KEEN Regions

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**KEEN-Regions**

Knowledge and Excellence in European Nanotechnology Regions

**REGIONS OF KNOWLEDGE** Maximising the benefits of research infrastructures for regional economic development

# D 2.3 – International Context analysis

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## 0 - Introduction. The "nanotechnology movement"[*]

Scientists, policy-makers and industry stressed the importance of studying the social impact of nanotechnologies and of starting public engagement activities in order to avoid the mistakes committed by biotechnologies. Biotechnologies are a "paradigmatic example because of their failure from the outset to take their social impact seriously". Such a failure "consequently created the conditions for research in the sector to slow down, or in some cases, indeed, to come entirely to a halt"[1].

While the possibility to establish a straightforward analogy between these two emerging technologies sectors and to draw ready-to-use lessons from bio to nano is debatable, the extensive research about the public debate on biotechnology can be a useful reference to elaborate an appropriate perspective for exploring how nanotechnology is publicly debated, advocated, and contested.

Literature on biotech, and more generally the literature on the social studies of science, remarked the complex social processes occurring when technology meets the public. The concept of "technology movement" was introduced to highlight this complexity.

> *The idea of a technology movement highlights several observations: the mobilizing of support for or resistance against a new technology; the use of ideology to motivate support and imagine a particular future, and a process without predetermined teleology. Far from being an integrated system of unified command and control, a movement is loosely held together by various lines of conflict. What links the various actors is a common reference to "biotechnology" for good or bad and the competition over resources and legitimacy for their particular vision of the future.* [2]

A constitutive dimension of this complexity is the diversity of environments where this interaction happens and defines what relevant decisions are about and who has to take responsibility for that. What should we worry? What actions should be taken? Who has the responsibility of oversight? Who has to decide? What counts as benefits and what risks are worth taking?[3] Figure 1 shows in schematic form where actors compete to orient a technology movement to specific directions. Literature has depicted the environment of the technology movement as a triangle consisting of regulation, mass media, and public perception. Public perception and mass media make up public opinion; regulation is a government activity. Public opinion can influence regulation and policy, either challenging government strategies and policies, thereby being a constraint, or supporting such policies. "Through regulation, modern states assure their publics that the uncertainties of new developments are contained. The regulatory framework is a negotiated social contract that specifies the terms under which societies come to agree on the costs and benefits of a new technology"[4]. Mass media and public perception exert a mutual influence: exposure to mass media influence opinions and informal conversations and everyday reception of media representations of technologies re-elaborate the latter.

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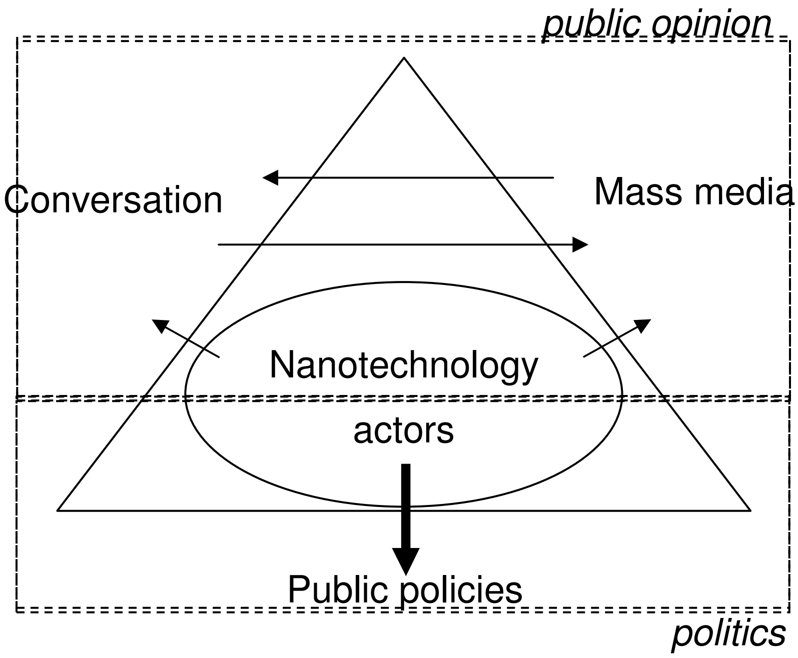
[1] Neresini (2006: 189).

[2] Bauer (2002: 94).

[3] These questions relate to issue salience, i.e. what are the relevant issues in the public debate, and issue representation and framing, i.e. the most important and diffused images and lines of argumentation.

[4] Bauer (2002: 95).

*Figure 1. A schematic form of a technology movement in the public sphere*




*Source: Adapted from Bauer (2002)*

This schematic form of the technology movement in the public sphere has been used to outline the structure of this short report. A concise literature review will highlight some of the major research findings that concern these three dimensions of the "nanotechnology movement":

- public perception;
- media coverage;
- policy formation through participatory mechanisms.

International comparisons will be introduced to support these claims. However, it is important to state from the outset that the coverage of the different national situations is uneven and consistent data are available for a handful of countries. The selection of countries and data sources was therefore aimed to balance different criteria: (1.) the importance of the countries in the global nanotechnology development; (2.) the existence of relevant studies and data sources on public perception and/or media coverage of nano. According to these two criteria, Germany, United Kingdom, and United States will be the primary cases in our comparison, while other countries will be less systematically introduced to enrich and detail the overall picture that this report provides.

## 1 - The public perception of nanotechnology: major findings

This section of the report illustrates some of the major findings regarding the public awareness of nanotechnology, as well as attitudes to and perception of nanoscale science and technology, as well as some of the factors influencing such perception.

**1.1. Public perception of nanotechnology: awareness and optimism**

Despite its dramatic growth, "[t]he literature on public perceptions of nanotechnology and nanoparticles reaches consensus on a few points"[5]. In particular, literature agrees that a considerable share of the population has little or no knowledge of nanotechnology. This result is persistently confirmed by a number of studies and for several countries. For instance, the pooled results of 11 national surveys about citizens' perception of nanotechnology (8 about USA and 1 respectively about Canada, Switzerland, UK) realized from 2003 to 2007 demonstrated that, on average, 51% of people have never heard of nanotechnology[6].

While the remarkable variance featured by these findings (the Royal Society and the Royal Academy of Engineering research in UK features that more than 70% of citizens have never heard of nanotechnology[7], while Scheufele and Lewenstein set the low end with merely 25% of US respondents who had never heard of nanotechnology[8]) is probably to be partly explained by referring to the heterogeneous samples and methods used to survey citizens' opinions, the share of the population unaware of nanotechnology is remarkably stable over time and no clear trend emerges. A comparison of national polls in EU and US regarding the public awareness of nanotechnology can illustrate this point (Table 1).

*Table 1. Public awareness of nanotechnology in selected EU countries and USA (% of the population unaware of nanotechnology)*

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| **EU** | 56 | n/a | n/a | n/a | n/a | 54 |
| **France** | 45 | n/a | n/a | n/a | n/a | 46 |
| **Germany** | 50 | n/a | n/a | n/a | n/a | 35 |
| **UK** | 56 | n/a | n/a | n/a | n/a | 52 |
| **USA** | n/a | 42 | 42 | 49 | 37 | n/a |

*Sources: Eurobarometer 64.3 (2006) and Eurobarometer 73.1 (2010), responses to the question "Have you ever heard of nanotechnology before?"; Hart and Research Associates (2009), responses to the question "How much have you heard about nanotechnology?".*

EU citizens are generally optimistic about the impact that nanotechnologies will have on their life, as showed by Eurobarometer surveys (Table 2a). Although EU citizens who think nanotechnology will impact positively their lives outweigh those who have a contrary opinions, it is interesting to notice the large share of respondents that have no

5 Berube et al. (2011: 3090).

6 Satterfield et al. (2009).

7 Royal Society and Royal Academy of Engineering (2004).

8 Scheufele and Lewenstein (2005). The research does not distinguish the degree of (self-reported) familiarity with nanotechnology.

opinions about the impact of nanotechnology. This may be seen as an indication that respondents are not very familiar with the role and implications of this technological field, thus reflecting the overall unfamiliarity (Table 2b).

*Table 2a. Impact of nanotechnology on our way of life (% of responses that positive effects/benefits will outweigh risks)*

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| **EU** | 48* | n/a | n/a | n/a | n/a | 41** |
| **France** | 41 | n/a | n/a | n/a | n/a | 45 |
| **Germany** | 53 | n/a | n/a | n/a | n/a | 43 |
| **UK** | 42 | n/a | n/a | n/a | n/a | 40 |
| **USA** | n/a | 15 | n/a | 20 | n/a | n/a |

*Table 2b. Impact of nanotechnology on our way of life (% don't know/not sure)*

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| **EU** | 40* | n/a | n/a | n/a | n/a | 40 |
| **France** | 49 | n/a | n/a | n/a | n/a | 39 |
| **Germany** | 32 | n/a | n/a | n/a | n/a | 37 |
| **UK** | 49 | n/a | n/a | n/a | n/a | 47 |
| **USA** | n/a | 43 | n/a | 48 | n/a | n/a |

*Sources: Eurobarometer 63.1 (2005), Eurobarometer 73.1 (2010), responses to the question "I am going to read out a list of areas where new technologies are currently developing. For each of these, do you think it will have a positive, a negative or no effect on our way of life in the next 20 years? Nanotechnology"; Hart and Research Associates (2009), wording of the question not available.*

**1.2. Public perception and knowledge about nanotechnology**

The large share of citizens who do not have an opinion or who are not familiar with nanotechnology interrogates about how this opinion is formed. Indeed, understanding what factors and processes can influence the public perception of nanotechnology can help to assess the effectiveness of communication and public engagement strategies that are currently implemented to anticipate (or fix) possible social conflicts around nanotechnology applications. The following paragraphs will concisely discuss two of these aspects.

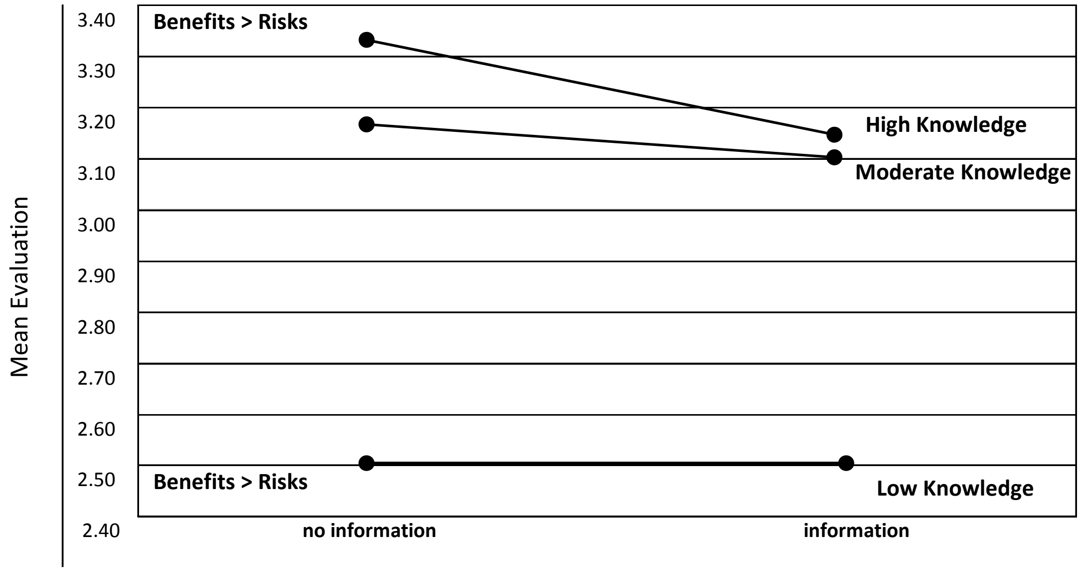
Firstly, it will be discussed the traditional view of science communication that considers social opposition to technological innovation as a result of a knowledge deficit[9]. According to this view, the more the public is acknowledged about a technology, the more his view of such technology will be favourable. The implicit assumption of this perspective is that opposition is basically irrational and that a rational appraisal of risks and benefits can drive to acceptance. However, existing studies show how this relation is not straightforward.

The literature has contested the a linear relationship between attitudes and information exposure, whose overall influence across treatment groups are much more complex. From this perspective, existing empirical analysis support an interpretation of the strong correlation in the no-information condition between prior knowledge and a

[9] Neresini (2008), Bucchi (2002)

positive attitude toward nanotechnology risks and benefits as an indication that persons disposed to a favourable view by some other influence are disposed to learn more (or at least report knowing more) about nanotechnology rather than that knowledge disposes persons to a favourable view [10]. "The observed failure of information exposure to narrow the gap between low-knowledge subjects, on the one hand, and moderate- and high-knowledge subjects, on the other, in the information condition strongly supports the latter view" (Figure 2)[11].

*Figure 2. Impact of information across condition by prior knowledge level*




*Source: Kahan et al. (2007)*

**1.3. Public perception and social knowledge: the case of trust**

What are the factors influencing perception? It is important to notice that judgement about a technology will be taken accordingly to individuals according to their knowledge on the societal context in which (nano)technology is embedded rather than on technical (expert) knowledge about nano per se. "The decision-maker's conception of acts, outcomes and contingencies associated with a particular choice are framed partly according to the norms, habits, and personal characteristics of the decision maker" and partly by its definition of the problem[12]. Trust and perception of other actors involved in nanotechnology development and governance is often and intervening variable in shaping citizens' opinion about technology, its risks and benefits[13]. Trust in industry and regulators is crucially important in such a shaping of opinion[14] and low trust in industry in general has been observed in existing studies, both surveys and experiments, about nanotechnology.

> *Past safety issues with specific products, ranging from drugs to genetically engineered crops, have led to a widespread perception that industry pushes products to market without adequate safety testing,*

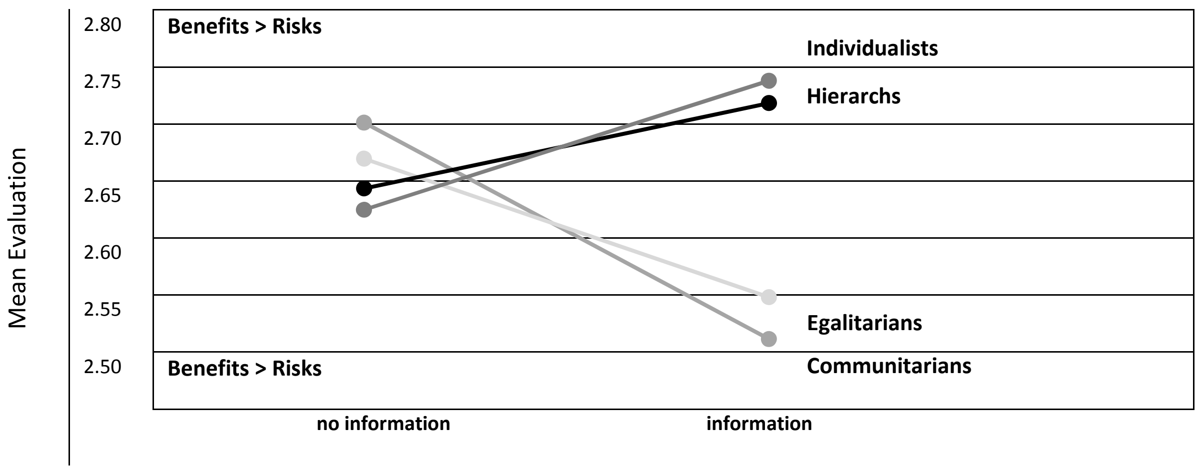
[10] Kahan et al. (2007)
[11] Kahan et al. (2007: 29)
[12] Tversky and Kahneman (1981: 453), cited in Schütz and Wiedemann (2008).
[13] Satterfield et al. (2009)
[14] Siegrist and Cvetkovich (2000)

*makes too many errors affecting people's health, and puts its own motives ahead of consumer safety."*[15]

While low trust in industry is not significantly related to knowledge about nanotechnology, it is strongly associated with perceptions of specific potential risks and benefits: less trust also results in more respondents claiming that risks will outweigh benefits[16].
In sum, people use more familiar aspects from the social context as cues for their risk evaluation. The social characteristics of the firms involved in the development of nanotechnology - though factually irrelevant - have an impact on risk perception. "It can be speculated that [risk stories in the past] are engraved in the collective memory […], so that they would be available as yardsticks for evaluation"[17]. If these characteristics are given a negative connotation, for instance as described above, this will amplify risk perception. If the connotation is positive risk perceptions will be attenuated.

**1.4. Public perception and cultural outlooks**
Individual broad cultural outlooks and values have been tested to examine their influence on the views about nanotechnology. Results show that Individuals who are inclined to prefer "a society in which resources, opportunities, privileges and duties are distributed along fixed and differentiated lines (of gender, race, religion, and class, for example)" have different views of those who think that goods should be distributed without regard to such differences. Similarly, citizens who think that "individuals secure the conditions for their own flourishing without collective interference" have views of the balance between risks and benefits of nanotechnology that differ from individuals who think that "the collective is charged with securing its members' basic needs and in which individual interests are subordinated to collective ones"[18].

*Figure 3. Impact of information across condition by dimension of cultural worldview*




*Souce: Kahan et al. (2007)*

The broad worldviews influence people's opinions about nanotechnology, affecting how information is elaborated. Survey results illustrate how this elaboration process ends into a polarization of opinions, that are organized around

[15] Macoubrie (2005: 4)

[16] Cobb and Macoubrie (2004)

[17] Schütz and Wiedemann (2008). It is interesting to notice that this study associate negative connotations to multinational companies and not to SMEs.

[18] Kahan et al. (2007). The two cultural dimensions corresponds to the hierachical-egualitarian and individualist-communitarian continua.

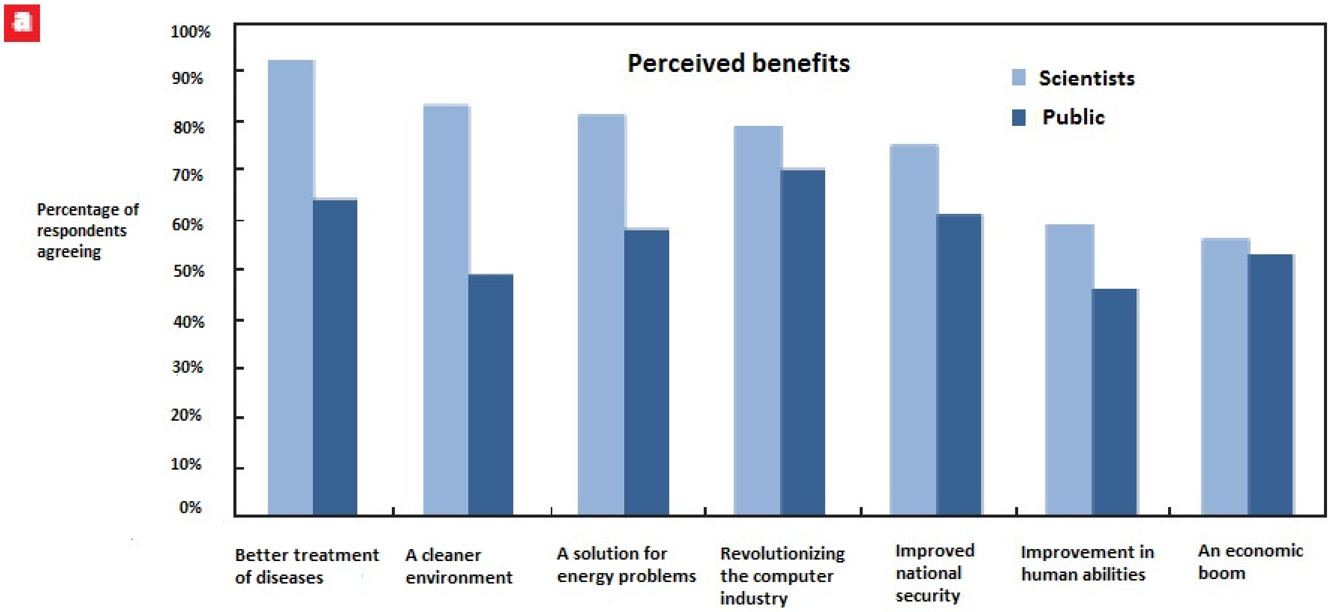
the different "cultural outlooks". Specifically, the more hierarchical and individualistic subjects were, the more favourable their views would become as they were exposed to information, whereas the more egalitarian and communitarian subjects were, the more negative their views would become. In other words, despite they receive the same piece of information, opinions diverge as a result of diverging cultural outlooks, as it is shown in Figure 3.

**1.5. Different perceptions of nanotechnology of experts and the public**

A comparison between two recent national surveys among nanoscientists and the general public in the US shows that nanoscientists are generally more optimistic than the general public about the benefits of nanotechnology (Figure 4a). In particular, scientists were significantly more inclined than the general public to agree that nanotechnology may lead to improvements in the medical field, in environmental remediation, and in the energy sector, as "a solution to energy problems".

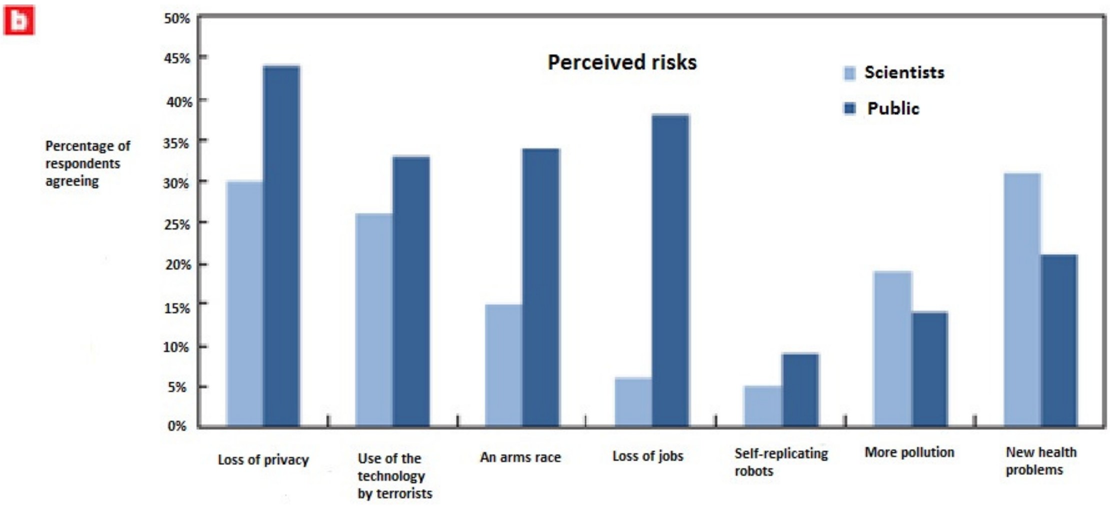
A second, and apparently more important, aspect differentiates expert and lay perception of nanotechnology. The same study illustrates that experts and the public are concerned of different things, as the former are significantly more concerned than the latter about issues related to pollution and environmental contamination and about the negative impacts on human health. When risks are discussed, members of the general public are instead more concerned primarily about the possible negative economic consequences of nanotechnology ("job loss"), followed by the perceived threat to personal privacy posed by the use of nanotechnology in surveillance devices; they also have fears related to the terroristic and military use of nanotechnology innovations. Curiously, the economic negative impact of nanotechnology is what nanoscientists are least concerned about (Figure 4b).

*Figure 4a. Perceived benefits of nanotechnology of scientists and the general public*




*Source: Scheufele et al. (2007)*

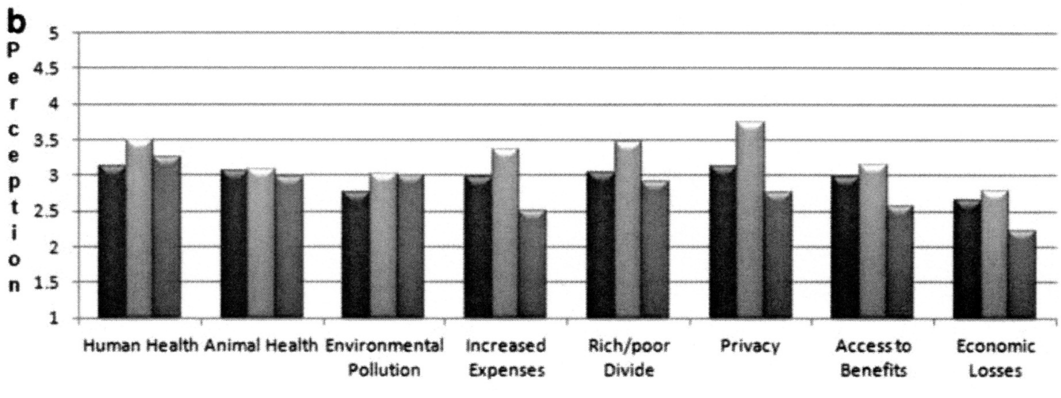
*Figure 4b. Perceived risks of nanotechnology of scientists and the general public*




*Source: Scheufele et al. (2007)*

Other studies confirm these findings. For instance, a comparison of a citizens' panel and of an expert's survey illustrated that opinions about risks differed most for socio-economic issues[19]. While scientists are mostly concerned about human and animal health, as well as for pollution, ordinary citizens are more concerned about privacy and issues related to the fair distribution of and access to the benefits nanotechnology is presumed to deliver, both at the national and international level (e.g. increase of the rich/poor divide, unequal access to benefits) (Figure 5).

*Figure 5. Mean panellist and scientist perception of nanotechnology risks*




*Source: Priest et al. (2010)*
*Note: Panel responses to the question "How risky do you believe nanotechnology will be for society over the 20 years with respect to each of the following areas," and scientist responses to the question "How important do you believe nanotechnology's risks will be for society over the next 20 years in each of the following areas."*

They fear a possible negative impact of nanotechnology on their economic condition (economic losses and increased expenses to afford in everyday life) as well. Furthermore, the longitudinal nature of this study shows that concerns of ordinary citizens grow, thus closing the gap between expert and lay risk perception in the health and environmental areas and augmenting the difference of opinions about unfair access to nanotechnology benefits.

[19] Priest et al. (2010).

## 2 - Mass media coverage of nanotechnology

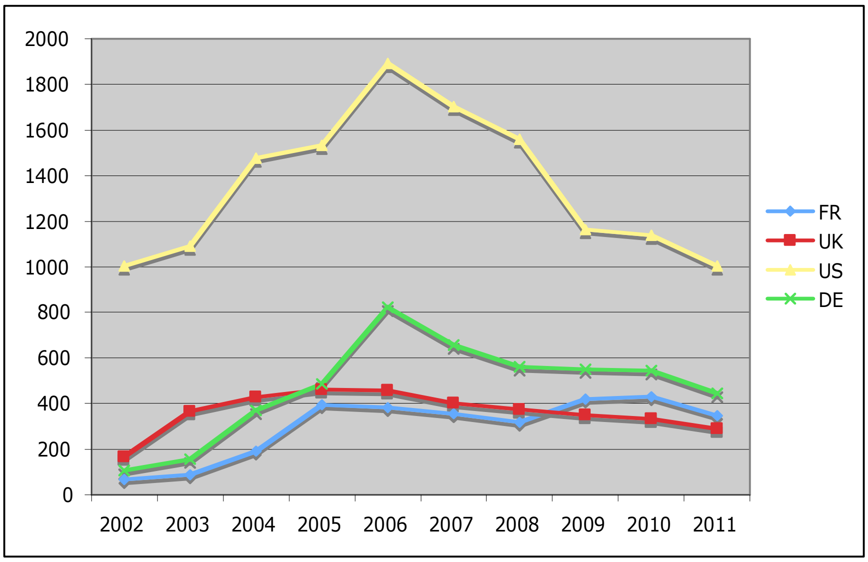
This section of the report offers some insights about nanotechnology media coverage. A first part is dedicated to a quantitative appraisal of such a coverage in selected countries. A second part will focus on the tone and news frames in the coverage.

### 2.1. Quantitative trends in media coverage

An examination of nanotechnology media coverage has to face the preliminary problem to find a working definition of what nanotechnology is for the purposes of research. This object has to be translated in a searchable query for retrieving news items in existing databases. Till now, queries vary widely and media outlets analysed alike. Therefore, a quantitative analysis of nanotechnology in the news can inform us about the broad trends in media rather than offering a precise quantitative picture of such a coverage.

Nonetheless, existing literature presents sufficient evidence to confirm that nanotechnology coverage has dramatically increased in the first half of the past decade in Europe and the United States. A rough estimation of such a growth is illustrated in Figure 6, which shows the trends of newspapers coverage in four countries (France, Germany, US and UK) in the period 2002-2011 can be provided by a simple search in one of the major bibliographic database available (Dow Jones Factiva).

*Figure 6. Newspapers coverage of nanotechnology in four countries (2002-2011)*

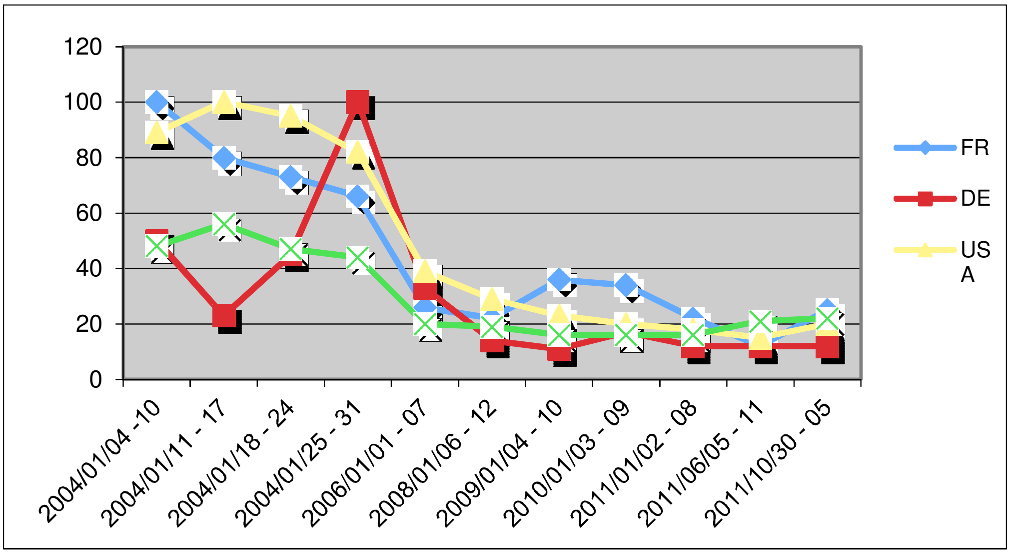



*Source: Factiva.com. Full text query of articles containing the words nanosci* OR nanowissenschaft* OR nanotec*. Indexed newspapers of four countries in the period 01/01/2002 – 10/27/2011.*

While these figures are to be considered cautiously, data seem to suggest an apparent split in two distinct half the past decade: the 2002-2006 period is characterized by a rapid increase of the news stories dealing with nanotechnologies, while numbers decline in the second half of the decade (with the partial exception of France).

A similar split can be seen also in how frequently internet users search for nanotechnology related contents on the www. Using Google searches for the word “nanotechnology”, and its equivalent in national languages, as a proxy, a declining trend can be observed after a peak in 2004. This trend is constant in the fourth countries for which this simple search was done. Figure 7 presents these results in different points of time in the 2004-2011 period. Searches peaked in three of the countries that are considered in the beginning of the 2004 (France, Germany, USA) or in earlier dates (UK). The figure "squeezes" the timeline by registering the search volume a week every six months (January-June) until 2011.

*Figure 7. Google searches of the word "nanotechnology"*




*Source: Google Insights*

While the face value of these data may suggest that interest in nanotechnology is declining, such a conclusion is hardly tenable without further evidence. A reasonable alternative explanation may refer to a change in users searching habits from the more general interest for "nanotechnology" broadly defined to a more sophisticated attention to specific fields and applications. It is nevertheless interesting to notice these trends in absence of recent comprehensive and robust data analysis about media coverage and interest for nanotechnology-related contents online.

**2.2. Characteristics of coverage: tone and frames**

Literature agrees that the media coverage of nanotechnology is overwhelmingly positive. Such a characteristic is stable over years and across countries.

Most of the research works focus on the US media outlets. Longitudinal studies in the period 1986-2004 illustrates that the number of positive stories are more than double than the negative ones[20]. Analyses of either shorter periods of time (2003-2005)[21] or a single year (2004)[22] notices respectively that either 60% of news items reports that benefits overweight risks and only 18% have a contrary opinion, or no risk is associated to nanotechnology in the 76% of news times. In other reviews of US media sources, researchers found that only 121 of almost 400 nanotechnology news stories were about social or physical risks, and even among those 121, only 33% of the paragraphs presented negative aspects, the remainder being either neutral or even positive about the technology[23]. In the 2000-2006, only about 7% of approximately 3,600 US and UK news reports on nanotechnology mention risks at all; of the 163 US news reports mentioning any risks, 111 mentioned environmental risks, 122 mentioned health risks, and 107 mentioned a variety of "societal risks"[24].

[20] Gorss and Lewenstein (2005)
[21] Stephens (2005)
[22] Laing (2004)
[23] Friedman and Egolf (2005)
[24] Friedman and Egolf (2008), cited in Priest et al. (2010)

Similar results are available for some EU countries. For instance, an analysis of 17 British newspapers in 2003-2004 confirmed that the majority of stories reports that benefits outweigh risks (58%), while only 17% express a contrary opinion and 25% affirm that the risks and benefits need still to be weighed[25]. An analysis of 2000-2007 coverage illustrates that German print media show a positive tone about nanotechnology: 84.7 % of all cases of coverage focus on the opportunities of nanotechnology (n=1696), mentioning one or more benefits. In contrast to the emphasis on opportunities in the coverage, the discussion of risks is less extensive, with only 13.9 % of the articles examined presenting one or more risks associated to nanotechnology. Interestingly, the most mentions of risks occurred in the "early days" of the coverage (2000, in total 74)[26].

In reporting a story, news articles "select some aspects of a perceived reality and make them more salient in *a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendations* for the item described"[27], thus setting down the interpretation of news topics. Examining how news stories are framed in the press can therefore offer information about what is considered a relevant aspect in the public debate of nanotechnology and, ultimately, how media define the latter. Research shows that media outlets demonstrated a dominant concentration of stories that profiled nanotechnology applications and research, connecting its development to a general path of scientific progress and discovery. In the US media outlets, this large share of articles counts from 33% to 60%[28], depending on the sources, but only in one case[29] is second for importance, as it is surpassed by news stories focusing on economic aspects (business and economic impacts) of nanotechnology, which is second in other analyses. Considered together the two frames count for between 59% and more than 90% depending on the source. As a coherent consequence of the very small presence of risks associated to nanotechnology in the coverage, news dealing with stories of public accountability, social, health and environmental implications of nano, or stories of risk and ranger associated to technology are much less frequent, thus confirming the overall positive tone of the coverage (Table 3)[30].

The emphasis on scientific and technical progress is even greater in the German coverage, where 71% of the articles frames nanotechnology in the context of scientific and technical progress, including in this case medical progress, while economic benefits (17%) and debates on risks and benefits (13%) are far distant from the technical and scientific frame[31].

The coverage in the Netherlands confirms these patterns. However, the long period (1992-2005) examined in this analysis offers an opportunity to observe how coverage changes over time and what are local specifics of such coverage. It is interesting to notice that the reference to scientific activities and progress, including science and education policies, decreases over time, while the societal consequences and risks emerge in the more recent period (2003-2005). It is interesting to notice that the economic frame is here less focused on opportunities than in the US: attention to innovation as a booster for a declining competitiveness and a policy option to be debated[32].

Local conditions are relevant also in the United Kingdom. If we consider existing researches, British media are indeed a partial exception[33]. This is due to the specific local condition of the public debate in the period that was analysed (2003-2004), which was characterized by a public statement by Prince Charles expressing concerns about the grey goo scenario of uncontrolled nanorobots and the simultaneous publication of Michael Crichton's novel "Prey". Both events fuelled the debate about futuristic and fictional development of nanotechnology, thus making science fiction and popular culture views of nanotechnology prominent among news frames (16%), like

[25] Anderson et al. (2005)

[26] Zimmer et al. (2010)

[27] Entman (1993: 52). Italics in the original. This activities defines what is commonly referred to as "news framing".

[28] Gorss and Lewenstein (2005) set the upper limit, while Laing (2004) and Stephens (2005) set the lower one.

[29] Laing (2004)

[30] Different researches use different definition of frames. Table 3 tentatively groups these frames in homogeneous categories.

[31] Zimmer et al. (2010)

[32] Te Ulve (2006)

[33] Anderson et al. (2005)

Prince Charles remarks (11%). Also in this case, business and economic impacts are a majority in the coverage (23%), followed by news items that consider scientific discoveries and research projects (16%).

*Table 3. Major frames in nanotechnology news coverage according to selected studies (%)*

| | **Stephens (2005) (N=350)** | **Anderson et al. (2005) (N=344)** | **Laing (2004) (N=381)** | **Zimmer et al. (2010) (N=1696)** | **Te Ulve (2006) (N=237)** |
|---|---|---|---|---|---|
| Scientific progress and discovery, celebration of science | 41 | 24 | 33 | 71 | 62 |
| Economics and business impact, funding | 30 | 23 | 40 | 17 | 11 |
| Popular culture, science fiction | 5 | 27 | 0 | 0 | 12 |
| Social implications, risks and oversight | 20 | 9 | 21 | 13 | 5 |
| Other | 5 | 17 | 6 | 0 | 9 |

*Source: elaboration by the Author. Note: Tables may not sum due to rounding*

While it is often feared by policy makers and analysts that mass media looking for sensational coverage of risks may hamper nanotechnology development, existing research on media narratives of nanotechnology are seemingly diffusing an overall positive image of nanoscale technologies and science, by emphasising the benefits over the risks and by linking stories reported in the news to inherently positive frames like scientific or economic progress.

## 3 - Some comments on NELSA and public engagement in nanotechnology policy

The trend in the acknowledgment of the importance of early study of nanotechnology ethical, legal and social aspects (NELSA) is coupled with the recognition of the importance of public engagement as a crucial tool for their assessment. This interest resulted into the flourishing of participatory experiences worldwide. A 2008 survey listed nearly 70 participatory exercises focusing on nanoscale science and technology in Americas (14), Australia (2), and Europe (47, including 17 EU sponsored activity). Prominent national examples, like the National Debate on Nanotechnology in France, can be added to this list in more recent years, as well as a long list of EU funded projects[34].

*Table 4. A survey of participatory exercises per country until 2008*

| ***Region/ Country*** | ***Number of exercises*** |
|---|---|
| Americas | 14 |
| *Brazil* | *1* |
| *Mexico* | *1* |
| *USA* | *12* |
| | |
| Europe | 47 |
| *Austria* | *2* |
| *Belgium* | *1* |
| *Denmark* | *2* |
| *France* | *7* |
| *Germany* | *3* |
| *Netherlands* | *2* |
| *Norway* | *1* |
| *Spain* | *1* |
| *Switzerland* | *3* |
| *United Kingdom* | *6* |
| *European Union* | *17* |
| | |
| Oceania | 2 |
| *Australia* | *1* |
| *New Zealand* | *1* |

*Source: Lafitte and Joly (2008)*

Participation in S&T policy has been cheered as a solution for the challenges to the legitimacy of democratic political decisions by the inevitable displacement of innovation across several arenas beyond the institutions of representative democracy[35]. Public engagement is considered a crucial dimension of this renewed political constitution of technical decision-making[36] and several scholars have set for public engagement the very ambitious goals of creating new forms of "technical democracy"[37].

[34] Lafitte and Joly (2008)

[35] Nahuis and van Lente (2008)

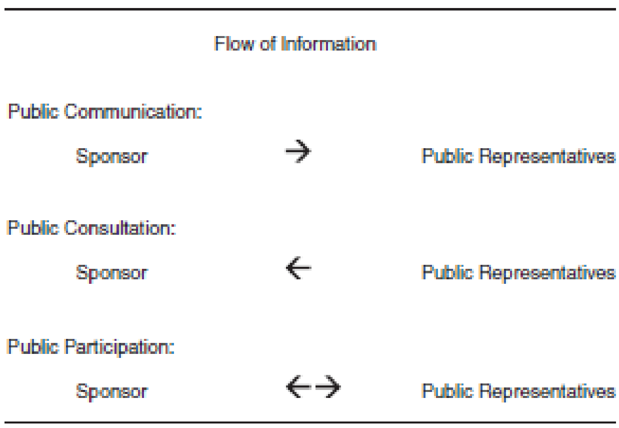
[36] Felt and Wynne (2007), Macnaghten et al. (2005)

[37] Callon et al. (2001), Joss (2002), Joly and Bellucci (2003)

These public engagement exercises adopt a variety of mechanisms and techniques (more than fifty types of engagement techniques have been listed[38]) and interpretive and assessment criteria are equally varied[39]. If we focus on the communicative dimension of these exercises, the presence and direction of information flows can be considered as *the* variable characterising different types of engagement mechanisms and experiences[40]. Though this view has two major limitations (it equates participatory processes to engagement mechanisms that are purposely promoted by a sponsor, like public authority, firm, etc., and, secondly, it does not enter the ways public engagement is actually linked to and influences decision-making[41]).
According to this perspective, what generally is referred to as “participation” includes three different patterns of information flows (Figure 7):

- *Public communication*, when information flow is one-way and information is conveyed from the sponsors of the initiative to the public. In this case, the public feedback is not required or specifically sought. There are no mechanisms specified a priori to deal with this at any level beyond, perhaps, simply recording the information;
- *Public consultation*, information is conveyed from members of the public to the sponsors of the initiative, following a process initiated by the sponsor. The information elicited from the public is believed to represent currently held opinions on the topic in question;
- *Public participation*, information is exchanged between members of the public and the sponsors. That is, there is some degree of dialogue in the process that takes place usually in a group setting between representatives of the parties or, indeed, only representatives of the public who receive additional information from the sponsors prior to responding. Rather than simple, raw opinions being conveyed to the sponsors, the act of dialogue and negotiation serves to transform opinions in the members of both parties (sponsors and public participants)[42].

*Figure 7. A typology of public participation mechanisms*




*Source: Rowe and Frewer (2005)*

If we observe the past and current collaborative efforts implemented under the EC Framework Programme to explore Nanotechnology Ethical, Legal and Social Aspects (NELSA), we can see that public engagement mechanisms are mostly limited to public consultation and communication mechanisms. Table 8 provides an

38 Smith (2007) cited in Reber (2010: 325).
39 Joss (1999), Joss and Bellucci (2003)
40 Rowe and Frewer (2005)
41 Bucchi (2008)
42 Rowe and Frewer (2005: 254-256)

overview of major activities from a non-systematic sample of 12 collaborative projects compiled from existing reviews[43] and additional internet searches by the author.

A cursory comment of this limited and non-systematic sample according to the communication/consultation/ participation distinction is an useful illustration of the modalities and extent of public engagement in NELSA projects:

- *Communication activities* towards the general public are dominated by web communication through websites, newsletters, downloadable reports (all the projects), while they are complemented by broadcast products and innovative solutions (Nano-TV), like, for instance, interactive software for the self-assessment of opportunities and risk of nanotechnology applications (Nanologue, ObservatoryNano). The general public and specific stakeholders are targeted through dissemination workshops and conferences (FramingNano, NanoCom, ObservatoryNano). In some cases, these dissemination activities are performed through training courses (Nanobioraise, Nanoyou, Nanototouch) and, mostly informal, educational products (Nanobioraise, Nanototouch, Time for Nano).
- *Consultation activities* are less frequent and the most used techniques include workshops (FramingNano, NanoCap, Nanocode, Nanologue, Nanobioraise), questionnaires and interviews (ObservatoryNano, Nanocode, Nanologue), online forum (Time for Nano) or more structured techniques like Delphi (FramingNano).
- *Participation activities* are mostly based on group discussion and dialogue like workshops and working conferences (FramingNano, Nanocode). More structured, ongoing dialogue activities are implemented through investment fora ( and standing groups (Nanomed Roundtable).

If we except communication activities, consultation activities and, especially, the few activities that can be labelled as “participatory” according to our distinction suggest a predominant focus on “organized stakeholders” [44]. Different consultation strategies are targeted to different publics: online surveys and forums are a tool mostly dedicated to the general public, or to broad socio-demographic categories like age cohorts, while more structured processes aimed at collecting and eliciting stakeholders opinions of more specific categories of stakeholders, like economic actors or NGOs/CSOs for instance through Delphi and workshops. Also, ordinary citizens seem not involved in the participatory settings and mechanisms that are detectable from an examination of the websites of these projects.

*Table 8. Selected NELSA projects in the EC Framework Programme*

| Project | Website | Programme | Status |
|---|---|---|---|
| **EthicsSchool** | www.ethicsschool.eu | FP6 | Completed |
| **FramingNano** | www.framingnano.eu | FP7 | Completed |
| **Nanobio-raise** | www.nanobio-raise.org | FP6 | Completed |
| **NanoCap** | www.nanocap.eu | FP6 | Completed |
| **Nanocode** | www.nanocode.eu | FP7 | Ongoing |
| **Nanocom** | www.nanocom-eu.org | FP7 | Ongoing |
| **Nanologue** | www.nanologue.net | FP6 | Completed |

43 Hullman (2008)

44 This situation is consistent with the results of Lafitte and Joly (2008).

| Project | Website | Programme | Status |
|---|---|---|---|
| **Nanomed RoundTable** | www.nanomedrooundtable.org | FP7 | Completed |
| **Nanototouch** | www.nanototouch.eu | FP7 | Completed |
| **Nano-TV** | www.youris.com/Nano/NANOTV | FP7 | Completed |
| **Nanoyou** | www.nanoyou.eu | FP7 | Completed |
| **ObservatoryNano** | www.observatorynano.eu | FP7 | Ongoing |
| **Time for Nano** | www.timefornano.eu | FP7 | Completed |

This section has noticed that participatory procedures are generally presented as tools for improving the legitimization of technology decisions. A cursory look at the notion of legitimization can, however, show how this assumption may not be fully justified. The term legitimization can be "reconstructed pragmatically as a three-constituent concept, which permits structuring the field of possible legitimization contexts: Something (an action/a decision) is legitimized before an instance with reference to a catalogue of criteria". While participation (in principle) ensures the legitimacy of decisions taken collectively by the parties engaged, "decisive for legitimization is, therefore, the question, according to which right and under which circumstances an external consent above and beyond the circle of participants can also be expected. Even if there is an internal consent of potential losers, under which conditions and with which right can this consent normatively be expected from the ''world outside''?"[45]. Therefore, this link between the inside and outside of participation is all but straightforward and experience shows that consensus, closure, selection and legitimization are not a necessary outcome of public engagement experiences: narrowing participation to a "legitimizing mechanism" may result in an instrumental move with uncertain outcomes[46].

Reframing the goals of participation in terms of social learning rather than (only) in terms of legitimization can offer a less problematic perspective about public engagement. According to this perspective, participation can be viewed as a tool for exploring conceivable scenarios[47] and it can be the engine of a reflexive process stimulating participants to rethink solutions, value systems, worldviews and priorities, and problems themselves. From this point of view, emerging and lasting divergences are not a failure of participation. They prove instead that the a participatory process is vital and pluralistic, and that assumptions, imageries, and practices of dominant actors do not impede the elaboration of a broad set of alternative technological trajectories and the charting of their connections, interactions and synergies with ethical and social issues[48].

Participation is therefore not only about closing down interpretations and options; it is also about opening up choices on technologies, about exploring alternative possibilities, about promoting social learning that reflects the systematic exploration of the features and frames of the discussion, as well as of the contexts, actors, and interests that are involved.

[45] Grunwald (2004: 109, 115)

[46] For instance, see Joly et al. (2003).

[47] Callon at al. (2001: 50).

[48] Stirling (2008: 228-229).

## 4 – Closing remarks

This report has concisely presented three dimensions of the societal context of nanotechnology development: public perception, media narratives, and patterns of public engagement mechanisms (with some references to its limits in policy-making) . Although this discussion is based on a non-systematic review of the literature and thus it cannot provide a comprehensive picture of such dimensions – this cautiousness has to be maintained especially with regard to the section about participatory mechanisms in technical decision-making –, the research findings illustrated above can offer some useful insights for nanotechnology policies. The following list presents the most relevant aspects illustrated in the previous sections of this report.

- A large part of the general public is seemingly not aware of nanotechnology. Although citizens who have a positive view of the future impact of nanotechnology on their life outweigh those who have a negative view, a majority is unsure about what these impacts will be. This situation appears rather stable over time and across countries.
- The traditional view of science communication that considers social opposition to technological innovation as a result of a knowledge deficit is put to the test. Indeed, empirical results illustrate that an increase in information and knowledge is not necessarily correlated to an increase in the positive attitude to nanotechnology.
- Opinions about a technology are affected by the knowledge of the social context in which (nano)technology is embedded rather than on technical (expert) knowledge about nano per se. For instance, risk and benefit perception is influenced by integrative values, like trust in industry or regulators, and cultural outlooks, i.e. worldviews.
- Socio-political risks, like unfair access, rich/poor divide, privacy, loss of jobs, terrorist and military use of nanotechnology rank high among citizens' concerns about nanotechnology, while scientists seem more concerned of possible adverse health and environmental consequences than lay people.
- Despite the widespread view that media predominantly report "the dark side" of nanotechnology, existing literature illustrates that the media coverage is overwhelmingly positive. Besides local/national specific frames, news are presented mostly as stories of scientific research and economic prospects. Inherently negative frames or coverage of risks are much less diffused.
- A simple search of the words "nanoscience" and "nanotechnology" shows that the coverage seem to peak in mid 2000s, then a decrease in newspapers attention appears. Interest of internet users, measured by the number of Google searches, seemingly follows a similar pattern. Two interpretations are possible: 1) interest is actually diminishing; 2) interest is shifting towards more detailed pictures of application areas, thus shifting from "nanotechnology" to "nanotechnologies".
- The acknowledgement of the importance of ELSA in the early development of nanotechnology is coupled with the diffusion and flourishing of participatory exercises and activities. These exercises enact participation differently and, according to the direction of the information flows they enable, can be distinguished in communication, consultation and participation mechanisms.
- No matter the structure of participatory mechanisms, participation is often assigned the ambitious goal of creating consensus and legitimacy for technology decisions, thus fostering social acceptance. However, the multiconstituent structure of technology debates challenge the efficacy of engagement strategies to transfer legitimacy and acceptance to the broader social context.
- Alternatively, participation can be considered as a process of social learning, where differences in knowledge, interests, and attitudes enable a systematic exploration of the encounter between (nano)technology and the public, thus offering to all the social actors engaged in the discussion a way through the complexity that characterises public debates about technology.

This short list suggests three major ambiguities when nanotechnology goes public.

Firstly, the current efforts in understanding what the general public think of nanotechnology, what citizens hope and fear, apparently suffer from an ambiguity. Citizens are not experts and they do not pretend to be experts. They care of the socio-political framework of innovation (who is involved, who is responsible, what are the goals of these policies) equally, and probably more, than the assessment of toxicological or ecotoxicological risks. The gap is here between what seem the priorities of “expert” communication and what are citizens’ concerns. It urges therefore scientists and stakeholders to rethink what areas and factors are relevant for nanotechnology perception and, at the same time, offers a framework to analyse public communication and its discontents beyond the deficit model.

Secondly, the relationship established between public engagement and democratic legitimacy of decisions about technology is ambiguous too. On one side, legitimacy is equalled to concepts like consensus, social acceptances, closing of controversies. From this point of view, participation is not always up to the task of transferring consensus and legitimacy beyond the circle of engaged stakeholders. On the other side, public engagement is always a powerful tool for the systematic exploration of the frames and features of the debate, its contexts, actors, relations, and interests. In other words, it can be considered as a learning process, where divergences and differences are enabling condition for charting developmental trajectories besides hegemonic ones.

Thirdly, these ambiguous identities of the public and of participation are coupled with a similarly ambiguous view of nanotechnology. On one side, nanotechnology (singular) has been, and still is, used successfully as a vehicle for the strategic positioning of a set of heterogeneous activities and actors, that are scientific (including social scientists and humanists), economic, and political, in the broadest sense. On the other side, this insistence on nanotechnology (singular) has overshadowed the enabling character, and then the pervasiveness and differentiation, of nanotechnologies (plural), in public communication and awareness. When asked to list the “new inventions and technologies” or “scientific discoveries” they are most interested in, only 8% of the European citizens answered “nanotechnology”. However, 61% answered “medicine” and 47% “the environment”[49]. Five years later, Europeans rank nanotechnology seventh in a list of eight new technologies prioritized by their perceived positive impact on society and everyday life. Nanotechnology ranks just above nuclear energy, in a ranking dominated by solar energy, medicine, and electronics. And these are all fields that are deeply impacted by nanoscale science and technology[50]. Indeed, although the general public may be not aware of or even not interested in nanotechnology (singular) as a generic label for a loosely defined technology field, European citizens are definitely interested in what nanotechnologies (plural) can do.

Disentangling these three ambiguities is crucial for better understanding what happens when nanotechnology meets the public.

[49] Eurobarometer (2005: 13).

[50] Eurobarometer (2010: 9).

KEEN Regions

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