy by Portuguese print media.

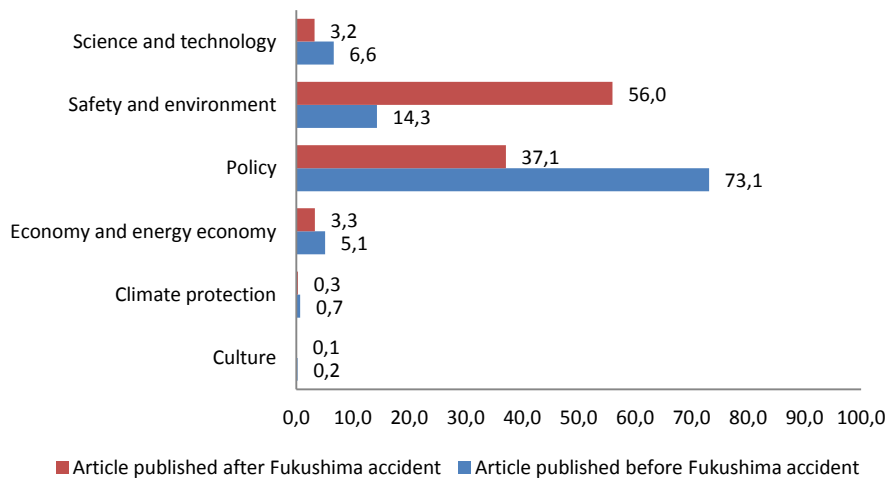
Figure50. Role of fission in the articles with nuclear energy related content published before and after Fukushima accident (2010/2012)



n= 848 articles

After the accident in Fukushima, Safety and environment related issues are covered to a larger extent than before the accident (Figure 51). In contrast, there is a strong decrease in the coverage of issues related to Policy (more significantly), Science and technology, Economy and energy economy in the same time span. The Fukushima accident impacted in media agenda in a way that themes associated with Policy were clearly overlapped by those associated with Safety and environment.

Figure51. General themes aggregated in articles with nuclear energy related content published before and after Fukushima accident (2010/2012)

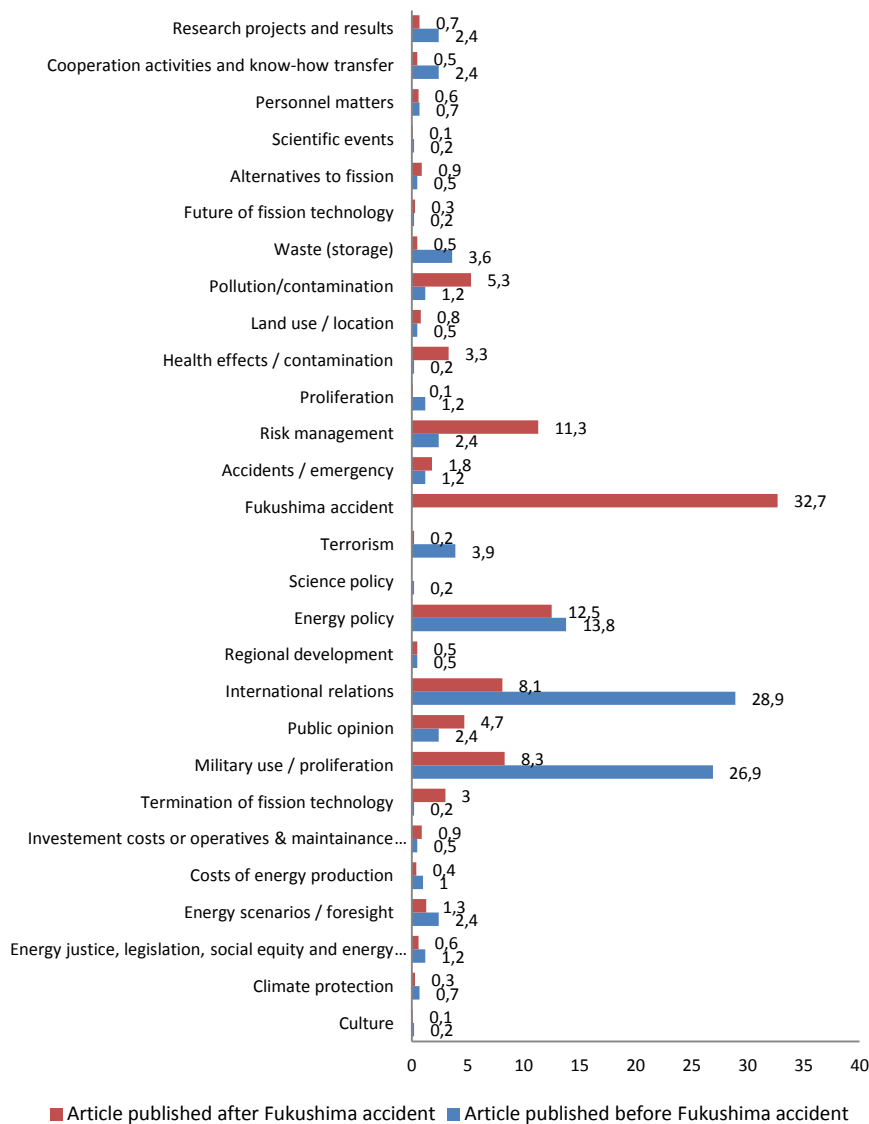


n=1393 Identified themes

As for themes associated with Climate protection and Culture, the difference from one period to another is almost imperceptible, since those themes are persistently kept out of focus from the media point of view.

The overturn from political related themes to safety and environmental ones in media framing of fission energy after the accident in Fukushima is clearly portrayed in Figure 52. Military use/proliferation and International relations, which are associated with the political dimension, are much less addressed after Fukushima than before. It is obvious that the Fukushima accident can only be identified in the period after it occurred. References to the accident are strongly predominant, making it the main theme in media coverage of fission energy, even if compared to the records of other major themes during the whole period of analysis.

Figure52. Themes aggregated in articles with nuclear energy related content published before and after Fukushima accident (2010/2012)

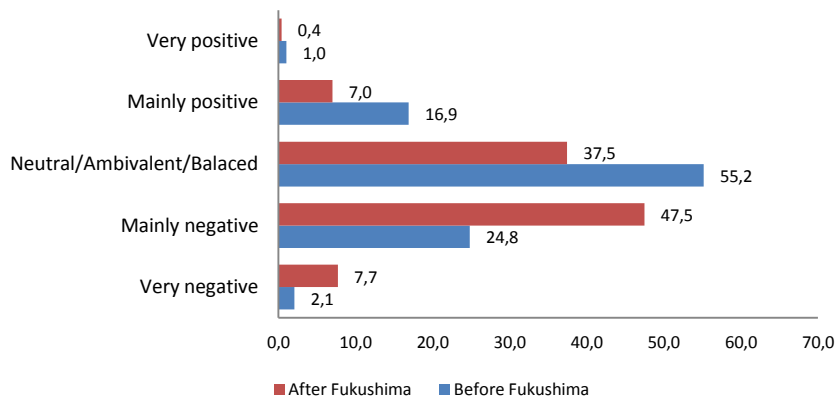


n=1393 Identified themes

With the emergence of Fukushima accident in the news, themes such as Risk management, Pollution/contamination and Health effects increase significantly in media coverage. These are all related to Safety and environment thematic category. We can also perceive here the pull effect of the Fukushima accident in the framing of fission energy related content.

In an overview of the way fission energy is evaluated in the media, is quite clear that negative assessments are much more common than positive ones, regardless the period of reference (Figure 53). Neutral valuations are also frequent and they prevail before the accident in Fukushima. However, it seems that these neutral views tend to evolve towards negative ones afterwards.

Figure53. General valuation of nuclear energy in print media with nuclear energy related content published before and after Fukushima (2010/2012)

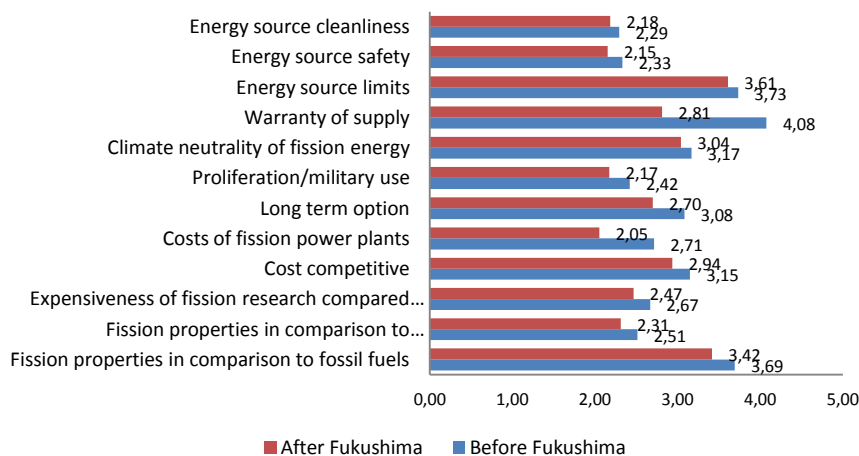


n=848 articles

The effect of Fukushima in the way that nuclear energy is evaluated can be sum in to four different aspects: i) a redirection from neutral to negative types of evaluations; ii) a decrease in positive valuations; iii) an increase of moderate negative valuations; iv) an increase of extreme negative valuations.

There are not significant differences in the averages of statements presented from the period before to the period after the accident in Fukushima (Figure 54). Warranty of supply is the only statement that shows a higher score in the period before the accident in comparison to the period that followed. This result is associated with the public perception of the stability attributed to the energy provision from nuclear power plants that diminished after the accident in Fukushima. In overall, average of statements made towards fission energy seem to be quite persistent regardless the moment considered.

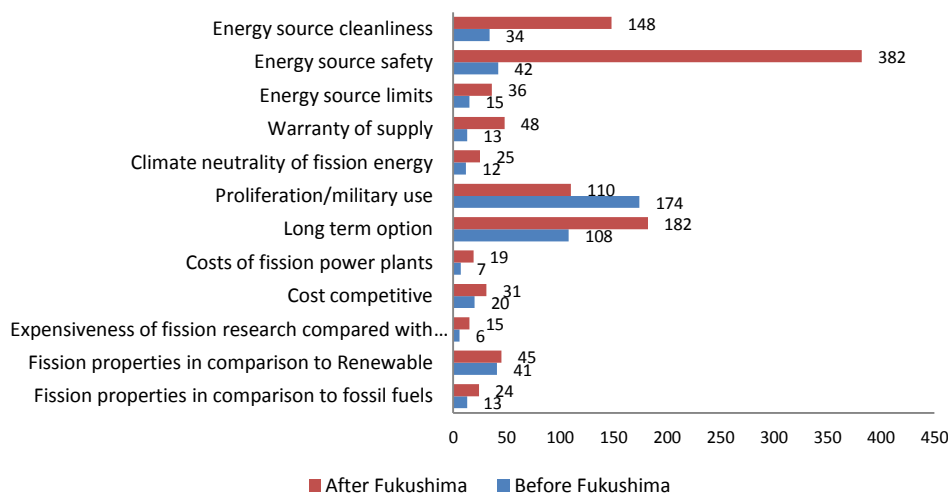
Figure54. Average evaluation attributed to various fission-related costs/benefits in print media with nuclear energy related content published before and after Fukushima (2010/2012)



n=848 articles (Scale from 1 – Very negative to 5 – Very positive)

The statements presented towards fission energy are more often mentioned after the accident in Fukushima than before (Figure 55). The exception is Proliferation/military use that shows a superior record before the accident. This is associated with the fact that military use of nuclear energy ceased to be one of the major thematic references in the post-Fukushima period.

Figure55. References to various fission-related costs/benefits in print media with nuclear energy related content published before and after Fukushima (2010/2012)

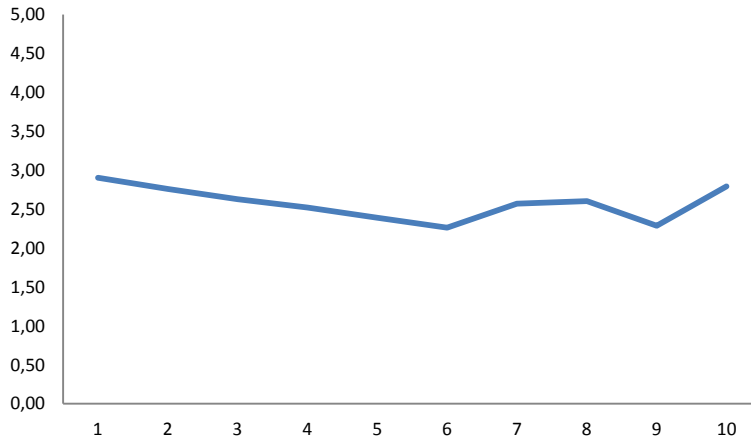


n=848 articles

The increase in the records is much more evident for Energy source safety and Energy source cleanliness than for any other statement. These two statements are closely associated with safety and environmental themes that, as we had the opportunity to see before, are largely covered in the post-Fukushima period.

As Figure 56 shows, the valuation towards fission is, on average, exclusively negative. In addition, it evolves constantly in a downward trend from the first trimester (January 2010) to the sixth trimester (April, May and June of 2011), reaching the lowest value precisely in this interval (2.26).

Figure56. Evolution of the average evaluation of the various fission-related costs/benefits in print media with nuclear energy related content published before and after Fukushima (2010/2012)



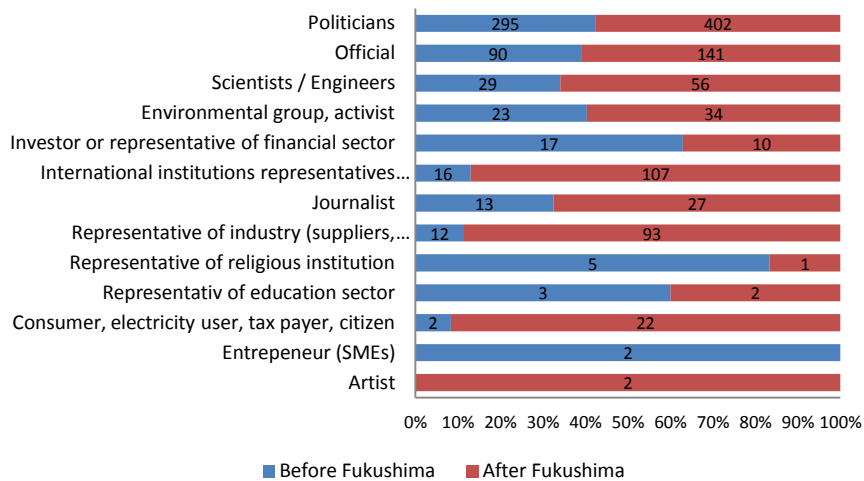
n= 1550 references
(Scale from 1 – Very negative to 5 – Very positive)

From the fifth trimester (which includes the month of the accident in Fukushima) to the sixth trimester, the average of valuation drops further (from 2.39 to 2.26). This is probably explained by the fact that, overall, the first news about Fukushima were more focused on facts and figures, while assessments and evaluations were presented at a larger extent in the aftermath of the accident (sixth trimester).

From the sixth trimester forward, negative valuations evolved in a more moderate way. By this time, the focus of print media shifted from the accident in Fukushima to a more heterogeneous set of issues related to nuclear energy.

The actors that have a greater participation in the construction of media discourse on fission energy, regardless the period of reference are politicians and officials (Figure 57). The importance given to these actors increased after the accident in Fukushima. Many articles refer Japanese politicians but also their counterparts from various countries in the context of that nuclear event. The role of politicians and officials is not restricted to that context, since they are also referred to with relation to other issues, such as the military use of nuclear energy.

Figure57. Main actors in print media with nuclear energy related content published before and after Fukushima (2010/2012)



n=1419 actors

Representatives of international institutions (like the International Atomic Energy Agency) and representatives of industry (like Tepco, the company that owned Fukushima power plant) also had a major role in debating the causes and consequences of the accident in Fukushima, which media tend to emphasize.

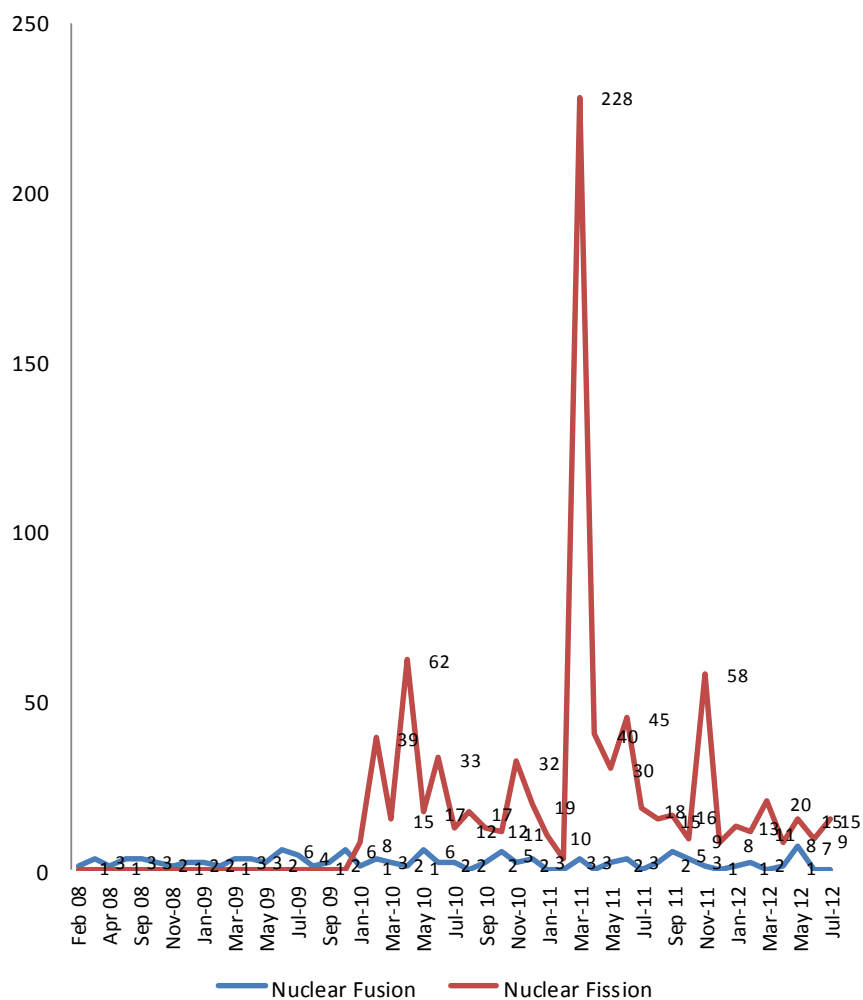
After the accident, other actors gain much more relevance in the construction of media discourse on fission, particularly environmental groups and other citizens - consumers, electricity users.

It is interesting to see that the media gave much more importance to scientists and engineers' insights on fission energy after this nuclear event than before. Thus, it seems that the media tend to highlight scientific discourse on fission technology mainly when it outlines a specific point of view over a nuclear accident.

Relation between fusion and fission

The comparison between the evolution of articles about fusion and fission can only be made in the period spanning from January 2010 to July 2010. The number of articles published about fusion evolves in a constant and very low level, with minor increases occurring sporadically (Figure 58). In contrast, the evolution of articles about fission is very irregular with some peaks occurring discontinuously over the monthly time span.

Figure58. Evolution of the number of articles with fusion or fission related content (2008/2012)



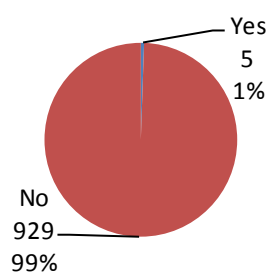
n= 934 articles

In the case of fusion, the evolution of published articles is not always associated with specific events or series of related events. As for fission, the evolution of published articles is associated with the setting of the most common themes in media agenda, especially the military use of nuclear technologies and international regulations on nuclear weapons control. Clearly, the accident in Fukushima had a strong impact on the publication of articles about fission, which increased to maximum point by mid-March 2011. The same cannot be said with regards to fusion, since after the accident in Fukushima no alteration in the number of published articles is observed.

From April 2011 to November 2011 the number of articles published about fission underwent a very pronounced decrease. In November, it reaches again a considerable level as a result of the attention given to international debates and negotiations over the Iranian nuclear energy programme. From that month on another decrease occurs and follows throughout the end of the period, almost reaching a level similar to the number of articles published about fusion.

Only 5 articles about fission mention fusion. In these cases, the articles cover both technologies as specific subjects, and there is no confusion between them (Figure 59). There is a significant number of articles about fusion that mention fission, which also does not mean that there is confusion between both, but rather a tendency to bring them together to the same context of discussion. Fusion is covered to a considerable extent with relation to fission energy. We could, although, identify one article where fusion is mistaken for fission. The article revolves around many subjects, including debates on the introduction of nuclear energy in Portugal, which is called at some point 'nuclear fusion'. It is plain semantics.

Figure59. Percentage of articles that confuse fusion and fission in print media with fusion or nuclear energy related content (2008/2012)

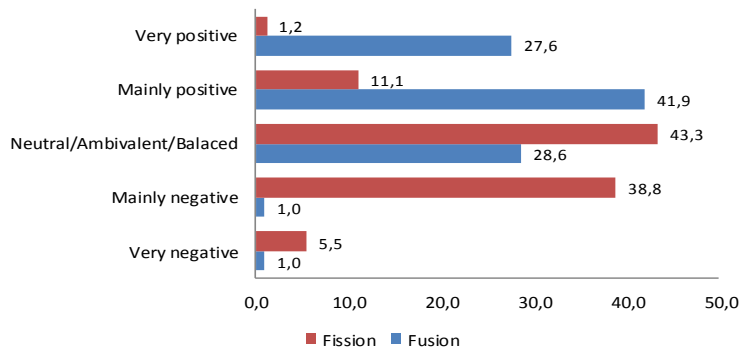


n= 934 articles

The valuation grades attributed in the news to these forms of energy are clearly divided between mainly positive or very positive, with higher scores for fusion and mainly negative or very negative, with higher scores for fission (Figure 60). In average, negative

evaluation of any degree towards fusion and very positive evaluations towards fission are almost insignificant.

Figure60. General valuation of fusion and fission in print media with fusion or nuclear energy related content (2008/2012)

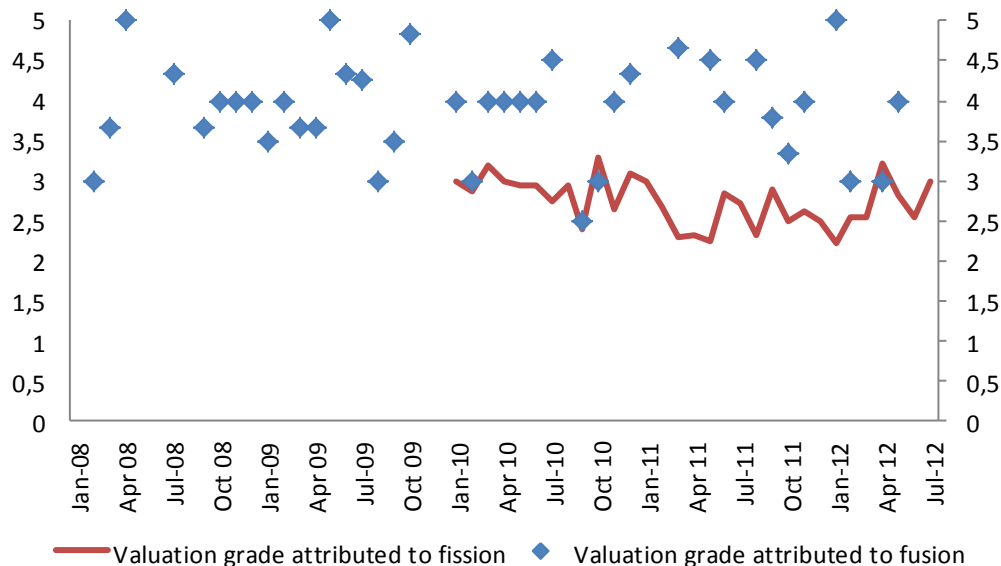


n=934 articles

Overall, fusion is largely evaluated in positive terms and at a higher degree in comparison to fission. On the other hand, there is a strong propensity to evaluate neutrally, even more than negatively, fission as a source of energy.

The averages of valuation grade attribute to fusion ranges from neutral to very positive throughout the whole period of analysis, while the averages of valuation grade attributed to fission are almost constant at a level that ranges from negative to neutral at most (Figure 61). The very positive valuations attributed to fusion occur in periods widely separated from each other - April 2008, May 2009 and January 2012. There are no particular reasons behind this trend.

Figure61. Evolution of average valuation of fusion and fission in print media with fusion or nuclear energy related content (2008/2012)



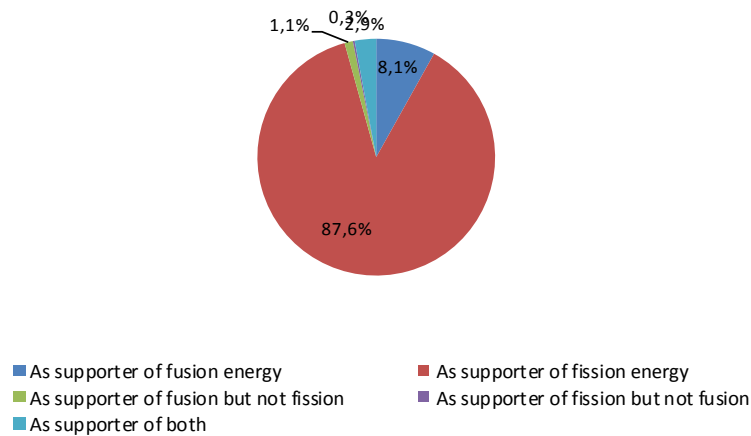
n=934 articles
(Scale from 1 – Very negative to 5 – Very positive)

The defining pattern of the evolution of valuations attributed to fusion is that of a positive grade that persists over a series of months and years (4 points in average from October 2008 to May 2012, with some alterations along the way). The moment of the accident in Fukushima (month of March 2011) and its aftermath had no considerable effect over this pattern. In fact, we can say that the valuation of fusion is independent from such events since fusion is itself dissociated from nuclear disasters, either in a positive or negative sense.

The valuation attributed to fission underwent a significant alteration since the moment of the accident in Fukushima. As we can see in figure 61, the valuation of fission ranges almost constantly from a neutral to negative grade, reaching the lowest value for the first time in March 2011 (2.3) which remains very similar throughout the months of April and May 2011. Increases in average valuation grade occur discontinuously until the end of the period of analysis.

There are much more references to actors that support fission than fusion energy (Figure 62). We found only one supporter of fission that opposes fusion, the French physicist Georges Charpak who in his life time considered fusion energy impossible to achieve at commercial levels. Supporters of fusion but not fission and supporters of both are also very few.

Figure62. Position manifested by actors about nuclear energy in print media articles with fusion or nuclear energy related content (2010/2012)



n= 791 actors

The probability of finding more support among the various actors is higher in the case of fission than in the case of fusion for three different reasons. First, there are many more articles about fission than fusion; second, fission energy (or conventional nuclear energy) has been a subject of debate for a long time in contemporary societies, involving various segments of public opinion, while fusion appears as a newcomer; third, nuclear energy is associated with a much more wider set of issues in comparison to fusion (military use, nuclear disasters, waste and contamination, effective energy supplying systems, energy programmes, etc.) that call for the opinion of more categories of actors - from lay persons to experts and politicians or even international institutions that regulate the use of nuclear energy.

In conclusion, from the actors' point of view, fusion and fission are to a great extent evaluated separately. Positions towards each nuclear technology are in most cases univocal, with a great emphasis on nuclear fission support.

Conclusions and summary of results

Data on Fusion

The sample of articles related to fusion energy is composed of 105 cases, published between January 1, 2008 and July 31, 2012 by 15 national newspapers and magazines. 49.5% of these articles were published by Quality newspapers/magazines. In 31.4% of total cases fusion is the core subject of the articles.

Information about fusion is scarcely available: 65.7% of articles do not explain the scientific basis of fusion energy whereas 22.9% provide only superficial information. A reduced amount of articles (11.4%) provide deeper information.

In news coverage, fusion energy is strongly dissociated from nuclear disasters: 71.4% of all articles collected were published before the accident in Fukushima, whereas 28.6% were published afterwards. Only 20.0% of the 30 articles published after Fukushima accident mention it and just 10.0% mention another nuclear accident.

Themes associated with Science and Technology are the most frequent in media coverage of fusion energy, representing 62.1% of the sample within which 28.2% concern *Research Projects and results*. Themes associated with Policy appear in second place, representing 21.5% of the sample. After the accident in Fukushima these trends did not change much, except for an increase in the number of articles referring to energy policy. Our analysis also revealed an increase in the number of articles where fusion is presented as an alternative to fission, alongside an increase in the number of articles written about *Future of fission technology*. Yet, articles do not account for a significant shift in thematic framing of fusion energy related content since the major thematic references persisted.

Scientists are the leading actors when addressing fusion energy in print media both before and after Fukushima, representing 54.9% of all actors mentioned. Politicians, who account for 13.9% of actors presented, also play a considerable role when talking about fusion, mainly when political and economic issues are brought forth in the articles (eg. funding of fusion research and energy policy guidelines drawn from fusion technology role in future energy scenarios). Supporters of fusion energy represent 41% of all actors. Officials and representatives of industry are the ones that on average evaluate to a higher positive degree fusion as a source of energy. Neutral or ambivalent positioned actors are also significant while opponents to fusion energy are residual.

Actors positions alone do not reflect the complex set of variables that shape the image of a specific subject (fusion or fission) in print news, namely the valuation grade attributed throughout news items to a specific subject and to its benefits and costs (in many cases mentioned by journalists themselves and not by actors). Accordingly, it is appropriate to summarize the most important findings concerning image framing (in the following case of fusion) with respect to these other variables considered in our analysis.

The valuation of fusion is positive in 50.3% of cases and very positive in 21.4% of them. Only in 3.0% of articles we found a negative valuation of fusion energy and in 25.3% of cases the valuation is neutral. Before the accident in Fukushima, positive valuations of

fusion energy represented 44.0% of all cases and very positive valuations represented 30.0%. After the accident, there was a decrease both in positive valuation (to 36.7%) and in very positive valuation (to 26.7%). However, these changes did not alter much the positive evaluation of fusion energy as it is presented in Portuguese newspapers and magazines.

The balance between benefits and costs present in media coverage is in favour of fusion energy. The most highly evaluated benefits of fusion concern *Energy source cleanliness*, *Energy source safety*, *Energy source limits*, *Warranty of supply*, *Climate neutrality* and *Fusion properties in comparison to fossil fuels*, all associated with positive averages of valuation both before and after Fukushima. In contrast, *Costs of fusion power plants*, *Expensiveness of fusion research compared with fostering of renewables*, *Fusion properties in comparison to Renewable*, and *Technologic feasibility* account for the least positively evaluated aspects of fusion energy but still hardly associated with negative averages of valuation even after the accident in Fukushima.

Data on Fission

The sample of articles related to nuclear energy (fission) is composed of 848 cases, published between January 1, 2010 and July 31, 2012 by 8 national newspapers and magazines. 67.3% of these articles were published by Quality newspaper or magazines. In 53.4% of total cases fission is the core subject.

Of the total number of articles collected 65.8% were published before the accident in Fukushima. This accident had a strong impact in news coverage of nuclear energy in Portugal. After Fukushima, 68.6% of articles mention the nuclear accident in Japan and 15.2% recall other nuclear disasters occurred in the past.

After the accident in Fukushima there was a shift in focus from military and political based subjects to security and environmental ones: the number of articles written about *Risk Management* increased from 2.4% to 11.3%, which added to 32.7% of articles written about the accident itself, whereas the number of articles written about *International Relations and Proliferation or Military Use*, decreased from 28.9% to 8.1% in the first case and from 26.9% to 8.3% in the second one. Thus, the most regularly focused themes in Portuguese print media concerning nuclear energy were nearly replaced by a news frame associating this energy source with risk and lack of safety.

The majority of **actors mentioned are Politicians**, representing 49.1% of the sample. Most of them are foreign or European whereas national politicians are very few. Politicians are also the ones that more frequently state some kind of position towards nuclear energy. Supporters are chief among them, although neutral positioned observers are also numerous. Officials, mostly representatives of public sectors and diplomats are second role players in the debate on nuclear energy. Their positions follow closely those stated by politicians. After the accident in Fukushima, international institutions representatives (mainly from IAE) and representatives of industry (mainly related to Japan nuclear industry) had a more considerable role when discussing nuclear energy related issues.

After Fukushima, references to positive valuations of fission decreased from 16.9% to 7.0%, whereas negative valuations increased from 24.8% to 47.5%. Altogether, these trends contribute to stress the already negative public image of nuclear energy. Neutral valuation increased from 37.5% to 55.2% which might be explained by a shift from mainly positive positions to neutral or ambivalent ones, conveying a more cautiously approach to nuclear energy in public debates within this period. Very positive valuations also registered an increase from 2.1% to 7.7%, probably explained by a reaction to public claims for closing down fission energy power plants in the aftermath of Fukushima.

Energy source limits, Fission properties in comparison to fossil fuels, Climate neutrality of fission energy and Cost competitive are the most consistently high valued aspects of fission energy. That is to say, they are associated with positive averages of valuation either before or after the Fukushima accident. In contrast, *Energy source cleanliness, Energy source safety, Proliferation or military use, Expensiveness of fission research in comparison to fostering of renewables, Fission properties in comparison to Renewable and Costs of fission power plants* are the least valued aspects of fission energy associated with negative averages of valuation (or at least neutral ones) either before or after Fukushima. It is also important to state that after Fukushima we register a strong decrease in averages of valuation attributed to *Warranty of supply* and *Long term option* (from positive degrees to negative ones). This might be explained by the fact that the nuclear accident in Japan impacted negatively on the degree of public confidence regarding fission technology capability for providing energy in a secure way (*Warranty of supply*) and also by the fact that some governments ceased to look at nuclear energy based on fission as an option for future energy scenarios.

In short, we can say that the **balance between benefits and costs weights against fission**, which contributes to the negative public image of this technology as it is depicted in Portuguese print news.

Final remarks

Our analysis concluded that the coverage of fission energy in Portuguese print media is much more extensive than the coverage of fusion energy. **Fission** is linked to a more diversified set of themes in comparison to fusion and involves a wider universe of actors. **Fusion** is a field of research that remains enclosed within the boundaries of scientific expertise and scientific discourse framing, referring from time to time public institutions especially when economic interest are at stake. Lay persons and actors that have a significant role in social change (environmental groups and activists, other experts and entrepreneurs), are not frequently involved in the debate on fusion energy.

Information on fusion is basic and connects mainly to research networks or research programmes such as ITER and its relation with IST, the national institution involved in research on fusion. In fact, this institutional linkage is of great importance and to some extent much appraised in Portuguese media coverage of fusion energy regardless the type of publication or the focus of reports, as it means the scientific capability of the country to participate in the development of a technology perceived as most advanced.

We also concluded that there is **no confusion between fusion and fission** in Portuguese print media. In addition, fission energy is clearly associated with the nuclear disaster of Fukushima, whereas fusion is seen either as a non-relevant factor in this equation or a future (although technically uncertain) solution to prevent such outcomes. The in-depth analysis also revealed that fusion is consistently portrayed as a safe, clean and unlimited source of energy with a potential only comparable to that of the Sun. The image of fusion is linked to a patterned style of discourse common to all types of newspapers and magazines and also to various actors involved in fusion energy content presentation, which reveals a strong presence of information disseminated by sources connected to institutions involved in fusion research. This also reveals that there is no controversy regarding media coverage of fusion energy.

It became clear throughout this report that **media coverage, framing and evaluation of fusion energy are independent from the accident in Fukushima**. Our findings do confirm the first hypothesis of this report: *the accident in Fukushima did not have a significant effect on framing of fusion image in Portuguese print media*.

In contrast, the accident did have a strong effect on media coverage, framing and evaluation of fission energy. This also confirms our second hypothesis: *the accident in Fukushima brought forth the debate on fission energy in Portuguese print media contributing for a clearly negative image of this technology*. As we had the opportunity to analyse, this debate connects mainly with the international agenda on nuclear accidents or nuclear energy risks, which overlapped for a short period of time with the most common and persistent theme in Portuguese media framing of nuclear energy (its military use). In any case, the scope of Portuguese media coverage and framing of nuclear energy is mostly foreign-related. Few articles link to the proposal of a nationwide debate about nuclear energy with regards to present and future energy scenarios, either before or after Fukushima. Timorous support has been given to this proposal, namely by few segments of the industrial branch and political parties (although we cannot say that there is a political divide about nuclear energy). Notwithstanding, positions towards effective inclusion of nuclear energy in the energy mix are not always straightforward even among these actors. On one hand the importance of public debate about nuclear energy is to some extent acknowledge; on the other hand, statements on public endorsement of nuclear energy tend to be neutral.

Media discourse clearly underlines that **nuclear accidents are related to faults in safety mechanisms and risk management plans** associated with conventional nuclear energy. Some articles also place a strong emphasis on the political misguidance and neglect over prevention or risk management procedures during and after this events. It is mostly in these terms that the public discourse on nuclear energy in Portuguese print media was shaped after the accident in Fukushima.

This is not the case of fusion technology since **fusion is still a controlled experience in a laboratory** type of environment and there are no reports of nuclear accidents associated with it. Social acceptability of fusion is based upon generalized confidence in top scientific work and expertise. Nevertheless, scientific discourse does not have the social visibility required to reach wider segments of public opinion in order to draw public attention over fusion energy potentialities. This is particularly the case of science press that has a narrower universe of readers. On the other hand, Portuguese mainstream newspapers and popular press, which have a broader universe of readers do not focus on fusion energy

with the depth and consistency needed to set it as a banner for public discourse on these new energy technologies.

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Annex 1 - Codebook

SERF 2012 - Public Discourse about Nuclear Energy before and after Fukushima accident codebook

Keyword: “nuclear fusion”

Period of analysis: 1 January 2008 – 31 July 2012

Sampling: all articles found

Newspapers: all relevant newspapers

Keyword: “nuclear energy”

Period of analysis: 1 January 2010 – 31 July 2012

Sampling: first 15 days of every month starting at Monday

Newspapers: mainstream national newspapers

V 1 Coder ID

V 2 Code case

Serial encoding: 1, 2, 3, ...

V 2.1 Keyword (type the keyword with which you found the present article in the search/collecting process).

Nuclear energy

Nuclear fusion

Both

V 3 Country

Spain

Portugal

Germany

Transnational

V 4 Newspaper / magazine

Name of newspaper or magazine

V 5 Type of newspaper

Quality newspaper/magazine

Economic newspaper/magazine

Popular press/magazine

V 5.1 Publishing scale

National

Regional

Transnational

V 6 Date (more detailed if necessary)

Publication date of article

Year

Month

Day (if applicable)

No., Vol., Supplement (if applicable)

V 7 Fukushima

Article published before Fukushima accident (namely: before 11 March 2011)

Article published after Fukushima accident (namely: after 11 March 2011...)

V 8 Is the Fukushima accident mentioned in the article?

Yes/No

V 9 Are other nuclear accidents mentioned in the article?

Yes/No

V 10 Caption

This category serves as orientation. The first three words of the caption are recorded; failing a caption, then it is the first three words of the text.

V 11 Accentuation

At the front page of the newspaper/cover story

Lead story of a section *(The object of analysis is the largest and topmost article.)*

At least two page article (if not any of the above mentioned)

Single page only article

One of many

No accentuation

V 12 Category of author

Journalist

Agency

Scientific expert

Risk management expert (deals with proliferation issues, security, prevention).

Other expert

Representative of NGO

Representative of an interest group

Politician

Other

V13 Background of author

public science institution, private science institution, insurance company, electric utility, other industry, civil service, alternative science institution (eco-institute. ...), NGO, background not named

V 14 Provenance of author

Europe, Germany, UK, France, ...

V 15 Form of presentation

News in brief

Report / reportage / feature

Commentary/opinion column

Interview

Portrait

Opinion poll

Reader's letter

Other

V 16 Is fusion or fusion research the core of the report?

Core subject

Subsidiary subject in the context of fission

Subsidiary subject in other context

Marginal subject.

V 16.1 Is fission energy the core of the report?

Core subject

Subsidiary subject in other context

Marginal subject

V 17 Magnetic Confinement Fusion (MCF)

mentioned / not mentioned

V 18 Inertial Confinement Fusion (ICF)

Mentioned / not mentioned

V 19 Hybrid of ICF & MCF

Mentioned / not mentioned

V 20 Hybrid of fusion & fission

Mentioned / not mentioned

V 21 'Cold' fusion

Mentioned / not mentioned

V 22 Theme: primary thematic frame.

(After reading the article and specifying its issues, select the primary thematic frame from the list below.)

It's necessary to create fields also for a secondary thematic frame, one article can cover several issues

Science and technology

(The article refers mostly to scientific discoveries, fundamentals, new studies, release of scientific reports on fusion science and technology. This category includes discussion of any scientific findings, scientific controversy, change in science, science reports, etc.)

Research projects and results (publications, achievements, awards)

Cooperation activities and know-how transfer (training)

Personnel matters (biographies, obituary)

Scientific events (conference)

Alternatives to fission

Future of fission technology

Safety and Environment

(The article refers mostly to safety and environmental issues, effects on plants, animals, biodiversity and habitat.)

Waste (storage)

Pollution/contamination

Land use/location (siting conflicts)

Health effects/contamination (for workers and/or general public)

Proliferation (nuclear weapons)

Risk management (coping with emergency, regulation issues, probability of accidents)

Accidents/emergency (real events)

Fukushima accident

Terrorism

Policy

(The article refers mostly to issues of governance and policy contention and formation at any level.)

Science policy (includes funding of fusion research)

Energy policy

Regional development

International relations

Public opinion

Military use/proliferation (weapons)

Termination of fission technology (consequences, costs, political reasons)

Economy and energy economy

(The article refers mostly to the economy and energy and the impact of these issues on society.)

Investment costs on energy (private funding)

Costs of fusion production (e.g. costs of electricity)

Energy scenarios/foresight *(status or competitive advantages of nuclear energy in present and future scenarios regarding the production/consumption of energy (This implies references to the use of other sources of energy, like carbohydrates, biomass, geothermal, hydroelectric, wind, etc.))*

Energy issues *(energy justice, legislation, social equity).*

Climate protection (the article deals with issues regarding the effects of nuclear energy use over climate matters and mitigation).

Culture

(The article refers mostly to lifestyles, practices of individual and community living, consumption patterns.)

Other, which

V 22.a Other primary thematic frame (Write in your own words preceded by the main thematic category (eg. Science and technology: "...."))

V 23. Theme: secondary thematic frame (use the same set of categories as in V.22).

V23.a Other secondary thematic frame (Write in your own words preceded by the main thematic category (eg. Science and technology: "...."))

V24. Theme: tertiary thematic frame (use the same set of categories as in V.22)

V24.a Other tertiary thematic frame (Write in your own words preceded by the main thematic category (eg. Science and technology: "....")

V 25 Main Research device focused (only for fusion)

ITER

JET

DEMO

ASDEX Upgrade

Wendelstein 7-X

Tore Supra

TJ-II

Textor

ISTTOK

Mast

KSTAR

HL-2a

EAST

DIII-D

NSTX

NIF

Other, which

V 25.a Other main research device focused

V 25.1 Second Research device focused (use the same set of categories as in V.25).

V 25.1a Other research device secondary focused

V 26 Laboratories/institutes/organisations mainly focused (only for fusion – code all mentioned)

CIEMAT

Culham Science Centre or JET

EFDA

F4E

Institute Superior Tecnico, Lisbon

ITER Organisation, Cadarache

Jülich Research Institute

Karlsruhe Institute of Technology

Max Planck Institute of Plasma Physics, Garching and Greifswald
Other, which

V 26.a Other laboratories/institutes/organizations mainly focused

V 26.1 Laboratories/institutes/organizations secondary focused (use the same set of categories as in *V 26*).

V26.1 a Other laboratories/institutes/organizations secondary focused

V 27 Actors involved

(V27a for coding the first actor mentioned in the article (first appeared); V27b for the second actor; V27c for the third actor...)

Scientists

Engineers

Regional politicians

National politicians

Foreign politicians

European politicians

International institutions representatives other than European politicians

Manager or managing/operative director

Investor or representative of financial sector

Entrepreneur (SMEs)

Representative of industry (suppliers, energy industry)

Official

Consumer, electricity user, tax payer, citizen

Environmental group, activist

Representative of trade union

Representative of religious institution (e.g. Church)

Journalist

Artist

Representative of education sector

Other, which

V 28 The position of the actors involved (If mentioned:)

(V28a for coding the first actor mentioned in the article; V28b for the second actor; V28c for the third actor...)

As supporter of fusion energy

As supporter of fission energy

As supporter of fusion but not fission

As supporter of fission but not fusion
As supporter of both
As opponent or against fusion energy
As opponent or against fission energy
As opponent or against both
Neutral/ambivalent

V 29 Sex of those involved

(V29a for coding sex of the first actor mentioned in the article; V29b for the second actor; V29c for the third actor...)

Male

Female

Not relevant (*mixed group ...*)

V 30 Does the article explain the basic science behind fusion energy?

No

Superficial information (only one sentence)

Deeper information

V 31 Does the article mention fusion?

Yes/No

V 31.1 Does the article mention fission?

Yes/No

V 32 Is there confusion between fusion and fission?

Yes/No

V 33 Valuation grade attributed to fusion

Very positive

(The valuation covers one or several of the following aspects: praise, approval, confirmation, respect, harmony, success, defense, justification.)

Mainly positive

(The above-mentioned tendencies occur in diminished form.)

Neutral/Ambivalent/balanced

(The pro and contra arguments are presented and discussed in a balanced manner.)

Mainly negative

(The following tendencies are identified: contradiction, reproach, criticism, accusation, warning, demand, conflict, failure)

Very negative

(The above-mentioned tendencies are very pronounced.)

V 33.1 Style of valuation attributed to fusion (How is valuation presented?)

Rational
Emotional
Aggressive
Benign
Ironical
Serious
Skeptical
Hopeful
Otherwise

V 34 Valuation grade attributed to nuclear fission (if applicable)

Very positive
(The valuation covers one or several of the following aspects: praise, approval, confirmation, respect, harmony, success, defence, justification.)
Mainly positive
(The above-mentioned tendencies occur in diminished form.)
Neutral/Ambivalent/balanced
(The pro and contra arguments are presented and discussed in a balanced manner.)
Mainly negative
(The following tendencies are identified: contradiction, reproach, criticism, accusation, warning, demand, conflict, failure)
Very negative
(The above-mentioned tendencies are very pronounced.)

V 34.1 Style of valuation attributed to nuclear fission (How is valuation presented?)

Rational
Emotional
Aggressive
Benign
Ironical
Serious
Skeptical
Hopeful
Otherwise

V 35 Valuation grade of arguments regarding fusion (V35.1 for coding Energy source cleanliness, V35.2 for coding Energy source safety, V35.3 for coding Energy source limits,...)

Very positive

Very negative

Positive

Negative

Neutral

Not mentioned

Energy source cleanliness

Energy source safety

Energy source limits (availability; abundance; unlimited resource)

Warranty of supply (energy security)

Climate neutrality of fusion energy

Proliferation/military use

Technologic feasibility (viability of development, lack of success)

Long term option (too far away in the future)

Costs of fusion power plants

Cost competitive

Fusion power plants as a form of nuclear energy

Expensiveness of fusion research compared with fostering of renewable

Fusion properties in comparison to Renewables (sustainability, environmental characteristics, land space needed, base load qualified, depending on weather, ...

Fusion properties in comparison to fossil fuels

V 36 Arguments stated regarding fission (V36.1 for coding Energy source cleanliness, V36.2 for coding Energy source safety, V36.3 for coding Energy source limits, ...)

Very positive

Very negative

Positive

Negative

Neutral

Not mentioned

Energy source cleanliness

Energy source safety

Energy source limits (availability; abundance; unlimited resource)

Warranty of supply (energy security)

Climate neutrality of fission energy

Proliferation/military use

Long term option

Costs of fission power plants

Cost competitive

Expensiveness of fission research compared with fostering of renewable

Fission properties in comparison to Renewables (sustainability, environmental characteristics, land space needed, base load qualified, depending on weather, ...
Fission properties in comparison to fossil fuels

V37 Does the article mention or suggest the idea that fission is necessary for climate change mitigation?
Yes/no

Annex 2 - Sampling for exploratory qualitative analysis

	Core						Subsidiary					
	Research projects and results and Scientific events	Cooperation activities and know-how transfer	Alternatives to fission	Fukushima accident	Energy policy	Energy scenarios / foresight	Research projects and results and scientific events	Cooperation activities and know-how transfer	Alternatives to fission	Fukushima accident	Energy policy	Energy scenarios / foresight
Ainda a energia											1	1
Caminhamos para a catastrophe												1
Carlos Varandas diz que abertura do debate sobre o nuclear é "extremamente oportuna"			1		1							
Centro de fusão nuclear inaugurado na Califórnia quer obter energia ilimitada até 2040	1	1										
Ciência na senda de um reactor que reproduza a energia do sol	1		1									
Construção de laser mais potente do mundo tem participação portuguesa através do IST	1	1										
Do Céu vai descer uma estrela	1	1										
Entrevista. "A situação é instável. Tudo depende do que acontecer nas próximas 24 horas"									1	1		

ESA contrata testes para "space shuttle" a Portugal								1		1				
Filipe duarte Santos 'O homem pode vir a utilizar a maquina para aumentar a capacidade do seu cerebro'														1
Investigadores portugueses "aprimoram o Sol"	1													
IPFN quer mostrar que fusão nuclear é fonte de energia viável								1		1				
IST continuará a fornecer equipamento para reator termonuclear	1		1	1										
Nuclear				1										
Nuclear: sempre os mesmos erros														1
O futuro está na complementaridade														1
O Mozart da Física acredita que os jovens vão mudar o mundo								1						
O que é o projecto ITER?	1													
Olhar o Sol											1			1
Uma Europa nuclear											1		1	