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Comparative Analysis of the public discourse about fusion and nuclear energy before and after Fukushima

WP12-SER-ACIF-1

Final Report

February 2013

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Introduction

This report presents a comparative analysis of media coverage of fusion and fission energy before and after the accident in the nuclear reactors of Fukushima, Japan. The analysis is based on research conducted under the EFDA Workprogramme 2012, addressing three national-based print media – Germany, Spain and Portugal as well as English-language print media addressing transnational elite.

The general hypothesis conducting the study is that the accident in Fukushima Daiichi nuclear power plant on 11th March 2011 impacted negatively in the public image of conventional nuclear power, while contributing to bring forward the debate over fusion technology as an alternative pathway to nuclear energy production. It was also important to assess if perceptions and representations of fission energy conveyed in the media after Fukushima had a negative effect on the image of fusion energy.

This analysis provides a contribution to understand the social construction of nuclear power imagery in contemporary societies.

Media coverage and risk perception of nuclear energy after Fukushima

Soon after the nuclear accident in Japan some research on media coverage and framing of nuclear energy was carried out. Perko et al (2011) published a study on two Belgium newspapers (*Le Soir* and *De Standaard*), which focused on the role of media in shaping public views about the accident and also in risk communication of 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 events 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 crucial 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 immediately after the accident is the one conducted by Sharon Friedman (2011). This study compares the coverage of the accident in Fukushima with two other previous 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 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 distinct features.

Media coverage and framing of fusion energy

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 print 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, for instance, the candidacy of Vandellós (in Spain) for the siting of the ITER research device (Prades et al, 2007). In another perspective and according to research work already developed on public acceptability of fusion energy, lay persons frequently confuse fusion with fission, which impacts negatively on the public image of fusion itself. Social rejection of fusion is based on 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 environmentally friendly features, or to a "positive association with pioneering scientific research"¹. (More extended review of the state of the art can be found in the Spanish Final Report).

National and transnational backgrounds of media research on fusion and nuclear energy.

Germany

The research conducted in Germany is restricted to the coverage and framing of fusion energy in national print media framework. From the German research team perspective, the nuclear accident in Fukushima was a call for consequences at a national level, which persuaded the German Federal Government to completely phase out of fission energy until 2022 (cf. German report 2012WP12-SER-ACIF-1-01/IPP: 3). A shift in German energy policy (German "Energiewende") towards the development of a system that aims to rely almost exclusively in renewable sources and energy efficiency is to be carried out within the next decades. Fukushima also brought forward the question of whether there was an influence of this nuclear fission accident on the media perception and presentation of nuclear fusion.

¹ 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/>

Portugal

The debate over nuclear energy in Portugal has been disregarded since the mid-1970s, following a social protest against plans to build the first Portuguese nuclear power plant in the small town of Ferrel. Since the nuclear power plant was not built, nuclear energy is not commonly addressed in Portugal, remaining mostly circumscribed to occasional discussions over risks associated with nuclear power plants sited close to Portuguese borders, mainly close to rivers shared by both Portugal and Spain countries (Schmidt, 2003). However, the debate over the construction of a nuclear power plant has recently re-emerged, promoted by industrial and financial lobbies, for which nuclear power is crucial to deal with the overreliance on renewables and with the absence of a straightforward alternative to fossil fuels in the Portuguese energy context (Rodrigues et al, 2006). The accident in Fukushima may have contributed to enhance the debate on fission energy in Portuguese public opinion, conveying a clearly negative image of this technology as already signalled in previous surveys (OBSERVA 2004; EVS 2008) and hence reinforcing public rejection of nuclear energy at nationwide level (cf. Portuguese report 2012WP12-SER-ACIF: 3; 4).

The country is involved in ITER by the participation of Instituto Superior Técnico (IST), particularly in know-how transfer and technical supporting activities. This institutional linkage can be crucial for the framing of fusion related content in national media over time, which may also contribute to public knowledge and public acceptability of fusion energy (cf. Portuguese report 2012WP12-SER-ACIF: 5; 6) .

Spain

Nuclear power plants deliver around 20% of electricity in Spain. Over the last decades the Spanish nuclear programme has been either submitted to criticism or supported by the nuclear lobby. In recent years (2007-2008) public commitment to nuclear energy has been justified by concerns over climate change and fossil fuels dependency. The media also played a significant role in this period, as the Spanish team states, “some articles (...) start expressing the possibility of building a new nuclear power plant in Spain” (cf. Spanish report 2012WP12-SER-ACIF-1: 4). However, nuclear energy industry has been confronted with a series of obstacles such as: the growth of renewable energies, the decline of electricity consumption and the investment costs of new nuclear reactors planned to be built in forthcoming years. After the accident in Fukushima the Spanish government planned to close down the oldest nuclear power plants, maintaining, however, its commitment to the nuclear energy programme. Plans to build new nuclear reactors seem to have been discarded.

Spain is also involved in fusion research programmes with competitive research centres on fusion technology. Media coverage of fusion energy was previously analysed between

2002 and 2003 in the context of Vandellós' candidacy to host the ITER research facility (cf. Spanish report 2012WP12-SER-ACIF: 3; 4), which enhances the importance of the comparative analysis presented in this report with regard to Spanish social and political contexts.

Transnational print media context

The main hypothesis underlying transnational discourse analysis was that the accident in Fukushima influenced the international public debate on the nuclear fission and fusion energy, with possible consequences on the perception of fusion technology, communication with external stakeholders and governance of its future implementation.

One important dimension of transnational media context is the global debate on the future energy scenarios, marked by a discursive struggle between those that support low carbon energy economy and those that support the *status quo* of energy systems based on conventional energy sources. Fusion is part of the highly advanced technological projects that are associated with sustainable production and use of energy, and therefore it can be addressed in this context.

The discourse in the English language print media addressing the “transnational elite” (such as The Guardian, The International Herald, The Wall Street Journal or The Washington Post, among others) is mainly issued by transnational elites themselves, i.e. by actors with solid political and economic backgrounds worldwide which can be considered as crucial actors in the public debate on the energy scenarios of the future (cf. Transnational media report 2012WP12-SER-ACIF-1: 3).

Methodology

Samples and sampling procedures

The research conducted in Portuguese, Spanish and Transnational print media contexts involved the analysis of articles about fusion and fission energy. Although the study aimed to investigate media presentation of fusion energy before and after the nuclear accident in Fukushima, we also found relevant to analyse media presentation of fission, because it could add important elements for understanding public representations of fusion energy in comparison to public representations of fission. For the German media analysis only articles about fusion were considered (complying with particular limitations of resources), without disregarding the premises and guidelines of the study.

With regard to **fusion**, all types of newspapers and magazines were selected from national-based print media (German, Portuguese and Spanish study areas) and English language quality newspapers and magazines aimed at the transnational elite (Transnational study area). Since it was expected a greater (and probably unmanageable) collection of articles in the German case, it was considered enough to set the period of analysis between the first quarter of 2010 and the first quarter of 2012. In contrast, it was expected a smaller collection in all other study areas, hence the period of analysis was set between the first quarter of 2008 and the third quarter of 2012². For searching and collecting the articles, all research teams relied on electronic databases of newspapers and magazines. The search words used were “nuclear fusion” or “fusion energy”.

With regard to **fission** only mainstream newspapers and magazines (either quality or popular) were selected from national-based print media (Portuguese and Spanish study areas) and English language quality newspapers aimed at the transnational elite (Transnational study area). The period of analysis extended from the first quarter of 2010 to the third quarter of 2012, according to the one year before/one year after Fukushima timeframe. Since we expected to find an overly large amount of articles, a sampling procedure was devised: only articles published in the first fifteen days of each month would be considered. The articles were also collected through electronic databases of each publication and selected by using the search word “nuclear energy”.

Table 1 presents the titles of newspapers and magazines selected both for fusion and fission research. Table 2 presents the sampled articles for each case study.

² Detailed information about the samples and sampling criteria can be found in each case study report.

Table 1. Titles of newspapers and magazines selected

	Fusion	Fission
Germany	<p><i>National quality/reference Newspapers and magazines</i></p> <p>Die Zeit Frankfurter Allgemeine Zeitung Focus Welt Die Tageszeitung TAZ Süddeutsche Zeitung Frankfurter Rundschau Spiegel Welt kompakt Welt FAZ.NET Financial Times Deutschland Neues Deutschland Münchner Merkur Die Tageszeitung TAZ Junge Freiheit Mitteldeutsche Zeitung taz.de</p> <p><i>National Economic newspapers/magazines</i></p> <p>Financial Times Deutschland Handelsblatt Focus Money - online</p>	<p>--</p> <p>--</p>
Transnational press	<p><i>English-Language quality newspapers and magazines</i></p> <p>Guardian The Observer The Washington Post International Herald Tribune New Statesman</p> <p><i>English-Language Economic newspapers/magazines</i></p> <p>Forbes The Economist The Wall Street Journal</p>	<p><i>English-Language quality newspapers and magazines</i></p> <p>The Economist The Observer International Herald Tribune New Statesman</p>

<p>Portugal</p>	<p><i>National quality/reference Newspapers and magazines</i></p> <p>Público Diário de Notícias Jornal I Expresso Sol Visão</p> <p><i>Popular newspapers</i></p> <p>Jornal de Notícias Correio da Manhã Diário Digital Destak</p> <p><i>National Economic newspapers</i></p> <p>Diário Económico Jornal de Negócios OJE</p> <p><i>Scientific magazines</i></p> <p>Ciência Hoje Ciência PT</p>	<p><i>National quality/ reference newspapers and magazines</i></p> <p>Público Diário de Notícias Jornal I Expresso Sol Visão</p> <p><i>Popular newspapers</i></p> <p>Jornal de Notícias Correio da Manhã</p>
<p>Spain</p>	<p><i>National quality/reference Newspapers and magazines</i></p> <p>ABC El Economista El Mundo El País El Periódico Expansión La Razón La Vanguardia Público</p> <p><i>Regional</i></p> <p>Avui Diario de Navarra El Correo El Diario Vasco La Voz de Galicia Norte de Castilla</p> <p><i>Free/popular</i></p> <p>Qué</p>	<p><i>National quality newspapers</i></p> <p>El País El Mundo</p> <p><i>Regional based newspaper (nationwide distribution)</i></p> <p>La Vanguardia</p>

20 Minutos <i>Scientific magazines</i> Quo Muy interesante Investigación y Ciencia
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Table 2. Number of sampled articles

	Germany	Transnational	Portugal	Spain
Fusion	174	95	105	166
Fission	--	569	848	486

Coding procedure

In order to ensure the comparability of results for all study areas (one of the task requirements), an encoding protocol for written press material was designed so that all articles could be framed and classified by common criteria (for more detail see the codebook in Annex 1). Doubts and different possibilities of interpretation in the encoding process were clarified through discussions by email and several meetings, whether personally attended by representatives of each team, or via skype.

Method of analysis

a) Quantitative content analysis

The first stage analysis deployed for the four data corpora was quantitative content analysis. This method aims at the identification of meanings, associations and intentions present in verbal or written texts. When 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 data sets of each case study were 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. 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. Comparisons were drawn according to differences and similarities identified when confronting the various research backgrounds.

b) Qualitative content analysis

In a second stage, all teams applied a qualitative content analysis for getting an in-depth insight into the media coverage of nuclear fusion. This analysis followed a template developed for all study areas and it was based in the description of codes associated to fusion which portray its characteristics. In all study areas the selection of articles corresponded to a purposive sampling, showed in Table 3, which attempts to cover as best as possible the diversity of journalistic coverage of fusion. Ultimately, the main results presented by each team were compared in order to identify either particular or common trends in the public discourse on fusion in all study areas.

Table 3. *Sampled articles for fusion qualitative content analysis*

Media context	Core subject	Not core subject	Total
Germany	16 articles	4 articles	20 articles
Portugal	11 articles	9 articles	20 articles
Spain	18 articles	6 articles	24 articles
Transnational	11 articles	13 articles	24 articles

Some difficulties resulted from the diversity of criteria that guided each research team regarding sampling procedures (periods of analysis, amount of data to collect, newspapers to select). Also, data submitted to content analysis was very diversified and, occasionally treated in different ways by research teams involved, which made the merging of databases, crucial for comparative analysis, very hard to accomplish.

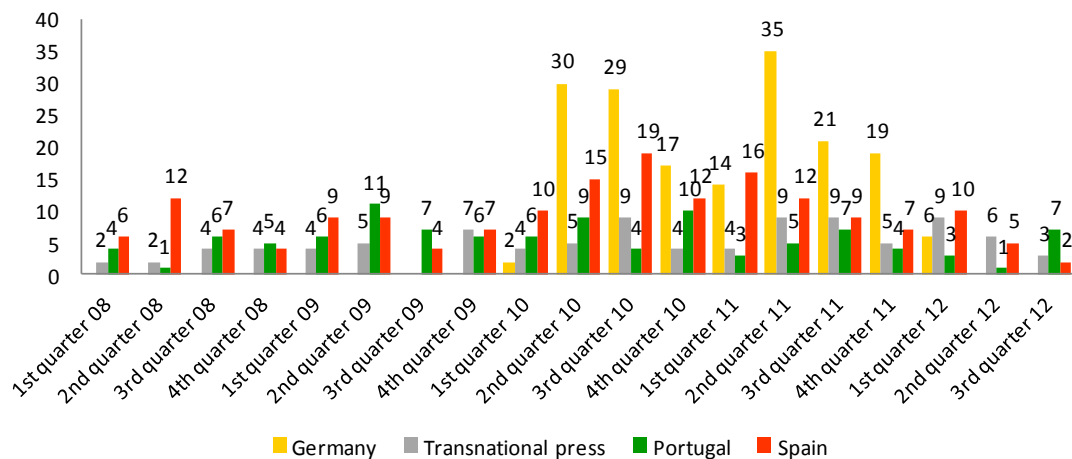
Presentation of main results

Fusion

1. Media coverage of fusion energy

The evolution of articles from the first quarter of 2008 to the fourth quarter of 2009 (as Figure 1 shows) is generally very regular with a low level of records for Spanish, Portuguese and the English language print media aimed at transnational elites (which will be subsequently referred to as “transnational print media”). It is not possible to identify a specific trend in this timeline although we are able to say that the Spanish press published more articles than the Portuguese and the International press.

Fig. 1 Evolution of the number of articles with fusion energy related content

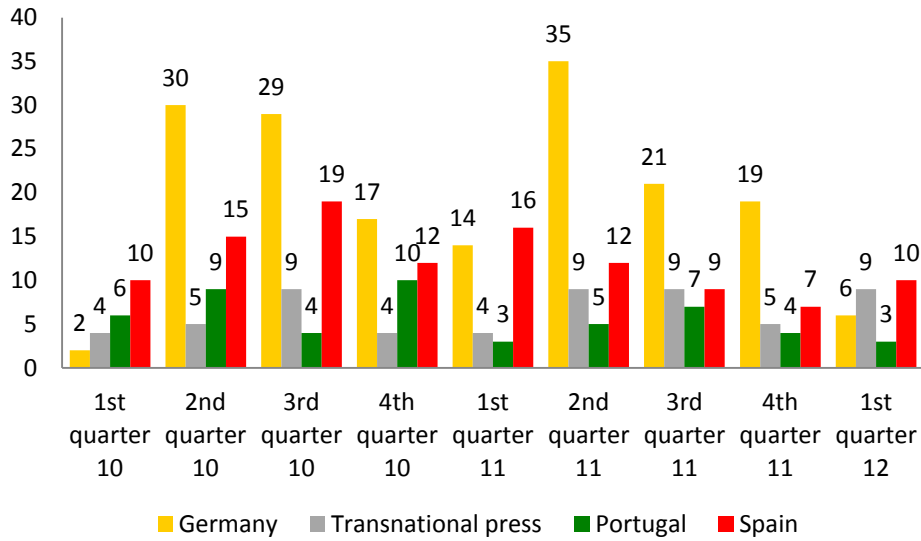


N Germany=173; N Transnational press=95 ; N Portugal=105 ; N Spain=175.

If we focus only on the interval between one year before and one year after Fukushima accident (Figure 2), we can see that the German press published many more articles than its counterparts in almost every quarter of each year and mainly in the second quarter of 2011, right after the nuclear accident in Fukushima.

The number of articles in Portuguese and Transnational print media evolves in a similar way throughout the whole period of analysis, always at a low level. As for the Spanish press, it seems to follow more closely the evolution of articles published in Germany from the second quarter of 2010 to the fourth quarter of 2011 although with fewer articles published overall. Although this can be a coincidence, it should be noted that such close trends occur in the two countries that have nuclear power plants.

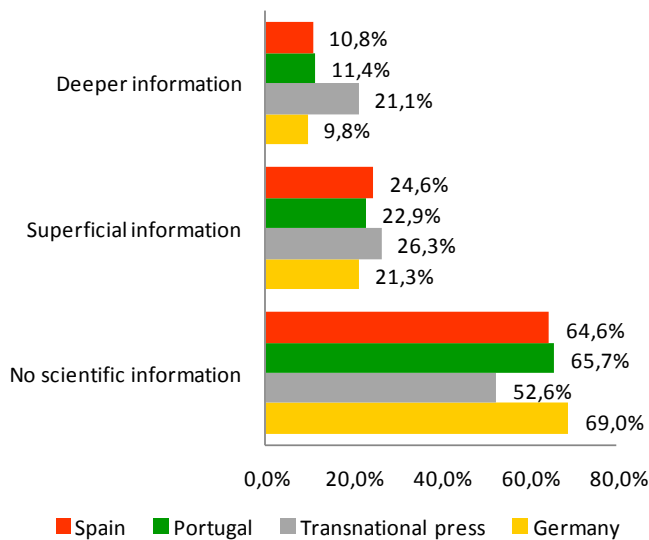
Fig. 2 Evolution of the number of articles with fusion energy related content



N Germany=173; N Transnational press=58 ; N Portugal=51 ; N Spain=110.

Scientific information about nuclear fusion is almost absent in most of the sampled articles for all research backgrounds regarding the three countries (Figure 3). More in-depth information is present mainly in the Transnational print media. In the national research contexts the percentages of articles that present deeper information are very similar. Superficial information show slight differences when comparing all study areas.

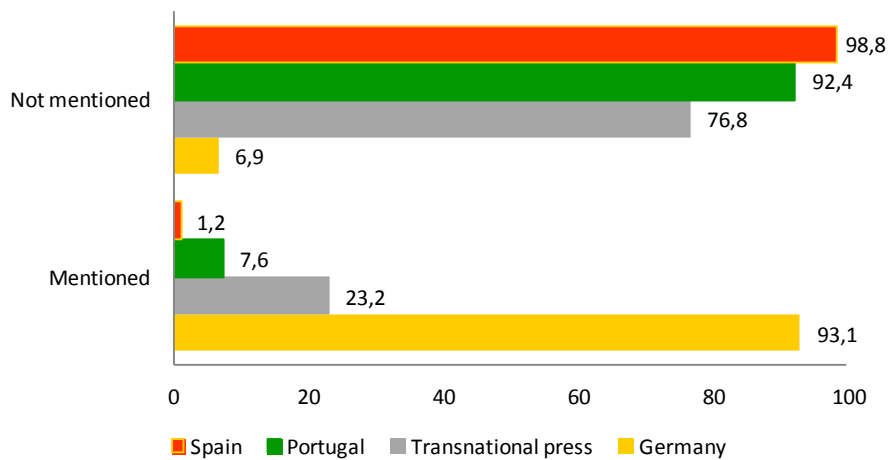
Fig. 3 Depth of information provided about basic science behind fusion energy in the articles with fusion energy related content



N Germany=174; N Transnational press=95 ; N Portugal=105; N Spain=167.

The only process behind nuclear fusion mentioned in the articles that we found relevant for comparison purposes was the **Magnetic Confinement Fusion (MCF)**. In fact, MCF is the core of fusion energy generation in large experiment facilities such as ITER. As we can see in Figure 4, MCF is very frequently mentioned in German print media (93%), much less in Transnational print media (23%) whereas in Portuguese and Spanish print media it is mentioned in very few articles.

Fig. 4 *References to Magnetic Confinement Fusion (MCF) in the articles with fusion energy related content*

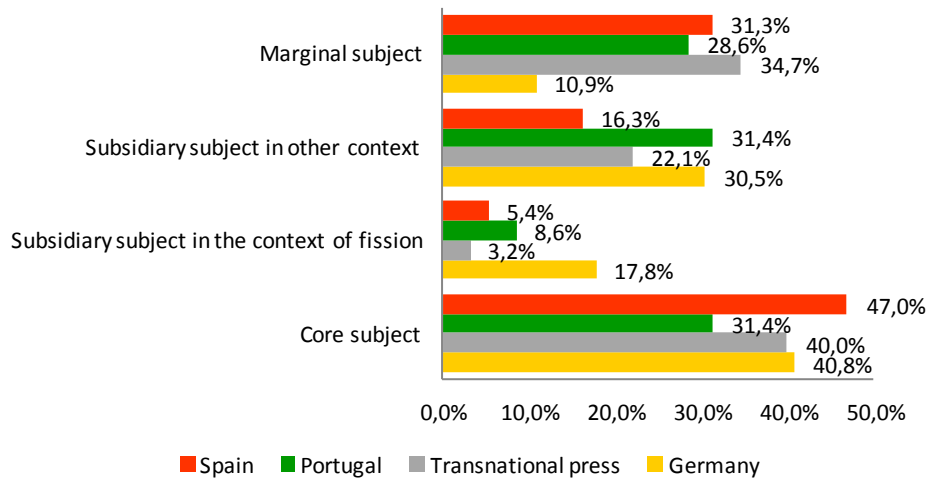


N Germany=174; N Transnational press=95; N Portugal=105; N Spain=167.

Fusion is the **Core subject of the articles** in less than half of the texts studied (i.e. of the texts which mention fusion), in all study areas. As a Core subject, fusion is covered more frequently in Spain and less frequently in Portugal. Fusion is also commonly approached as a Marginal subject in the Spanish, Portuguese and Transnational print media, whereas in German print media it is rarely presented as such.

It is interesting to see that in all countries there are few articles that presented fusion as a Subsidiary subject in the context of fission (Figure 5). The proportion of those articles is slightly higher in the German press, which implies that fusion energy is more often confronted with conventional nuclear energy in Germany than in any other country.

Fig. 5 Role of fusion in the fusion related articles



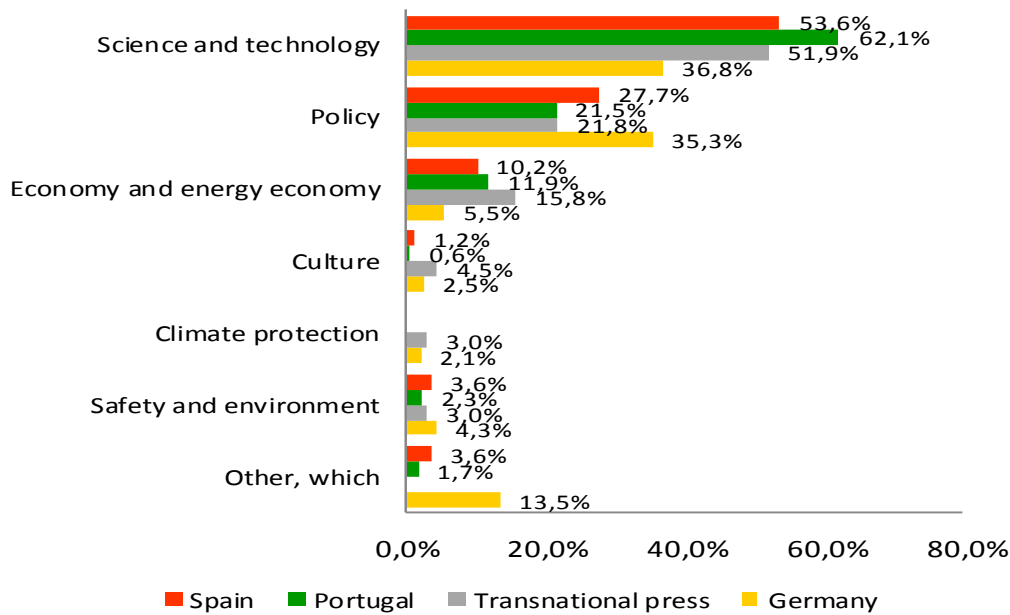
N Germany=174; N Transnational press=95 ; N Portugal=105 ; N Spain=166.

II. Thematic framing

Thematic frames were identified according to two different variables. The first one refers to thematic areas covered in written news which were encoded in three distinct levels - primary, secondary and tertiary; the second one refers to specific themes/issues related to those thematic areas, also coded at primary, secondary and tertiary levels. In order to simplify the analysis and presentation, we decided to aggregate all coding levels into one single level for each variable separately. The aggregate of thematic areas is presented in Figures 6 and the aggregate of specific themes/issues is presented in Figure 7.

Science and technology is the main thematic area covered in framing of fusion related content for all study areas, but especially in Portuguese print media. Policy is the second most covered thematic area also for all study areas, with a higher proportion in German print media, where 35% of articles address political themes. Figure 6 also shows that fusion is clearly dissociated from safety, environmental and climate change issues, which is a drawback of the media presentation of fusion energy.

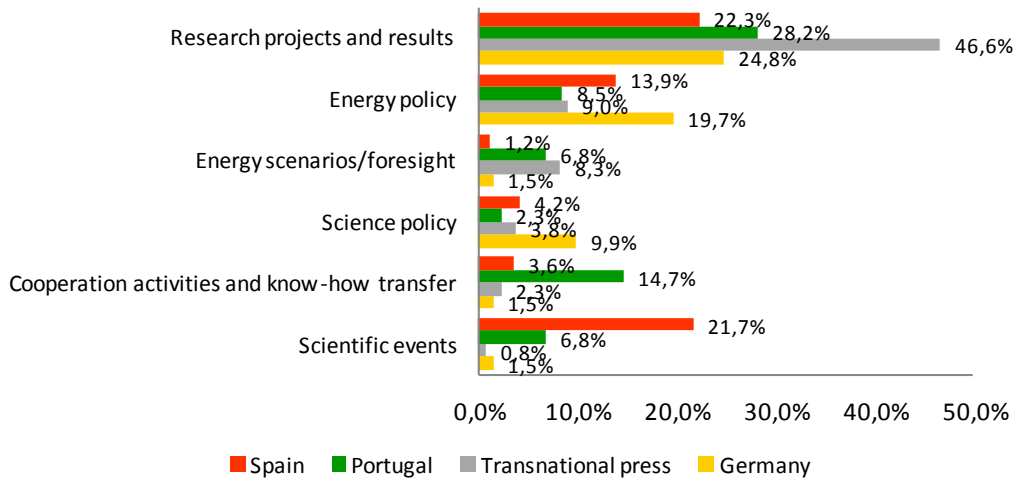
Fig. 6 *Aggregate of thematic areas covered in articles with fusion energy related content*



N Germany=318; N Transnational press=133; N Portugal=177; N Spain=168.

Research projects and results is the most common themes/issues in all study areas, particularly in Transnational print media (Figure 7). Other themes are differently approached, depending on the case: In the German print media Energy policy and Science policy occur with a median proportion (more than one third each). In contrast, Scientific events are very common in Spanish print media and almost insignificant in the German and Transnational contexts. Cooperation activities and know-how transfer is one of the most important themes in Portuguese print media, while it has little expression in other media contexts.

Fig. 7 Aggregate of specific themes/issues in articles with fusion energy related content

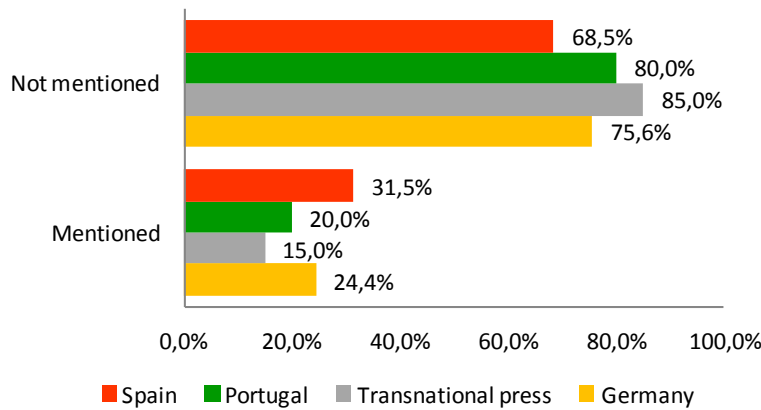


N Germany=318; N Transnational press=133; N Portugal=177 ; N Spain=168.

III. Discourse framing of fusion in the various media contexts

Nuclear accidents, including Fukushima, are not frequently associated with fusion energy. As we can see in Figure 8, in all study areas the majority of articles do not mention Fukushima or any other nuclear incident. The higher proportion of articles that mention Fukushima is found in the Spanish press (31%), followed by the German press (24,4%). Also, there are no records of other nuclear accidents besides Fukushima mentioned in the German press, whereas in the remaining study areas the proportion of articles that mention these events is much lower than the proportion of articles that mention Fukushima.

Fig. 8 *References to Fukushima accident in the articles with fusion related content*

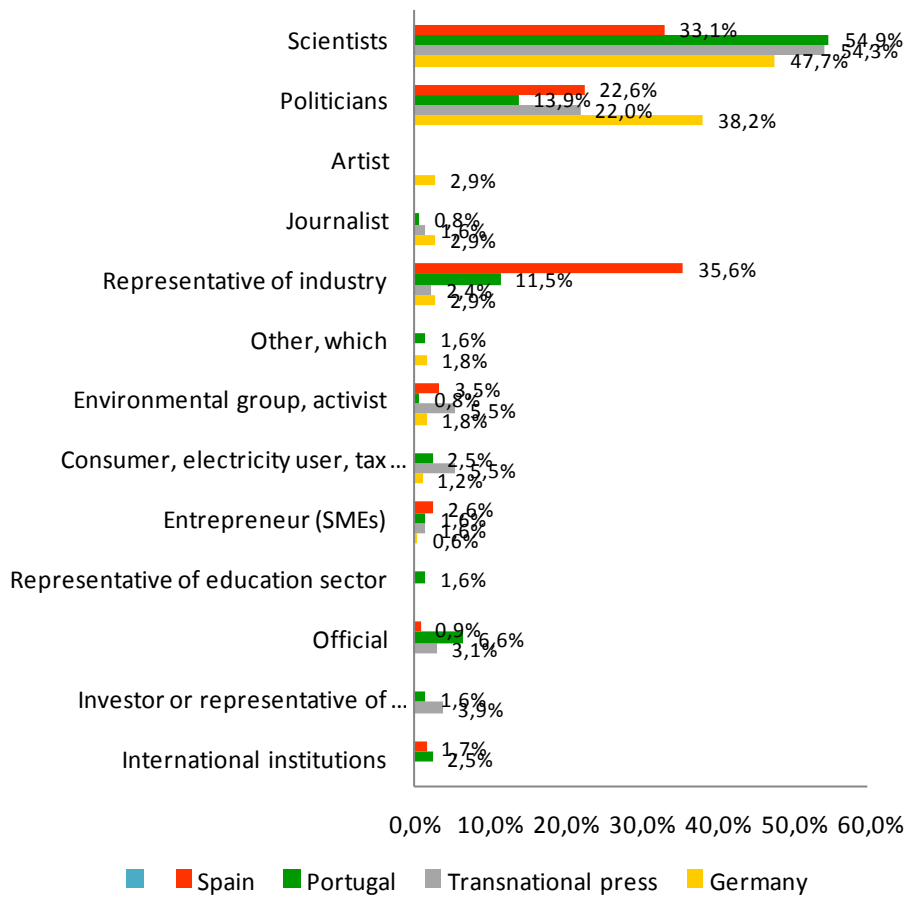


N Germany=90; N Transnational press=40; N Portugal=30; N Spain=54.

Scientists are the main actors when fusion energy is the subject of the articles in German, Portuguese and Transnational print media. It is only in Spain that the main focus is given to Representatives of industry rather than to scientists, who in this case are secondary players when talking about fusion. In Germany political actors are much more relevant than in any other study area especially in comparison to Portugal (Figure 9).

Other actors play a minor role in news about fusion. In Portugal, after Scientists, Politicians and Representatives of industry, Officials have a less reckonable but still considerable role to play in the framing of fusion discourse, while in the remaining study areas they are either absent or almost disregarded. Environmental groups and activists, who nowadays are very important players in social change, are shadowed by other actors when addressing fusion energy.

Fig. 9 Main actors in print media articles with fusion energy related content

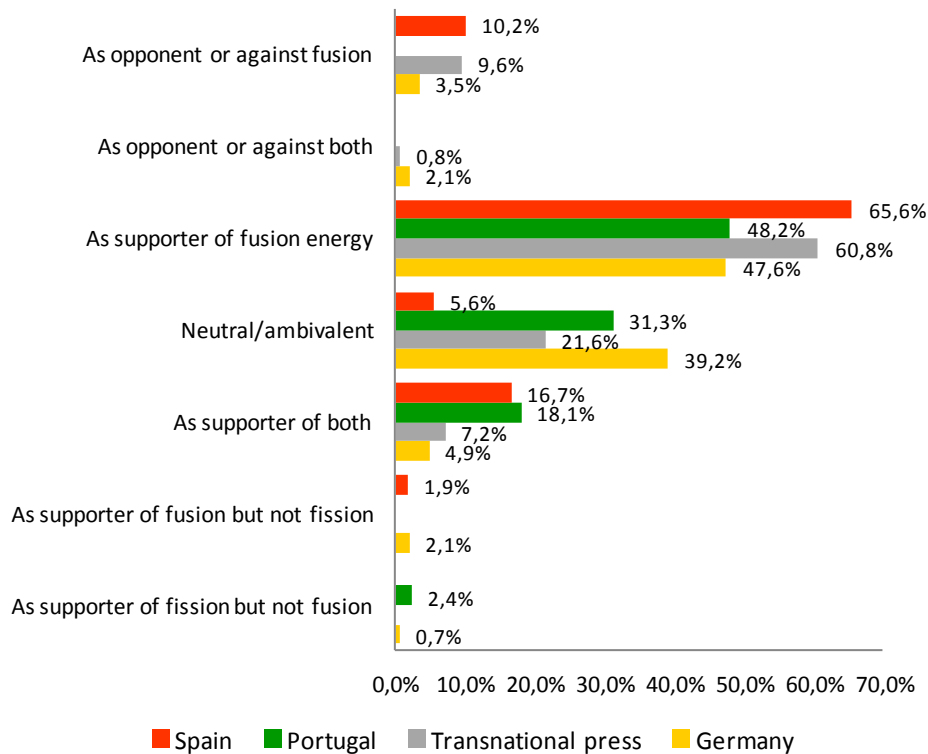


N Germany=170; N Transnational press=127; N Portugal=122; N Spain=115.

Most actors state their support to fusion energy, especially in Spanish (65%) and Transnational print media (60%). Neutral or ambivalent positions are mainly found in German and Portuguese print media. Actors that oppose fusion are very few, and in the case of Portugal there are no records of such position (Figure 10).

Supporters of both fusion and fission are found in every study area with a higher proportion of records in Spanish and Portuguese print media, while very few opponents of both technologies are found only in articles published in Germany and in the Transnational print media. Supporters of fusion but not fission or, otherwise, supporters of fission but not fusion are residual, which indicates that a great majority of actors clearly dissociate both technologies.

Fig. 10 *Position manifested by actors about fusion in print media articles with fusion energy related content*

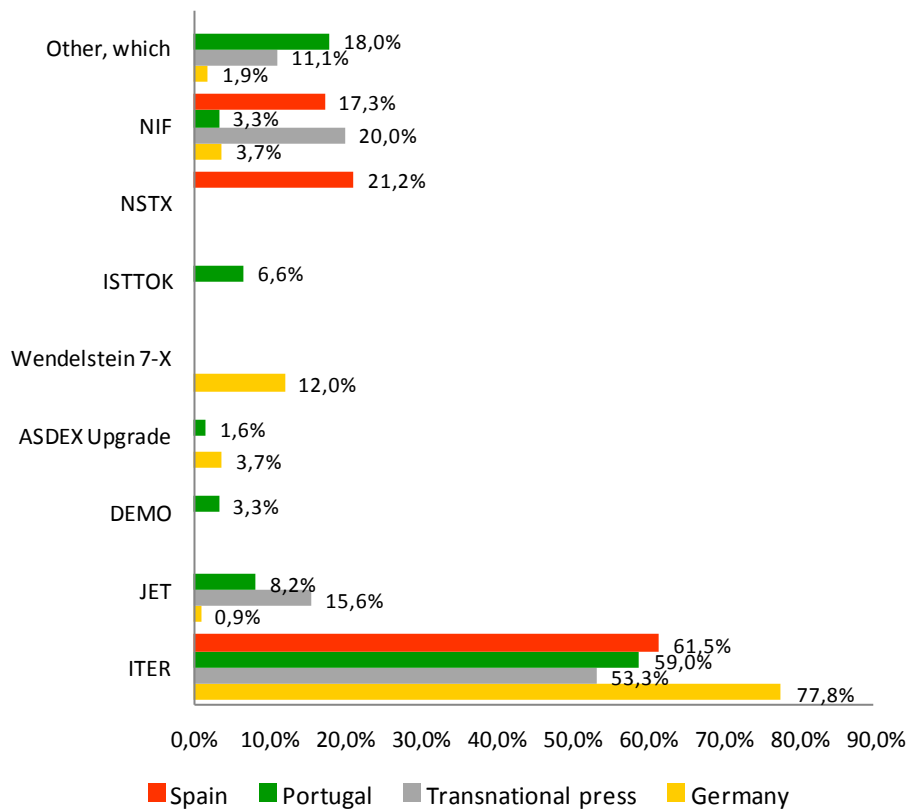


N Germany=170; N Transnational press=127; N Portugal=122; N Spain=115.

ITER and NIF are the only devices mentioned in every studied area. ITER stands out as the most frequently mentioned research device, with a larger proportion in the German press. It is interesting to see that NIF (National Ignition Facility), sited in California, USA is more often mentioned in the Transnational print media than in any other studied area. Some devices are only mentioned in one country, for instance NSTX in Spain, ISTTOK and DEMO in Portugal and Wendelstein 7-X in Germany (Figure 11).

We can also see that JET, the predecessor of ITER, is mostly mentioned in Transnational and Portuguese print media, with some minor references in Germany. Other devices that we did not expect to be mentioned (are not listed in our codebook), occur fairly frequently in Portuguese and Transnational print media.

Fig. 11 Main research devices focused or mentioned in the articles with fusion related content

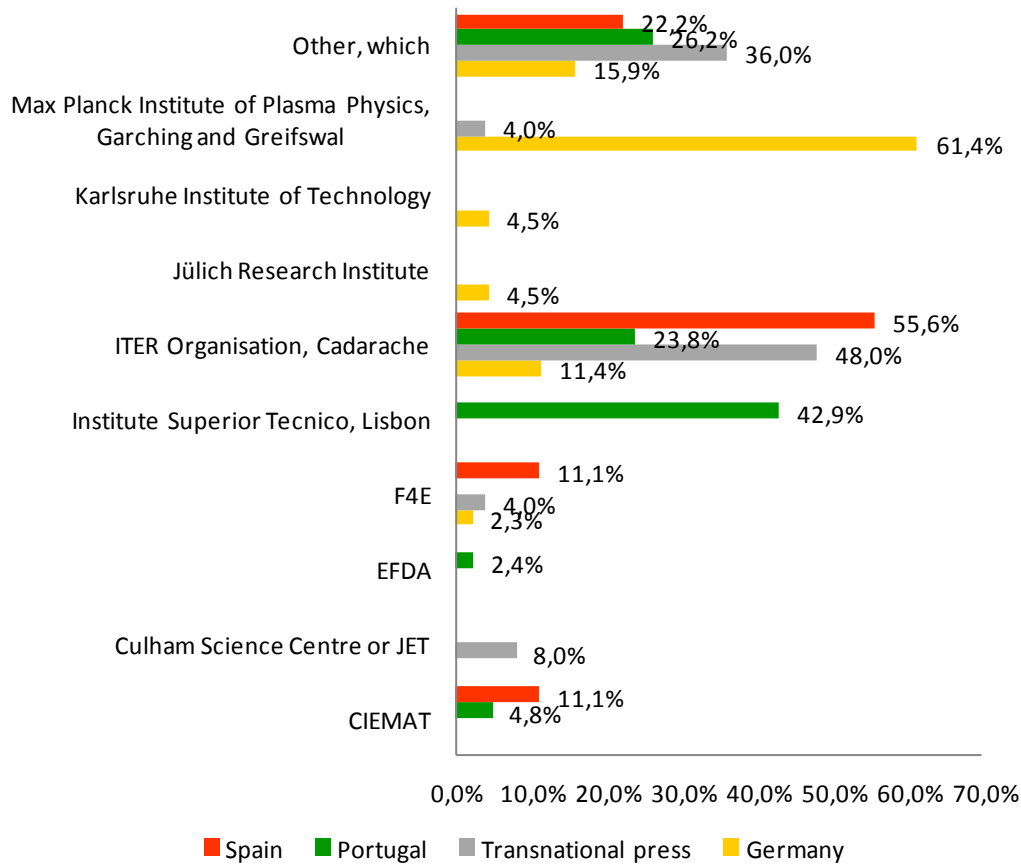


N Germany=108; N Transnational press=45; N Portugal=61 ; N Spain=52.

The ITER Organization is referred to in every studied area, especially in Spanish and Transnational print media. In German and Portuguese print media ITER is mentioned less frequently than “Other” (not identified) structures. EFDA is only mentioned in Portuguese newspapers and magazines.

Figure 12 clearly shows the national bias behind references to the various supporting structures of fusion energy. As we can see, national **laboratories or organizations are mainly or solely mentioned in their respective countries** – the Max Planck Institute for Plasma Physics, the Karlsruhe Institute of Technology and the Jülich Research Institute, in Germany; Institute Superior Técnico in Portugal and CIEMAT in Spain.

Fig. 12 Main laboratories focused or mentioned in the articles with fusion related content



N Germany=44; N Transnational press=25; N Portugal=84 ; N Spain=18.

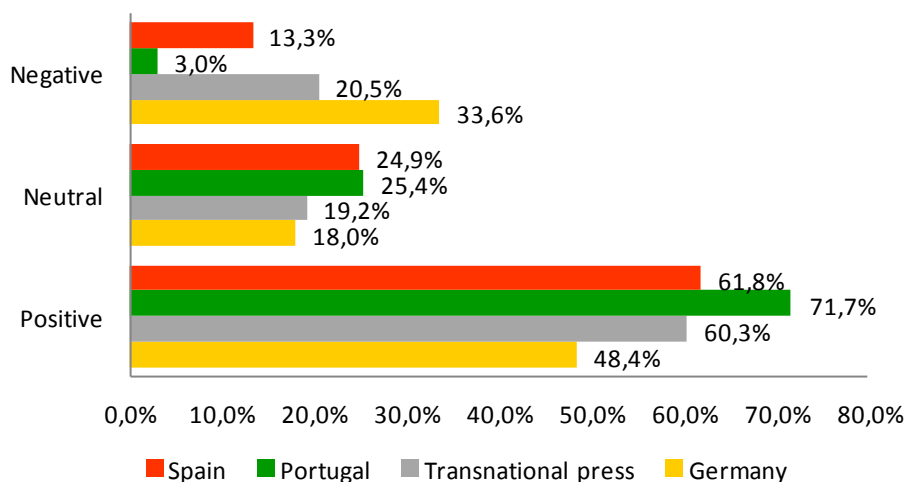
Actors and actors positions are very important *but not sufficient* to understand how a particular subject (fusion or fission) is presented in the media, since in many cases the actors’ positions are not even mentioned and in other cases it is the journalist’s perspective that determines the tendency of news content with regard to the subject. Therefore, we found necessary to analyse these tendencies by creating a variable that aggregates all valuations attributed to benefits and costs of either fusion or fission energy in the news. We call this ‘Image’, making it possible to draw a more comprehensive picture of the subject of the article. Figure 13 depicts the **Image of fusion based on valuations attributed to its various benefits and costs.**

A positive image of fusion is presented in over half of articles published in Portugal (71%), Spain (61%) and Transnational press (60%). The exception is the German press which presents a positive image of fusion in only 48% of articles analysed. Actually a negative image is more frequently portrayed in Germany (33%), followed by the Transnational press (20%) and much less in Portugal (3%) or Spain (13%). A neutral image has some relevance in Portugal (25%), accounting for ¼ of the articles analysed, closely followed by

Spain with 24% of articles, but not so much in Germany (18% of articles) and in Transnational print media (19% of articles).

Overall, we can say that the image of fusion is clearly positive in Portuguese, Spanish and Transnational print media whereas in German print news it is shaped according to a stronger divide between positive and negative valuations, although positive ones predominate.

Fig. 13 *Image of fusion based on various fusion-related costs/benefits in print media with fusion energy related content*



N Germany=328; N Transnational press=234; N Portugal=398 ; N Spain=293

IV. Qualitative analysis

The articles written about fusion address mainly science and technological achievements and refer to it in positive terms especially when long-term future scenarios are taken into account (hope and future). However, the majority of articles do not even explain the basic science behind fusion energy, which is related to the fact that fusion is rarely the core subject of the articles. Very rarely fusion energy is discussed in the context of energy policy, but if so - and this is very significant - it is represented usually in a less positive way, e.g. as an obstacle to fostering renewable sources like solar or wind energy (eg. Spanish results). It is considered, perhaps, as “a game changer” on the political scene, potentially with enormous impact on every aspects of social life, but still remaining so distant from complete achievement that one can hardly take it into account.

Following our in-depth analysis and without disregarding contextual-based characteristics there are some defining features (more or less shared among the various study areas), of media discourse about fusion energy to report:

- i) in the current stage of research fusion is presented as a scientific endeavour rather than a technical standard for energy production;
- ii) the Sun metaphor (artificial replication of fusion energy that occurs within the Sun) is a common and powerful symbolic reference;
- iii) safety and cleanliness of the source are taken for granted, although scientific evidences or technical – based arguments are rarely presented in order to support these statements;
- iv) fusion is portrayed as an endless source of energy, but again, scientific or logic-based arguments supporting this idea are frequently missing in media discourse;
- v) technologic feasibility is the item that involves more in-depth discussions. There is a divide in public discourse regarding the technologic feasibility of fusion (with large contribution from the scientific community), apparently more evident in comparison with other items. Statements presented are rather very optimistic - *Fusion is not a dream anymore*, cautiously positive - *The ignition might even be possible. But there is still much to learn; fusion is no illusion but not yet available* or even conveyed with irony and ridicule - *The old joke has it, fusion is the power of the future— and always will be*;
- vi) economic costs of fusion are mainly associated with the funding of ITER in national media contexts (Germany, Portugal and Spain) or with other fusion large experiment facilities such as NIF (Transnational print media context). Valuations presented toward costs of fusion research vary mostly from negative to neutral. Economic aspects are also commonly framed with regards to the balance between present costs and predicted benefits of fusion energy in the long-term future.

Nuclear energy or Fission

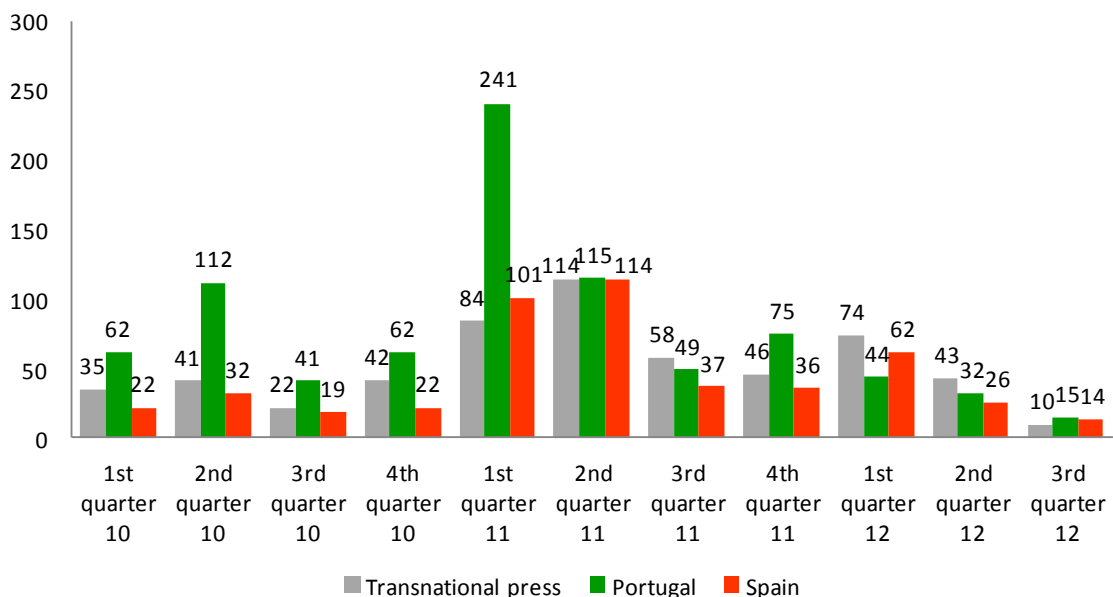
I. Media coverage of nuclear energy or fission.

The number of articles about **nuclear energy** follows a very consistent pattern over the whole period of analysis when comparing the three areas of our study (as it was explained in the Methodology, German analysis was limited to texts mentioning fusion energy) (Figure 14). In every quarter of each year there are articles published about nuclear energy. The Portuguese press publishes more articles than its counterparts in the majority of quarters, followed by Transnational press, except for the third quarter of 2011 as well as the first and second quarters of 2012, where it comes in second place with respect to the number of articles released.

A strong increase of the number of articles occurs in the first quarter of 2011 and extends to the second quarter of that same year. The first quarter of 2011 includes March, the month of the nuclear accident in Fukushima. It is clearly this event that makes the publication of articles on nuclear energy scale up in every media context.

From the second quarter of 2011 onward, there is a strong decrease in the number of articles, which continues until the end of the period.

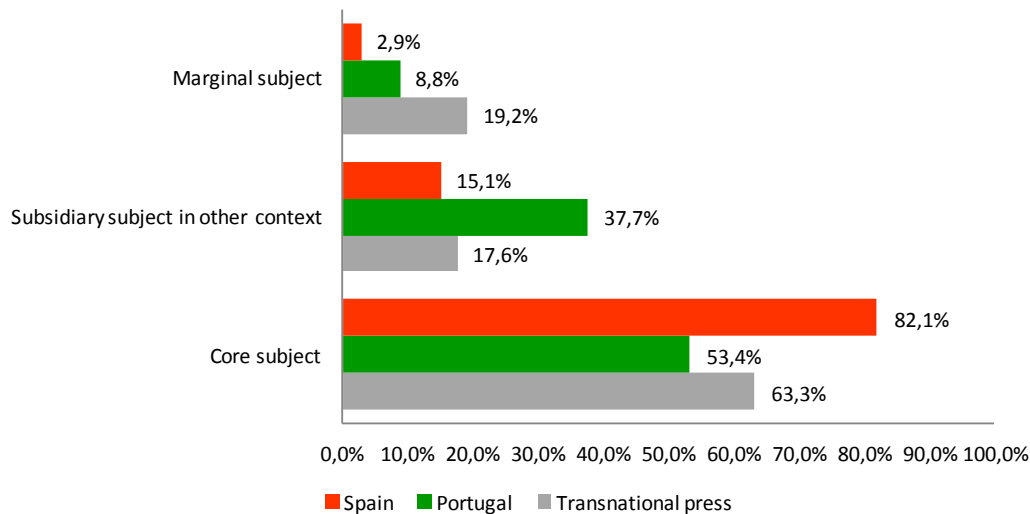
Fig. 14 Evolution of the number of articles with nuclear energy related content



N Transnational press=569 ; N Portugal=848 ; N Spain=485.

In most cases nuclear energy or fission is the core subject of the articles, especially in the Spanish media, with a proportion close to the totality of articles analysed. As a subsidiary subject in other context fission is more frequently presented in Portuguese print media (37%) than in any other study area (15% in Spain and 17% in Transnational print media). As a marginal subject fission is more frequently addressed in Transnational print media, whereas in Spain and Portugal it has a minor expression (Figure 15).

Fig. 15 *Role of nuclear energy in the nuclear energy related articles*



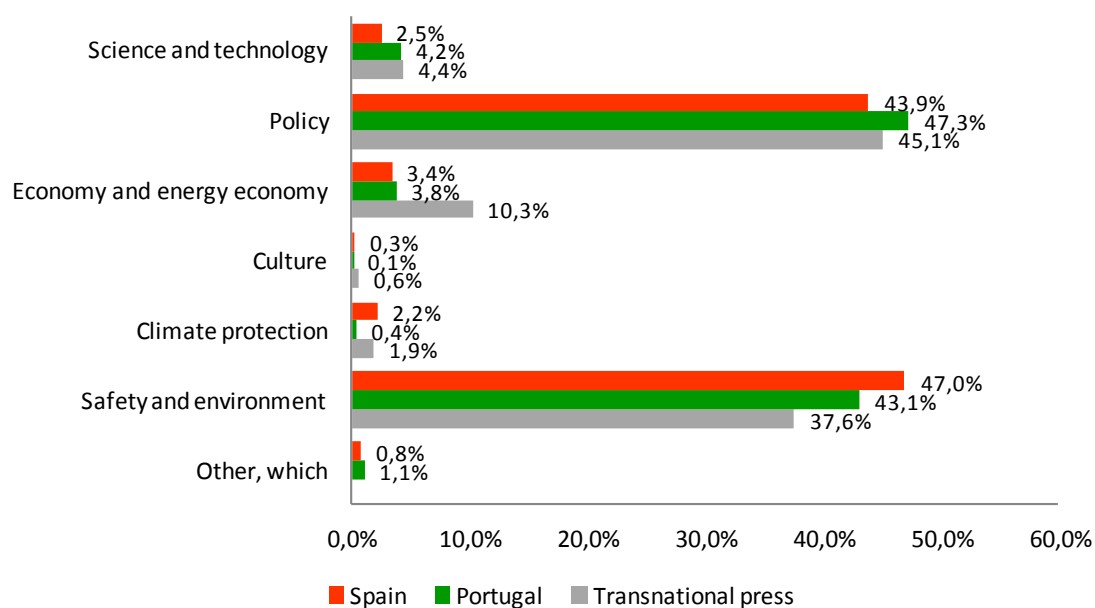
N Transnational press=569 ; N Portugal=848 ; N Spain=485

II. Thematic framing

Thematic framing of nuclear energy is built mainly around **policy and political issues**, along with safety and the environment. Nuclear energy has been for a long time an established source of energy which involves political decision-making, debates as well as facts, processes and controversies or consensus over the safety and environmental issues. These features help explain such high proportion of articles that deal with these two categories of themes. Political issues are slightly more frequently addressed in Portuguese than in Spanish or Transnational print media, while safety and environmental issues are more commonly presented in Spanish print media than in any other study area (Figure 16).

Other thematic categories are less crucial in media framing of nuclear energy related content. Themes related to science and technology, along with economy and energy economy, do have some relevance, especially in the Transnational print media, while themes related to climate protection are almost residual.

Fig. 16 *Aggregate of thematic areas covered in articles with nuclear energy related content*



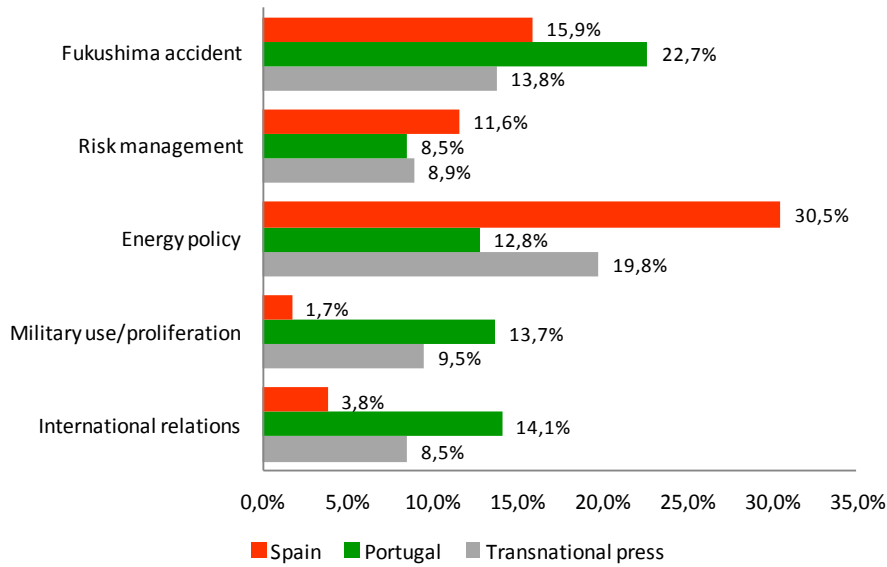
N Transnational press=937; N Portugal=1393 ; N Spain=640 .

In Spanish and Transnational newspapers the theme/issue most frequently covered is energy policy, while in Portuguese newspapers it is the Fukushima accident. Indeed, the accident had a stronger impact on media presentation of fission energy in Portugal (22%) than in any other study area - for instance, articles written about Fukushima account for 15% less of the sampled articles in Spain in comparison to articles written about energy policy.

It is interesting to see that the amount of articles written about military use follow closely the amount of articles written about international relations in every study area. This is not a coincidence, since military use and proliferation of nuclear weapons or nuclear materials are in fact related to debates and negotiations conducted in the international political arena, especially when addressing issues such as nuclear weapons control and non-proliferation treaties. This relation is more significant in Portuguese newspapers (13% of articles written about military use of nuclear and 14% of articles written about international relations), while in Spain it is almost disregarded.

Articles published about risk management in Spain account for 11% (4% plus than in the other study areas) and seem to follow closely the number of articles written about the accident in Fukushima.

Fig. 17 Aggregate of thematic areas covered in articles with nuclear energy related content

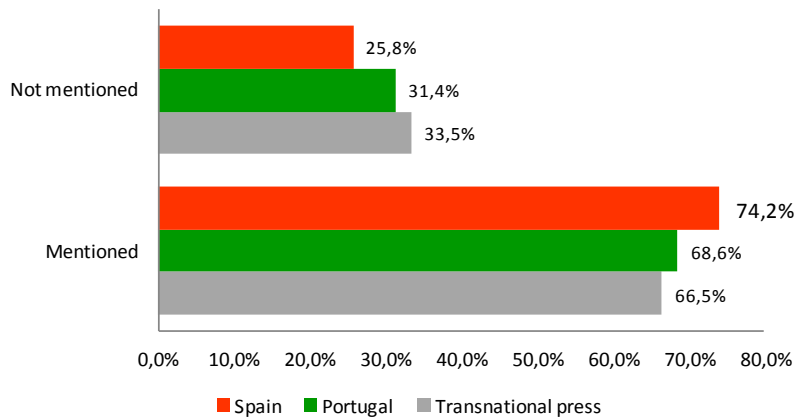


N Transnational press=937; N Portugal=1393 ; N Spain=640.

III. Discursive framing of fission in the various media contexts.

The Fukushima accident is a major reference in discursive framing of fission energy for Spanish, Portuguese and Transnational print media. As figure 18 shows, the proportion of articles mentioning the accident is about 70% of the sampled articles in each case study.

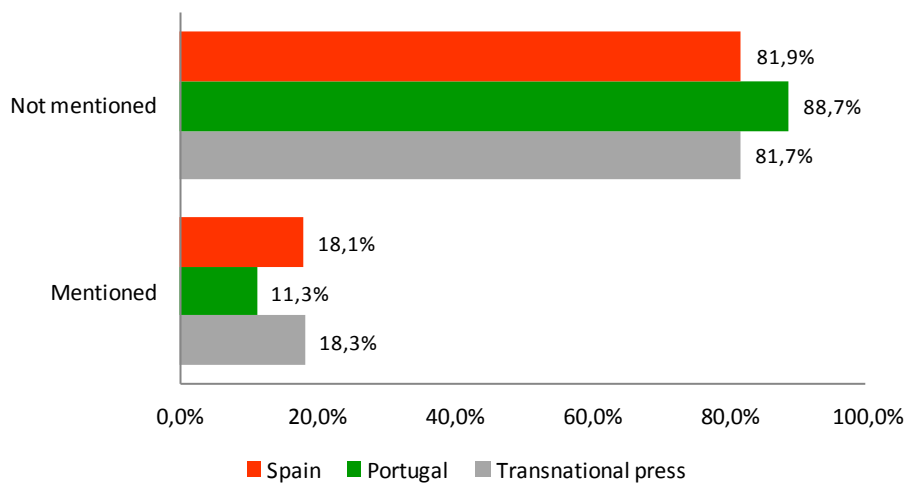
Fig. 18 References to Fukushima accident in the articles with nuclear energy related content



N Transnational press=409 ; N Portugal=558 ; N Spain=376 .

Other nuclear accidents are also mentioned with high and very similar proportions in all study areas. In the Spanish and Portuguese newspapers, Chernobyl and Three Miles Island are the main references, contributing to associate fission technology with the memory of nuclear energy’s most undesirable and menacing outcomes (Figure 19).

Fig. 19 *References to other nuclear accidents in the articles with nuclear energy related content*



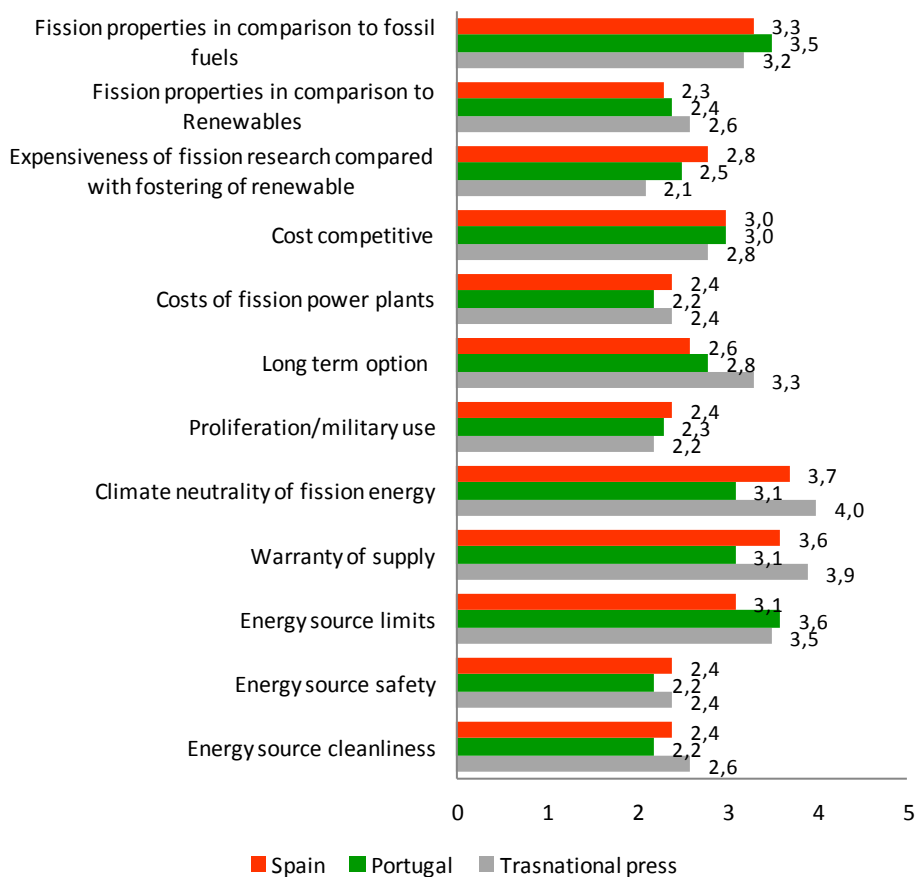
N Transnational press=569 ; N Portugal=848 ; N Spain=485 .

When comparing the evaluation of various **benefits and risks of nuclear fission energy**, it is possible to identify some homogeneous trends. As we can see in Figure 20, safety, cleanliness, costs as well as possible military use of nuclear or proliferation risks, are the features most negatively associated with fission energy (with averages scores under 3 in a 1 to 5 scale). In contrast, fission properties in comparison to fossil fuels, and especially warranty of supply, climate neutrality, energy abundance and, to a lower degree, cost competitiveness, are the features most positively associated with this technology (average above 3 in a 1 to 5 scale).

Climate neutrality and warranty of supply are the most highly valued benefits of fission energy, especially in the Transnational press, reaching in this case almost the top of the scale of average evaluation, which corresponds to a very positive assessment. In Portugal, averages attributed to both these items are lower, but still associated with positive degrees of evaluation. Climate neutrality and warranty of supply are core both in the Spanish and Transnational press, while energy source limits and fission properties in comparison to fossil fuels are the most highly valued items in Portuguese newspapers. Averages related to the cost competitive item are paired in Spain and Portugal, with scores slightly above that of the Transnational press, but corresponding in any case to neutral judgments.

Although fission is more positively evaluated when confronted with fossil fuels in all study areas (as showed in the first category of Figure 20), it is negatively or neutrally evaluated with regard to renewable sources (second and third categories of the graph). That is to say, in the energy mix framework fission is positively evaluated only when compared with fossil fuels, and it is less valued when compared with renewable sources, both in terms of characteristics and in terms of costs.

Fig. 20 Average evaluation attributed to various fission-related costs/benefits in print media with nuclear energy related content (1-very negative; 5-very positive)

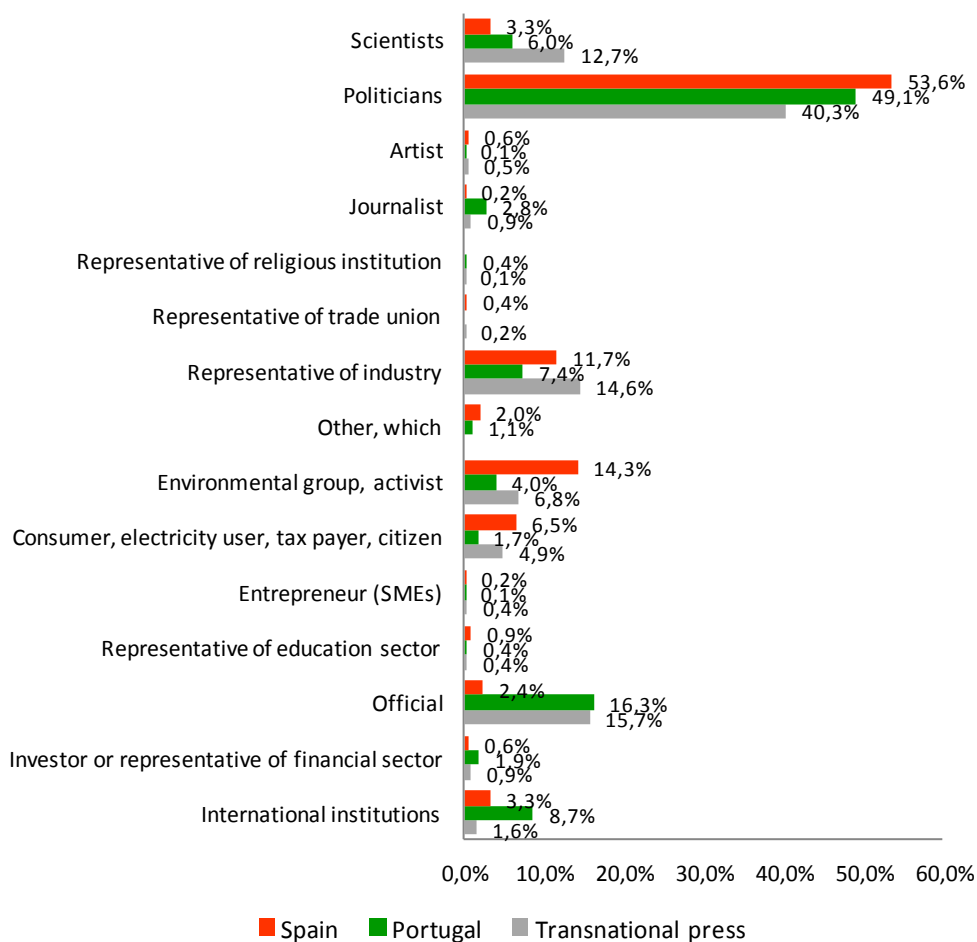


N Transnational press=569 ; N Portugal=848 ; N Spain=485

Politicians are the main actors involved in the media discourse about nuclear energy in all contexts under study, with a strong emphasis in Spanish and Portuguese newspapers, which is consistent with the major thematic areas covered in all cases (Figure 21). Other actors either play a minor role in the discursive construction of nuclear energy or are simply overlooked. In the Spanish press, environmental groups and activists stand with a relatively significant role (14.3%), especially when compared with other study areas.

Representatives of industry also have some significance both in the Transnational press and in Spain. Officials, who are often associated with political decision making, play a relevant part in Portuguese and in Transnational public discourse on nuclear energy. It should be underlined that scientists have little relevance in the media discourse about nuclear fission energy, although with some exceptions as far as the Transnational media are concerned.

Fig. 21 *Main actors in print media articles with nuclear energy related content*



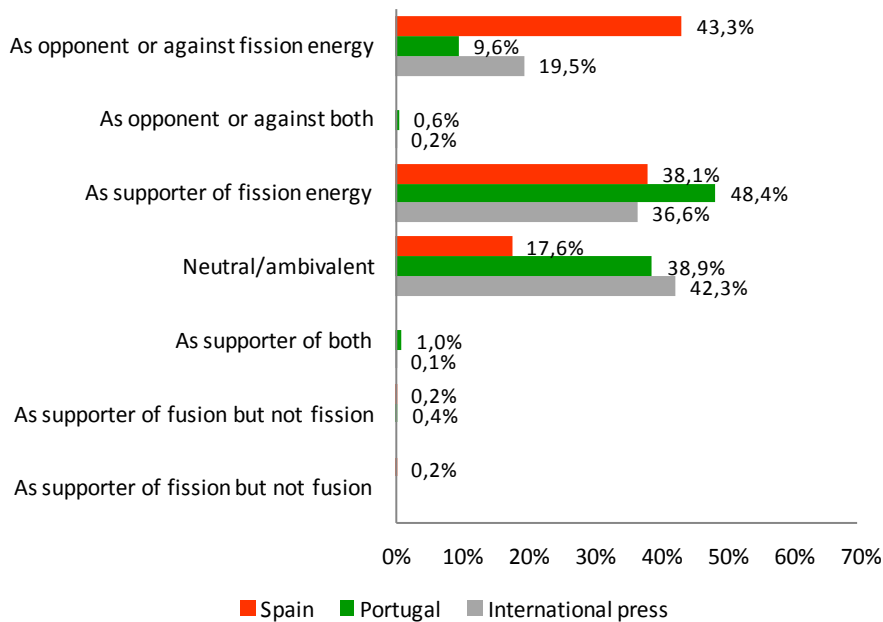
N Transnational press=1277; N Portugal=1419; N Spain=539.

Figure 22 portrays actors' positions with regard to fission and fusion in articles with fission related content. As we can see, supporters of fission have a remarkable presence in all study areas, especially in Portugal where they represent almost half of actors that take a specific position over these matters. Opponents of fission are found mainly in the Spanish press. In fact, it is only in Spain that we identify polarized positions towards fission and that opponents are dominant in comparison to supporters.

Neutral or ambivalent positions can be found in every media context studied especially in the Transnational and the Portuguese. We may say that the predominant characteristic of actors' attitudes towards fission is signalled by the balance between positive and neutral attitudes in the Transnational and Portuguese press contexts, whereas in the Spanish there is a divide between supporting and opposing attitudes, making it more radicalized.

Few actors mentioned in the articles about nuclear energy take some kind of position with regards to fusion energy. Supporters of fusion and fission as well as opponents to both technologies are almost residual in all media. The same can be said with respect to supporters of fusion but not fission or, otherwise, supporters of fission but not fusion. This seems to be an important characteristic of media discourse regarding nuclear fission, since it signals that fusion and fission are in any case strongly dissociated.

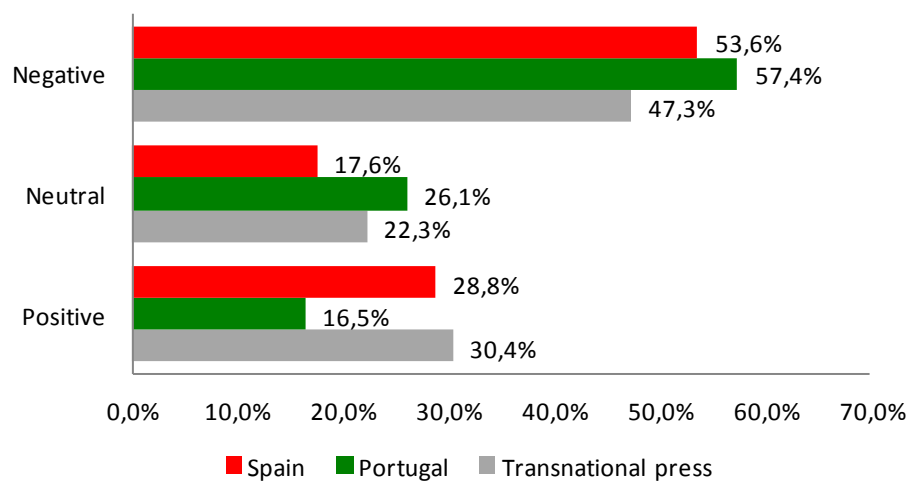
Fig. 22 *Position manifested by actors about nuclear energy in print media articles with nuclear energy related content*



N Transnational press=1277; N Portugal=1419; N Spain=539.

Apart from actors' position and considering that they do not reflect all perceptions and valuations presented in the news, we might say that **the image of fission is negative in a great part of the articles studied**, as it is possible to see in Figure 23. In Portugal and Spain, the negative image of fission is present in over half of the articles studied, remaining slightly under such proportion in the Transnational print media. Fewer articles present a positive image of fission, especially in Portugal, where a neutral image is more frequently depicted in comparison with the Spanish and Transnational print media.

Fig. 23 *Image of nuclear energy based on various fission-related costs/benefits in print media with nuclear energy related content*

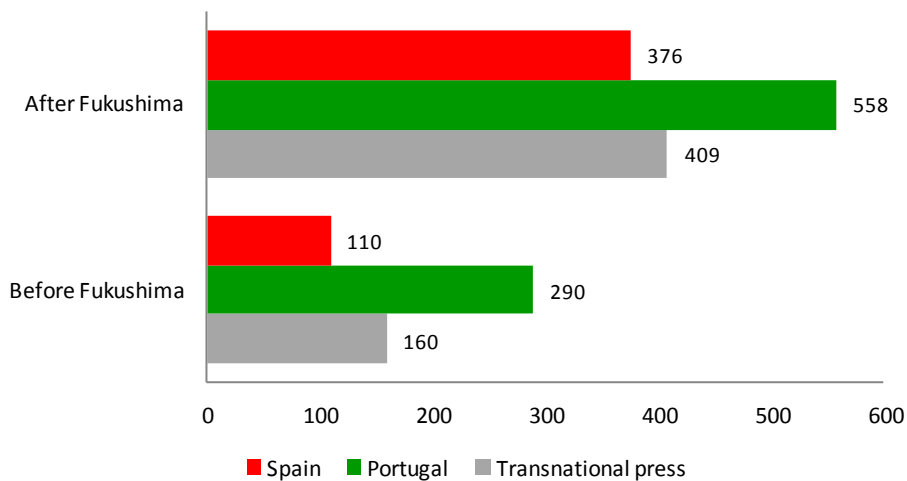


N Transnational press=1306; N Portugal=1550 ; N Spain=753 .

Fukushima effect on media image of nuclear energy

Figure 24 illustrates the linkage between Fukushima and media coverage of nuclear fission. Nuclear energy was covered to a larger extent after the accident in Fukushima in all study areas. In Portugal, the coverage of nuclear energy is proportionally higher in comparison to both Spanish and Transnational newspapers either before or after the accident in Fukushima, but in any case we can state that the accident had a homogeneous impact in media coverage of nuclear energy.

Fig. 24 Percentage of article with nuclear energy related content published before and after Fukushima accident



N Transnational press = 569; N Portugal = 848; N Spain = 486.

After the accident in Fukushima negative evaluations of nuclear energy increased in Portugal and Spain, while positive evaluations decreased. Neutral evaluations did not change much. In Transnational media context both positive and negative evaluations increased, which indicates a polarization of nuclear energy image (Table 4).

Overall, we may say that nuclear energy was already negatively portrayed by the media before the nuclear accident in Fukushima, a fact that became more visible afterwards, especially in Spain and Portugal but less in the Transnational context.

Table 4. Image of nuclear energy based on various fission-related costs/benefits before and after Fukushima

	Transnational press		Portugal		Spain	
	Before	After	Before	After	Before	After
Positive	38,4%	41,2%	25,6%	13,8%	47,5%	24,6%
Neutral	28,3%	20,4%	28,5%	25,4%	16,1%	17,6%
Negative	33,3%	38,4%	45,9%	60,8%	36,3%	57,7%

For a more comprehensive insight about the effect of Fukushima on media evaluation of nuclear or fission energy, it is best to differentiate what were the specific features (benefits and costs) of fission that underwent significant changes within this period.

Table 5 presents the averages of evaluation attributed to various benefits and costs of fission that decreased after the accident in Fukushima in each study area. In Transnational print media minor changes occurred after Fukushima with regard to items negatively evaluated (average score under 3 on a 1 to 5 scale), such as safety, the possibility of military use of nuclear energy, costs of power plants and fission properties in comparison to renewable energy. Climate neutrality of nuclear power and its persistence as an energy option in future scenarios (Long-term option) also remained positively evaluated in Transnational newspapers (scores above 3). The most significant change concerns cost competitiveness which evolved from negative to neutral evaluation. Persistent positive evaluations of climate neutrality and long-term-option as well as neutral evaluations of cost competitiveness might reveal a fall-down in media attention rather than structured opinions with regard to these items, since they were almost set aside by other items more extensively and profoundly debated in the aftermath of Fukushima, such as risks associated with nuclear fission (cf. Transnational media report 2012WP12-SER-ACIF-1: 35-40).

In Portugal there was a shift from positive to negative evaluations regarding the long term use, competitiveness and supplying warranty of nuclear energy. Also there was a slight decrease in the average attributed to climate neutrality, but it only corresponded to a shift from positive to neutral perspectives (from 3.2 to 3). On one hand nuclear energy remained positively associated with alternatives to fossil fuels and energy limits, on the other hand, it remained negatively associated with safety, cleanliness, military use, costs of power plants and costs of research compared to fostering of renewable sources.

In Spain there was a clear fall in averages of evaluation attributed to safety, limits, continuity and costs of nuclear energy after the accident in Fukushima, corresponding to shifts from positive or neutral to negative judgements. These items are more closely linked to declining credibility of nuclear energy in the context of nuclear accidents, especially safety and long-term use of nuclear power. They are also vital in Spanish public opinion (therefore in Spanish media), since the country has nuclear power plants. Cleanliness, military use and fission properties compared to renewables remained negatively evaluated after Fukushima as they were before. Only climate neutrality, supplying warranty and fission properties compared to fossil fuels remained positively (although to a lesser degree) associated with nuclear energy. Judgements about costs of fission research compared with fostering of renewable energies also changed but in this case from negative to neutral, probably reflecting a change in media attention (less articles referring this subject) more than a consistent change of public opinion towards it (cf. Spanish report 2012WP12-SER-ACIF-1: 36-37).

Table 5. Changing trends in average evaluation of costs/benefits of fission energy (1-very negative; 5-very positive) after the accident in Fukushima.

	Transnational press		Portugal		Spain	
	Before	After	Before	After	Before	After
Energy source cleanliness	2,6	2,6	2,3	2,2	2,6	2,3
Energy source safety	2,8	2,4	2,3	2,1	3,2	2,3
Energy source limits	3,3	3,5	3,7	3,6	3,1	2,9
Warranty of supply	3,9	3,9	4,1	2,8	3,7	3,6
Climate neutrality of fission energy	4,1	3,9	3,2	3	3,8	3,6
Proliferation/military use	2,3	2,2	2,4	2,2	2,7	2,3
Long term option	3,5	3,2	3,1	2,7	3,0	2,3
Costs of fission power plants	2,7	2,3	2,7	2,0	3,0	2,0
Cost competitive	2,4	3	3,1	2,9	3,7	2,8
Expensiveness of fission research compared with fostering of renewable	1,2	2,4	2,7	2,5	2,0	3,0
Fission properties in comparison to Renewables	2,8	2,4	2,5	2,3	2,7	2,2
Fission properties in comparison to fossil fuels	3,1	3,3	3,7	3,4	3,5	3,2

Conclusions

1) The 'Fukushima Effect' - Media coverage of fusion and nuclear energy with relation to Fukushima

There was no evidence that the accident in Fukushima had a specific effect on media coverage of **fusion energy**. The number of published articles with fusion-related content evolved independently from public attention given to the accident in Japan. However there are some differences when comparing the various media contexts. We found that German press published more articles than Portuguese, Spanish and transnational press in the period between one year before and one year after Fukushima, not as a result of the accident itself, but rather as a consequence of a more lively and continuing public debate about fusion in Germany.

Before the Fukushima accident, the thematic content of the articles in Germany concentrated on research questions and science policy in a mostly positive way. The fact that fusion is a long term option and the future power plant costs were already pointed in a negative way. After Fukushima, energy policy evolved as a main thematic subject when talking about fusion, and the valuation of fusion tended towards stronger polarization: the neutral approach declined and extreme valuations grew (cf. German report 2012WP12-SER-ACIF: 23). Generally the most positive aspects underline fusion as a possible energy alternative to fission, and also warranty of supply, safety and cleanliness. The most negative statements concern fusion properties in comparison to renewables, fusion as a long-term option and power plant costs. **In the English language articles addressing the transnational elite, the Fukushima accident impact is minor** – as can be noted by a slight decrease from a positive to a more neutral/balanced/ambivalent valuation (cf. Transnational media report 2012WP12-SER-ACIF-1: 20).

The Fukushima accident had otherwise a significant impact on media coverage of nuclear **fission energy**. The number of articles published in Portugal, Spain and transnational print media scaled up after the accident, but only for a limited period of time (first and second quarters of 2011). From the third quarter of 2011 onwards, previous trends in the amount of news about fission published in all print media contexts were re-established.

The major effect of Fukushima in thematic framing of nuclear energy was a shift in focus from routine issues concerning nuclear energy (such as military use, waste, energy policy, etc.), to accidents and emergencies, security, risk management or environmental risks associated with nuclear disasters. Only a few months after the accident, it ceased to be the keynote of media coverage, opening the way to other sorts of subjects more regularly incorporated in media agendas with respect to nuclear energy.

Fukushima also brought to memory past nuclear disasters such as Three Mile Island and Chernobyl, especially in Portuguese and Spanish print media, contributing to drawing a stronger link between fission technology and nuclear energy most undesirable consequences. In general the public media discourse on nuclear fission became more negative in all the countries surveyed, especially Spain and Portugal (where it doubled), but also in transnational press, albeit to a lesser degree. In Germany, despite our study not covering nuclear fission, other studies have shown a strong negative trend regarding media discourse on fission in post Fukushima (Keplinger & Lemke 2012).

Another important aspect to underline is that we did not find any confusion in our analysis between fission and fusion in articles with fusion related content, meaning that representations about fusion are largely dissociated from nuclear fission energy.

2) Content and image framing of nuclear fusion

Presentation of fusion in print news is irregular and mostly framed around science and technology related themes, mainly addressing special events and scientific achievements - much of the media attention is directed towards research projects and results. Scientific breakthroughs, the role of ITER and other research devices or organizations involved in fusion research are the main subjects of the articles. However, the great majority of the articles do not explain the basic scientific concepts behind the fusion process (in fact, fusion rarely is the core subject of the articles.) Thus, without clearly stating the difference between fusion and traditional nuclear energy it is possible that this distinction is not transposed to public perception and therefore, lay citizens confuse the two forms of energy.

Policy-related items also have some significance, but remain well behind scientific ones. In fact, it is very rare for fusion energy to be debated in the context of energy policy. When this does happen, it can assume negative dimensions, such as for example, competition with the promotion of renewable energies such as sun and wind (the Spanish case). The potential of fusion for changing the energy paradigm also occasionally comes up, but such a possibility seems so remote that it is far from the political horizon.

Fusion's image is mainly positive in all media contexts studied. Polarized positions (very positive or very negative) are not common, while neutral ones display a median record. Some negative evaluations of fusion are found in German articles, especially after the accident in Fukushima. Limitless of energy, warranty of supply, safety and cleanliness are the most commonly stated benefits of fusion energy, conveying either positive or very positive evaluations, whereas its technological feasibility, considering that fusion is a long-term option and the costs / complexity of fusion power plants, is associated with negative views / (approaches) – mainly in the Transnational press - where fusion devices and

fusion research centres are presented sometimes as “ridiculously complex, prohibitively large and very costly” (cf. Transnational media report 2012WP12-SER-ACIF-1: 56).

Metaphoric representations / images of the fusion project are often highlighted in articles in transnational press. On the one hand, it is commonly associated with outstanding and highly collective enterprises such as medieval cathedrals, the Apollo Program and the Manhattan Project; on the other hand, it is associated with unachievable goals or desperate quests such as El Dorado and the search for the Holy Grail (in English language print media addressing transnational public).

Fusion is scarcely associated with climate protection and the warranty of supply in the public discourse. These links appear as (misguidedly) unexploited communication resources, which the fusion communication strategy should employ, especially in the energy policy debate context.

Scientists in first place and politicians in second are the leading actors in fusion discourse framing. Fusion coverage is mainly linked to scientific discovery and technological developments, which makes it normal for scientist to get under the spotlight when fusion is presented in the media. In all case studies, a remarkable number of different actors are fusion supporters; a considerable number are neutral or ambivalent towards fusion, while opponents are a minority.

3) Content and image framing of nuclear fission

Fission energy is the core subject in over half of news published. This proportion is higher in Spain than in any other context. Apart from this, focus on fission as a core subject increased after Fukushima in every media context.

For nuclear fission energy related articles, the main thematic areas covered are Policy, Safety and the Environment. Nuclear energy based on fission technology draws media attention towards political decision-making and political debates over a broad set of issues. Chief among them are: energy policy agendas (eg. commitment to *versus* termination of nuclear energy in the energy mix) and nuclear armament *versus* nuclear weapons control in the geopolitical scenario.

The cost/benefit balance for nuclear fusion in the media is negative. The major weaknesses attributed to fission are its properties in comparison to renewable sources; fission research in comparison to fostering of renewables; costs of power plants; safety and cleanliness; military use and to some extent the long term option of fission as a supplying source of energy. Safety, cleanliness, costs of power plants and military use are the most negatively assessed dimensions of nuclear energy.

Some advantages are underlined when comparing fission properties to fossil fuels, or when fission is discussed in the context of climate change mitigation. Energy source limits and warranty of supply are also benefits (the main ones) attributed to fission energy.

Politicians are the main actors involved in the discourse framing of fission, which conforms to prevailing political based themes presented in the articles. These actors emerge from various segments of the political sphere, such as national and foreign governments, national and foreign political parties or EU organizations. There are some references to scientists (transnational press), representatives of industry (Spain and transnational), environmental activists (Spain) and officials (Portugal and transnational contexts), but they play a minor role when talking about nuclear energy.

Before Fukushima, the public discourse conveyed by key actors about fission was more positive and/or neutral compared to after the accident. In fact, among actors mentioned by the media, there were many more supporters of fission than opponents, except in Spain where opponents prevail. Neutral or ambivalent positioned actors were also numerous, especially in the transnational media context.

However, whereas actors tend to be more neutral or positive, the image of nuclear fission transmitted by the media is, in general, more negative than positive, deteriorating substantially after the Fukushima accident, especially in Spain and Portugal.

4) Case-studies - Framing nuclear fusion and fission

Besides these common trends, there are some context-based features concerning framing of fusion and fission that are worthy of mention, especially with relation to the accident in Fukushima. The following should take into account the specific settings of each research background as described in the introduction to this report.

Germany

The energy policy frame is of particular importance in Germany, since much of the public debate on fusion is centred on the funding of research projects such as ITER and discussions on the role of fusion energy in future energy scenarios. The accident in Fukushima had a moderate effect on German print media in terms of the approach to fusion, namely the growing attention given to energy policy related issues, within which fusion is presented, as a possible alternative to fission. The accident also contributed to shape a less favourable image of fusion. Before Fukushima, fusion was very positively evaluated in most articles studied. Afterwards, some negative evaluations emerged. Nevertheless, positive evaluations are still higher and prevalent (cf. German report 2012WP12-SER-ACIF: 23; 32).

Portugal

Regarding news coverage of fusion, research projects along with cooperation activities and know-how transfer are very relevant in Portugal as a result of the country's participation in ITER through IST. Funding and institutional support of Portuguese organizations, as well as the highly valued commitment of these organizations to pioneering science like fusion research, are paramount in written news. These aspects constitute the main links between fusion and the media agenda.

After the accident in Fukushima there was a slight decrease both in positive and negative perspectives on fusion, accompanied by an increase in neutral perspectives. Overall, the accident did not have a significant impact on the image framing of fusion energy.

Fission content is mainly framed around the military use of nuclear energy and the international political debates (mostly nuclear weapons control) associated with it. Energy policy is also covered, but to a lesser extent. After the accident in Fukushima, the media focus shifted from political themes to safety and environmental ones. The accident itself was paramount in the news. Political accountability, associated with nuclear ruling and risk communication, were also portrayed after the accident. Finally, the Portuguese geopolitical scope of media presentation concerning nuclear energy is mainly foreign related, which also reflects broad public disregard of the nuclear energy debate against occasional lobbied initiatives that struggle to endorse it.

After the accident in Fukushima it was possible to verify a radicalization of valuations attributed to fission, namely an increase of negative and very negative evaluations and a decline of positive ones. Neutral based assessments also decreased: there was a shift from neutral or ambivalent to negative views on fission in this period. This change can be related to a shift in focus towards accidents, risk management and security issues after Fukushima (cf. Portuguese report 2012WP12-SER-ACIF: 55).

Spain

Spain is also involved in fusion research networks, namely ITER and other national-based research centres. Research projects, results and scientific events prevail in Spanish news, with particular emphasis given to technological developments and information on current stages of fusion research. Energy policy related issues are also covered in a substantial amount of articles. The accident in Fukushima did not have any specific effect on the thematic framing of fusion energy.

The image of fusion in Spain is also mainly positive with no significant relation with the accident in Fukushima. Neutral perspectives are also commonly presented and to a larger extent than very positive or very negative ones.

The framing of fission content is mostly based on energy policy, risk management and waste (storage). Focus on waste is a distinctive feature in Spanish print media when compared to Portuguese. This is explained by the fact that Spain has nuclear energy power plants, unlike Portugal, which makes the storage of nuclear waste a more relevant issue for debate in Spanish public opinion. After Fukushima there was an increase in articles addressing the already central issues in Spanish media regarding nuclear energy. The accident itself was paramount in the news and, additionally, drew more attention towards other accidents and emergencies.

Before the Fukushima accident, positive views of fission in the news were more frequently presented than neutral ones, which indicates that overall, Spanish public discourse towards fission is consistent and straightforward (either favourable or against and less neutral or ambivalent). After the accident in Fukushima, a negative image of fission was clearly portrayed as a result of increasing news about accidents, emergencies and risk management.

Transnational print media

Thematic framing of fusion energy in transnational print media closely follows the general trends already described. Fusion is overwhelmingly related to scientific research and much less to other sorts of themes. It was expected that Fukushima would influence the global debate conducted by transnational elites on future energy scenarios by creating a window of opportunity or a new pathway for public acceptability of fusion energy, mainly by comparison with fission technology. But themes such as energy scenarios, energy economy and energy policy, which relate to this conceptual setting, are hardly addressed in transnational print media.

The image of fusion in transnational media is mainly positive. However, neutral and negative evaluations are also present, especially when related to viability and the time required before being able to start producing this form of energy. In the transnational press we find references praising fusion (an energy abundant future – Eldorado); but we also find ironic references highlighting its fictional side and comparing it to something unattainable (a continually postponed promise). Also complying with the general trend, Fukushima did not have any relevant effect in the image framing of fusion energy.

The main thematic categories covered in fission related articles are energy policy, military use and, after Fukushima, the accident itself. Fukushima raised the global debate on nuclear energy, which was also reflected in an increase in articles published on safety and cleanliness, and even the termination of fission energy.

In transnational newsprint, fission is portrayed as source of energy with a more neutral discourse than in other media contexts. After Fukushima, negative evaluations of fission increased, although less so than in Portugal and Spain.

5) Final observations and Recommendations

Representations of fusion energy as portrayed in the media are rooted in the idea that **fusion is safe, unlimited and clean from the core**. Dissociation from conventional nuclear energy and nuclear accidents plays in favour of a positive image of fusion energy. The in-depth analysis revealed that fusion is much appraised when compared with fission technology and less when compared with renewables, balancing in this case between views that include fusion as a complement to renewables in future energy scenarios and those that support only the fostering of renewables, especially considering the costs of fusion research.

a) The **technological feasibility** of fusion raises doubts constantly. Fusion is still seen as a scientific curiosity, a controlled experiment in research and laboratorial environments that does not represent any danger to populations, but which does not provide an answer to the real challenge of current energy needs in contemporary societies. It is seen as a distant promise and without transposition to the economy (in contrast to nuclear fission, clearly associated with productive activity).

So how do we get from science to the economy? How do we go from a scientific marvel to productivity? A possible route would be to find content that expressed victories in stages, creating an expectation of evolutionary progress.

b) Another criticism that public discourse, especially in transnational news, issues about fusion is that fusion energy is a **long-term option** – a continually postponed project (decades in the future). This could be transformed into a ‘journey of conquest’. The technological progress should be communicated as it is achieved, as should the next steps, the countries investing, and the countries that are coming on board.

Nuclear fusion has to stop being seen as an unattainable objective (a Holy Grail) and start being seen as ‘good sense’, and increasingly less associated with a utopia and fantasy and increasingly seen more as a viable reality. This means referring to it, with the contribution of credible and renowned actors, as something that already exists, but which needs more time to be productive. It needs to be seen as ‘useful science’.

c) Another negative point mentioned in public discourse is that of **economic cost and high investment**. It is true that the return on current expenditure/investment is far off. However, this current expenditure stimulates various other industries. It is important to explain the corollary of activities that fusion originates and promotes, highlighting that all this expenditure will one day result in cheap and abundant energy.

d) Nuclear fusion does not appear in public discourse explicitly associated with climate change. The linkage to renewable energy and to climate change seems to be crucial to capture public attention towards fusion properties and potentialities, moreover now that the USA has already accepted climate change as a fact. Therefore it is important to

underline that fusion will not impact climate change negatively, and will be capable of contributing to decarbonate energy. It can be presented not only as a benign energy regarding climate change (satisfying environmentalists), but also as one of the only sources of energy capable of decarbonating the economy using modern technology.

e) This points to another aspect. Nuclear fusion is, at the same time, represented as “big science and hard technology”. This is a theme where it is possible to call extreme positions to dialogue. It could be a kind of mediator – a meeting place for environmentalists and productivists. But since it also results from international cooperation, its installation transcends frontiers – it could also be a bridge between countries and peoples, limiting the possibility of conflict. Fusion implies trans-nationality and cooperation in terms of knowledge and technology, which could be presented as a very positive aspect. While nuclear fission is very much associated with war, fusion could become associated with a policy of peace and cooperation. It could take us to the proposal made in 1985 by Mikhail Gorbachev to Ronald Reagan concerning the launch of a programme to develop fusion energy for peaceful ends.

For this to happen, fusion has to strengthen its communicative association and capacity with respect to political decision makers. It has to form a link between scientists and politicians with regards to the collective value or public interest of fusion energy (contrary to the corporate or private interests that prevail in energy markets and nuclear fission).

Future communication of fusion energy can benefit from its distinctive features already underlined, mainly with regards to conventional nuclear energy

f) The analysis carried out on public discourse on fusion over different studies has allowed us to conclude that fusion energy is suffering from a **problem of science communication**. The communication is insufficient, fragile and crude. The big question in terms of communication is that scientists exaggerate prudence to gain credibility. And in this case, excessive prudence could be fatal for communication, creating a growing distance between people’s conscience and the scientific project of fusion. We all know that research on fusion will take time, that it is a complex process, and therefore requires caution. But we put the question in another way: does anyone believe that so many countries would spend so much money if fusion were so unrealistic and unattainable as this caution suggests?

Also, in-depth information and inclusion of social actors, other than scientists or politicians in public debates about the role of fusion in present and foreseen energy scenarios, can also play in favour of public acceptance, or at least, public understanding of fusion energy. Safety and cleanliness should be constantly emphasised.

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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, 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 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