Gov4Nano
meeting the needs of nanotechnology

Deliverable Report

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Table of Content

1 Summary

This deliverable report describes the results of Task 3.1 of the project Gov4Nano: "Information needs and communication with civil society". It first brings together insights from sociological risk research and public perception studies on nanotechnologies and discusses four interconnected questions:

- The "Why" – Why do the risk perceptions of different civil society groups matter?
- The "How" – How do risk perceptions in civil society emerge?
- The "What" – What do we know about the risk-perception of different civil society groups?
- The "What next" – What to do about the risk perception in civil society?

Whereas Europeans perceive nanotechnologies for the most part positively, most Europeans know little about nanotechnologies and have difficulties in assessing their risks and benefits. In addition, the maturing of nanotechnologies into an "enabling technology" has led to changes in their visibility. Whereas the potentials of nanotechnologies were communicated extensively in the early 2000s, "nano" is today used less as a buzzword. At the same time, less nano-specific Science, Technology and Innovation (STI) policies concur with less nano-specific communication.

In a second step, the report describes recent developments in the public discussion of emerging technologies. Focusing especially on the COVID-19 pandemic and the debate on vaccines, the report highlights different trends in the public discussion: The more and more central role of social media, the emergence of different social media "influencers" and, as a result, stronger unpredictability of the "civil society". Domains and topics that were previously left for scientific experts are discussed by people with limited scientific background.

Although the current public opinion on nanotechnologies can be described as positive, the emergence of new civil society actors and communication channels bears some risks. Considering the diversity of nanomaterials and their applications, it is possible that some nanomaterials or uses become subject to stronger public attention or direct criticism. If new civil society actors and influencers – who do not necessarily share the principles of technical risk assessment, but at the same time enjoy audiences much larger than scientific or public institutions do – participate in the discussion, the debate may take an unpredictable course.

Building on this review, possibilities for public communication by the "Nano Risk Governance Council" (NRGC) were discussed in qualitative in-depth interviews with experts from industry, civil society organisations (CSOs), public authorities and social media influencers. The aim was to lay foundations for possible dialogue and communication activities by the NRGC that would support its overarching aim, safe development and societal desirability of nanotechnology applications.

In sum, the NRGC should provide the public scientifically sound foundations for informed choices. It should however, not duplicate existing initiatives: As laypeople-oriented information platforms on nanomaterials already exist in Europe, the NRGC should aim to strengthen and support them. By "horizon scanning", monitoring of emerging discussions and communicating nanomaterial- or case-specific information the NRGC could provide added value: It could react to emerging topics and communicate what is known about the risks and safety of nanomaterials in question in the context of their benefits. Furthermore, the NRGC could develop and use easy-to-share information formats, pay attention and reach out to the aforementioned influencers and in this way strengthen the scientific voice in social media.

2 Description of task

The project Gov4Nano (2019-2023) develops a model of a "Nano Risk Governance Council" (NRGC). It emphasises safe development of nanomaterials, with a focus on key aspects for their risk governance, including risk assessment, risk management, risk perception and risk communication, risk-benefit evaluation, and risk-transfer and the societal desirability of nanomaterial applications. The Gov4Nano consortium works closely with the two other risk governance projects funded by the European Commission under the same NMBP-13-2018 call: RiskGONE and NANORIGO.

The aim of Task 3.1 of Gov4Nano is to identify and analyse elements, parameters and information that influence the risk perception of different civil society groups. The findings and recommendations of Task 3.1 feed into Task 3.4 "Conceptualization of civil society and insurance governance pillars" and into Work Package 5 of Gov4Nano, responsible for establishing the model for the NRGC – this way civil society's needs can be directly addressed while conceptualizing the Council.

In a first step of T3.1, existing studies on risk perception of nanotechnologies by different social and demographic groups were reviewed. These nanotechnology-specific findings were supplemented with insights from sociological risk research and results of risk perception studies focusing on other technologies, such as nuclear and energy technologies.

Based on this analysis, the first deliverable of T3.1 ("Report on parameters, elements and information forming and influencing the risk perception of different civil society groups") described the emergence of public risk perceptions of nanotechnologies and discussed four interconnected questions:

- The "Why" – Why do the risk perceptions of different civil society groups matter?
- The "How" – How do risk perceptions in civil society emerge?
- The "What" – What do we know about the risk-perception of different civil society groups?
- The "What next" – What to do about the risk perception in civil society?

Building on this understanding of the parameters that influence risk perception (of nanotechnologies), the next step of T3.1 consisted of developing concrete recommendations for the NRGC for communicating with the civil society. Considering the changes in media consumption of the general public, the role of social media and the implications it has for public communication of different institutions were emphasised. In this context, special attention was paid for crisis communication. The aim was to identify ways and formats how the NRGC could either itself interact with the general public or how it could support the communication of different stakeholders (public authorities, industry, research, CSOs) in situations where nanomaterials or their applications would become subject to increased public criticism or in outright crisis situations.

Keeping in mind that different public information platforms on nanomaterials already exist, it was discussed if and how the NRGC could complement the existing initiatives without duplicating them. In this deliverable report it is argued that targeted, nanomaterial- or case-specific communication by the NRGC would indeed be of added value for the general public. Building on in-depth expert interviews, concrete recommendations are given on possible formats and contents of public communication by the NRGC, as well as on establishing transparent, credible communication structures.

3 Description of work & main achievements

3.1 Background of the task

Task 3.1 aims to support the conceptualization of the NRGC by examining risk perceptions in the civil society and the information needs of laypeople when it comes to risks, benefits and safety of nanomaterials. The findings of T3.1 feed into T3.4 "Conceptualization of civil society and insurance governance pillars" in the NRGC. This way T3.1 contributes to the development of the model of NRGC by WP5 of Gov4Nano and ensures that civil society's needs are appropriately addressed through the NRGC.

3.2 Description of the work carried out

Task 3.1 combined methods of desk research and qualitative expert interviews. Drawing on deliverable 3.1 and an analysis of current public discussion patterns (e. g. in the context of the COVID-19 pandemic) DIALOG BASIS interviewed ten experts working in the field of public communication of nanotechnologies (representatives of existing consumer information platforms, industry, CSOs, public authorities) as well as bloggers and social media influencers not primarily focused on nanotechnologies. The list of potential interview partners and a set of main questions[1] were consolidated in beforehand with WP3 and WP5 partners in order to secure the relevance of the results for setting up the NRGC concept. The interviews were carried out as semi-structured interviews. In addition to the questionnaire, follow-up-questions were used for discussing the different topics and insights brought forward by the interview partners in detail. In agreement with the interviewees, the list of the individual interview partners and their organisational background are kept anonymous.

Based on the interviews, task leader DIALOG BASIS formulated eleven concrete recommendations for public communication of the NRGC. The recommendations were sent to the interviewed experts and WP3 and WP5 partners for comments. Although transparency and the development of a shared understanding were strived for, the recommendations and this deliverable report however are to be viewed as a synthesis by task leader DIALOG BASIS: The final recommendations do not necessarily represent the opinions of all individual persons and organisations involved. In the spirit of the close coordination between the other two NMBP-13 projects, the recommendations and the final "civil society pillar" could ultimately be consolidated in a joint expert workshop.

The working process as well as individual sources and findings were discussed in regular telephone conferences of Gov4Nano's WP3, where the WP partners provided valuable feedback for the analysis.

3.3 Results

3.3.1 Background – key findings of deliverable 3.1: Parameters, elements and information forming and influencing the risk perception of different civil society groups

Nanotechnologies, defined as one of the Key Enabling Technologies (KETs) by the European Commission (EC), have large potential to tackle societal challenges of our time. The EC concluded already in 2009 that nanotechnologies promise "radical breakthroughs in vital fields such as healthcare, energy, environment and manufacturing" (European Commission 2009). With the Horizon 2020 research and innovation programme, the EU has accordingly invested in

[1] The questionnaire can be found in the annex of this report.

nanotechnologies and the five other KETs of micro- and nanoelectronics, photonics, advanced materials, biotechnology and advanced manufacturing to boost the competitiveness and sustainability of European industry.

The question if the potential of nanotechnologies can be unlocked further does however not depend on their technological and economic potential only. The marketability of technological products is co-determined by their public perception. The risk-perception of different civil society groups ultimately influences technology developers' and companies' "social license to operate", the acceptability of their research and development efforts and marketed products.

Ever since the divisive public discussion on genetically modified organisms (GMOs), public attitudes towards emerging technologies have accordingly been subject to great interest. For nanotechnologies, technology developers and policy-makers feared direct adoption of arguments and communication patterns from the GMO debate and thus pursued a more proactive approach of dialogue and engagement (Fuchs & Gazsó 2014). Early awareness of public risk perception and stronger public engagement have been seen as keys for the aforementioned social license to operate.

In recent years, public engagement in technology development has been increasingly discussed under the term of Responsible Research and Innovation (RRI). As coined by von Schomberg (2011), RRI is a "transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)". It thus puts co-creation and mutual learning in the focus of the dialogue process.

The relevance of risk perceptions of different civil society groups can also be considered in light of the RRI concept. It points at three central reasons why risk perceptions of civil society – that should flow in the interactive innovation process and co-determine the social license to operate – matter:

- Acceptability: The use and marketability of a technology and its individual products ultimately depends on its (ethical) acceptability.
- Sustainability: The technology and its products should meet the requirements of economic, environmental and social sustainability. This is more likely if the concerns of civil society groups are heard.
- Societal desirability: The technology and its products should ultimately serve the society and address societal needs and preferences.

Defining civil society

Civil society can be defined as the realm for collective action of individuals around mutual interests, values and goals. It is often described as the "third sector", distinct from public and private sector institutions. In reality the lines between the three sectors are however often blurred. Civil society includes many different kinds of actors, who speak with different voices, contradict or cooperate with one another. Therefore, it is necessary to examine risk perceptions in civil society in the plural – there is no "civil society position" shared by all its parts.

In the context of nanotechnology, it is helpful to differentiate between laypeople and professional civil society representatives, i. e. civil society organisations (CSOs). The latter include environmental organisations, consumer organisations, trade unions, churches and religious organisations, which actively engage in the public discussion on nanotechnologies on global, European and national levels. In their work, professional CSOs represent their position in the

public discussion but also act as multiplicators. They influence the perceptions of the laypeople, both through their own campaigning work and appearances in the media.

Distinction between technical risk assessment and public risk perception

The emergence of risk perceptions in civil society have been studied extensively in social sciences. After Rachel Carlson's "Silent Spring" first thematised unintended side effects of technologies (Beck 1986) – in this case, adverse environmental effects of pesticides – accidents at chemical production facilities and at nuclear power plants increased the public attention to technology risks (Rayner 1992, Wildavsky & Dake 1990). The subsequent public discussions also highlighted the gap between "scientific", evidence-based risk assessment and the public perception of risks.

The scientific community – including the CSOs – commonly shares an understanding of risk as a function of hazard and exposure and generally agree to the principles of technical risk assessment. Risk-perception of laypeople however often follows different dynamics. In the past, the ability of laypeople to assess risks was often questioned: It was assumed that laypeople are characterized by "…a lack of understanding of risk, probability, statistics…" (Royal Society 1985, p. 15). This "deficit model" of civil society risk perception is no longer commonly applied. Instead, Renn & Beninghaus (2013, 307) conclude that "the observed discrepancy between the results of technical risk assessment conducted by experts and intuitive assessment of the same risk by non-experts is not, in the first instance, due to ignorance about the statistically derived expected values or an expression of erratic thought processes, but rather an indication of a multidimensional assessment process in which anticipated harm is only one factor among many factors". In other words, laypeople assess different risks just as "experts" do, however, in addition to technical risk assessment, feelings, values, personal experiences and preferences play a part here.

Risk research studies point here often to a distinction between self-selected and externally imposed risks. Self-selected risks are generally considered less dangerous. In this sense, Luhmann (1991) points at the general asymmetry between decision-makers and those who are affected by the decision in question. If we are exposed to a risk that we neither chose nor can influence, we tend to be more concerned. This is especially the case for so-called large-scale technologies such as chemical production units, nuclear energy, and genetic engineering (Beck 1986). "These technologies are characterized by the potential to have major physical and social impacts on the natural and cultural environments, by the need to make collective decisions with respect to regulation and risk governance, and by the experience of the potential side effects by those who neither directly approved these technologies nor immediately benefit from them" (Renn et al. 2013, 294). As Ulrich Beck describes with his notion of risk society, we live among interconnected, overlapping technologies and infrastructures but are no longer in a position to understand their diverse interactions and interconnections. As new technologies are introduced to us by their developers and not "chosen" by ourselves, it is natural to observe them as new risks we are being exposed to.

Determinants of individual risk perception (of nanotechnologies)

The project Nanoview of the German Federal Institute for Risk Assessment (BfR) differentiate in their overview of studies on public perception of nanotechnologies four factors (categories) that influence the perception of nanotechnology: **object-related factors, sociodemographic factors, psycho-social factors and others** (Correia Carreira et al. 2013).

The first category, **object-related factors**, encompasses one`s knowledge about and familiarity with nanotechnologies and general knowledge of science and technology. Here the direct perception of risks and benefits of nanotechnologies and of their applications play a part. Different studies on risk perception confirm that familiarity with the technology in question has a positive

effect on its acceptance. General interest towards new technologies, manifested for example in the use of scientific media, also correlates with fewer technology-related concerns (ibid., 26-28).

Sociodemographic factors such as gender, age, education, income, ethnicity or migration background also play a part. Nanoview summarises general findings in this regard: Men tend to be more positive towards new technologies and their benefits than women, who in turn emphasise risks more. Gender, age and – perhaps surprisingly – education are not seen as dominant factors influencing the individual risk perception. Different studies have delivered mixed results: Whereas some studies observe a strong correlation between higher levels of personal education and higher estimations of the usefulness of nanotechnologies, other studies detect no significant influence (Correia Carreira et al. 2013, 30-31).

Psycho-social factors illustrate different aspects of one's personality structure. Our attitudes towards technological developments are influenced by our values, beliefs, societal and cultural backgrounds. Consequently, studies on risk perception take factors such as religion, general stance towards technology or nature, trust in public or scientific institutions and political attitudes into account. The fact that different individuals and social groups assess risks differently – even when provided with the same information – implies an internalised selection of information and highlights the impact of personality and cultural structures in risk assessment (Renn 2014, 303).

Other factors that influence individual risk assessment include one's role as a layperson or as an expert and the use of media. As described before, the risk perception of laypeople differs from that of experts. In addition to factors such as personal knowledge and familiarity with technology in general and with the individual technology in question, laypeople tend to put more focus on the severity of possible damages rather than on the probability of their occurrence (Renn 2008).

On the use of media, af Wåhlberg & Sjöberg (2000) described in their meta-analysis of studies on risk perception and media the way media affects risk perception. According to them, the role of media is often exaggerated: Media content is often far from objective when it comes to risks, but also far from being as biased as often thought. Of the different biases the media is prone to, neutrality bias or "false balance", might be most common. In trying to be neutral or in deliberately building tension and suspense inside their articles or commentaries, journalists give voice to arguments that represent opposing views on an issue – even though (scientific) evidence may clearly point in one direction. Considering the ever-stronger competition between different traditional and social media there are indications that sensationalism – coverage of exceptional positions or polarisation of views – has increased in the media. Whereas deliberate attempts to spread of misinformation are still not common, media can be criticised for giving voice to positions that do not reflect the current opinion of the scientific community. In fact, media's most fundamental way of altering people's risk perception may be through sheer availability: by the number and vividness of articles or features covering specific issues and viewpoints.

Role of framing

As the role of media highlights, risk perception does not take place in a vacuum but in an interplay with the surrounding society. As Simon (1987) points out, people are able to process only a limited amount of information and therefore interpret different phenomena always in a biased way. After Goffman (1974), this process has been called framing: Interpretative frames can define the issue in question, diagnose its causes, make normative assessments of it and suggest ways for solving it (Entman 1993, Kinder 1998).

Despite the reservations of af Wåhlberg & Sjöberg (2000), in today's interconnected society media plays a central role as creator and conveyor of frames. As Iyengar (1996) notes, framing in media

coverage has a strong impact on how people view different societal problems, e. g. what kind of solutions people attribute to different problems and whom they consider responsible. In addition, the frames people become accustomed to influence their interpretation similar issues in the future too. With the emergence of social media and new communication channels, framing through mass media might have lost some of its power. The dynamics of framing in the media however remain the same: Traditional media is only complemented and challenged by new "influencers".

To conclude, framing can be seen as an overarching layer that influences the interplay between the different determinants of individual risk perception. Considering nanotechnologies, it is important to note that knowledge and familiarity with nano represents only one – albeit important – corner of the quadrate. Information provision does therefore not automatically lead to a more positive perception of opportunities and risks: The new information is rather interpreted in the different frames and in interplay between the other factors.

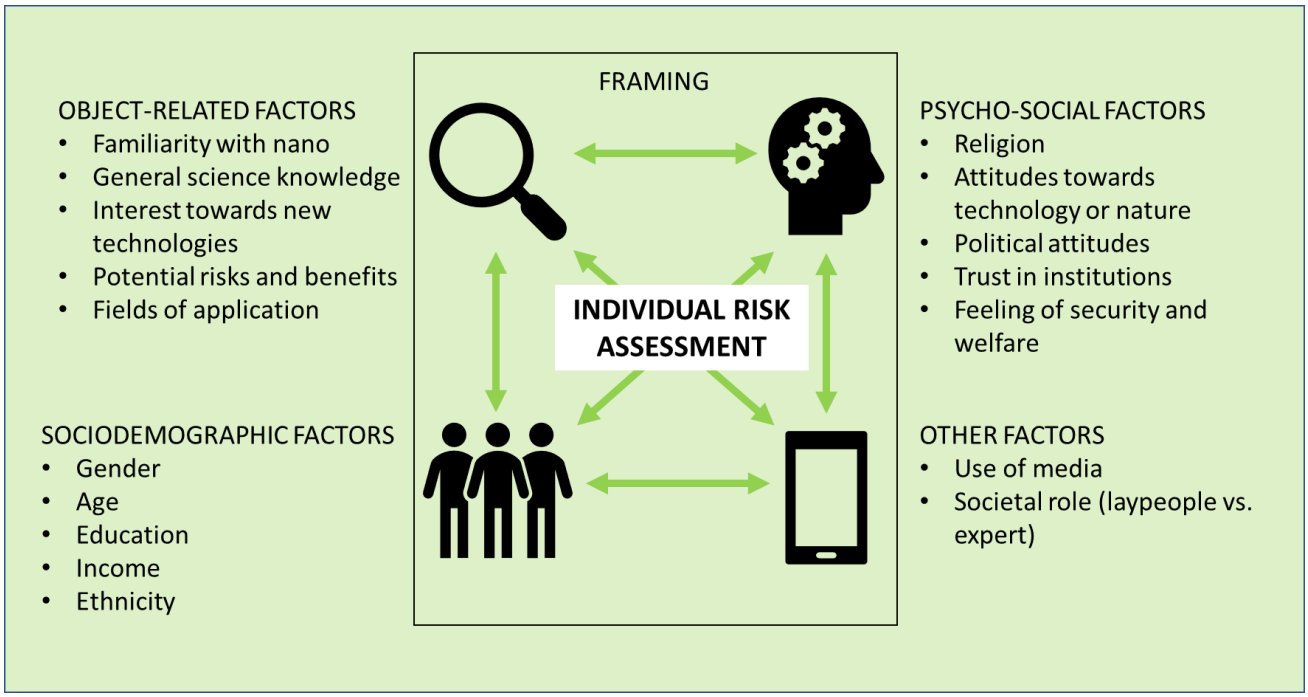

Figure 1: Determinants of individual risk perception in the context of nanotechnologies

Risk perception of nanotechnologies

Public opinions of nanotechnologies have been frequently assessed by means of qualitative and quantitative studies. In its overview in 2013, the German project Nanoview identified 88 international studies on public perceptions of nanotechnologies published after 2000 (Correia Carreira et al. 2013). The studies cover the public knowledge on nanotechnologies, general attitudes towards nanotechnologies in general as well as towards individual fields of applications, valuation of risks and benefits as well as the use of different channels of information.

It is important to note that many surveys confirm that **laypeople know relatively little about nanotechnologies** (e.g. TNS Opinion & Social 2010, 33). It can thus be argued that their individual risk-perceptions are not fully "nano-specific": In addition to the knowledge laypeople have on nanotechnologies, their risk perceptions echo their general attitudes towards new technologies and other societal risks as well as their individual experiences and values.

The awareness of nanotechnologies varies significantly in the EU27 and in other European countries. Whereas 46% of all Europeans have ever heard of nanotechnologies, awareness levels are considerably higher in Scandinavian (Norway 78%, Denmark 77%, Sweden 76%) than in Southern European countries (Turkey 25%, Malta 22%, Portugal 21%). In addition to nationality, gender, education, occupation and internet use are influencing factors. Men, those who studied until 20+ years of age, white-collar workers, managers or students and people who use internet regularly are more likely to have heard of nanotechnologies (TNS Opinion & Social 2010, 33-35).

The **public perception of nanotechnologies is generally more positive than that of many other emerging technologies** (Correia Carreira et al. 2013). In the Eurobarometer, 41% of Europeans consider nanotechnologies to have a positive and only 10% a negative effect on our future way of life (Gaskell et al. 2010). With these figures nanotechnologies are in the middle: They are associated with less positive impacts than energy technologies (solar or wind energy), information technologies, brain and cognitive enhancement or biotechnology but with less risks than biotechnology or nuclear energy. It needs however to be noted that 40% of Europeans replied that they didn't know about nano – a figure much higher than for other technologies examined.
The Eurobarometer further asked a number of questions on what kind of an impact nanotechnologies might have: Whether they would bring economic benefits, help people in developing countries, do no harm to the environment and so on. Again, the views are less developed than for other technologies, with high proportions – 31 to 44% - of "don't know"-responses for all questions asked. **Economic benefits are considered highest** with 49% Europeans agreeing to the statement that nanotechnologies are is good for the national economy. At the same time 50% Europeans agree to the statement that nanotechnologies benefit some people but put others at risk. 29% Europeans view nanotechnologies as not safe for future generations, 37% as not good for oneself and one's family and 33% as harmful to the environment (TNS Opinion & Social 2010, 38).

When comparing the expressed attitudes with the socio-demographic data, the Eurobarometer again confirms large differences between European countries. National awareness levels and public attitudes seem to coincide especially when it comes to economic impacts and personal good. If we take Norway – the country with the highest awareness of nanotechnologies in Europe – as an example, we observe that Norwegians (those who expressed an opinion) tend to think that nanotechnologies are good for the Norwegian economy and to disagree with the statement that nanotechnologies would not be good for them and their family. The Portuguese – more often unaware of nanotechnologies – see less benefits for their national economy and also more often consider nanotechnologies to be not good for them and their families (ibid., 40-42).

Higher awareness levels do not however equal with uncritical attitudes. **Awareness of nanotechnologies rather contributes to an awareness of both benefits and risks**: Scandinavians with high awareness levels agree more often than their Southern European counterparts that nanotechnologies benefit some people but put others at risk. The concerns related to adverse health and environmental impacts are higher in the "more informed" countries too (ibid., 45-50).

Considering the different application areas, food and food packaging count as the areas, where public attitudes have most often been observed. Whereas the applications in the food sector are viewed with scepticism, products that are not used close to the human body are generally seen more positively (Correia Carreira et al. 2013). This general pattern illustrates that people tend to emphasise risks to individual health rather than e. g. more general environmental risks of nanotechnologies.

In its overview the project Nanoview also confirms the effect of framing. It differentiates between unaided and aided attitudes – whether respondents of a survey were given information about nanotechnologies before being asked for their assessments of them. **If laypeople are not provided with initial information on risks and benefits of nanotechnologies before their opinions are asked, they are unaware of possible risks and largely positive**. Once questions are however prepared and possible (positive and negative) impacts of nanotechnologies introduced before asking, the citizens become more wary. Framing has therefore a decisive role: The more the risks are mentioned, the more negative attitudes laypeople convey (Correia Carreira et al. 2013, 20).

3.3.2 Recent developments in the public attention to nanomaterials

Applying a text-mining analysis of scientific publications assigned to subject categories of biotechnology and nanotechnology, Friedrichs (2018a) found out that the focus of nanotechnology research has changed significantly over the past 20 years. Nanotechnologies entered the limelight as a curiosity-driven, essentially materials-related field of research. In the last decades, the field of nanotechnologies has however broadened and morphed into a an "enabling technology", applied in many industrial sectors and devices. At the same time, the use of nanotechnologies as a buzzword has declined. Nanotechnologies are no longer a central campaigning issue for CSOs and media articles on "nano" have become scarcer. A look into Google search queries with the Google Trends online tool confirms the trend: Since 2004, queries with the keyword nanotechnologies have dropped steadily.

Figure 2: Changes in Google queries for "nanotechnologies" in 2004-2019 (percentages from the peak (100%) in 1.1.2004, Source: Google Trends)

This development is not necessarily negative. First of all, changes and cycles in the public attention a technology or an issue is subject to can be considered normal (e.g. Downs 1972). The potential or public acceptance of a technology does not directly depend on the public attention it receives.

The lack of recent assessment of public perceptions can be attributed to the fact that very few national governments today support nanotechnology development with nano-specific research or funding programs. In her analysis of Science, Technology and Innovation (STI) policies of the past three decades Friedrichs (2018b) also found that nanotechnology policies have to a large extent shifted from "technology-push" to "application-pull" policies, i. e. they focus on specific applications instead of the entire technology field or its sub-fields. After the largest number of technology-push policies for nanotechnology was launched in 2006, the emphasis of policies has changed. According to Friedrichs, this development is to common to emerging technologies: Whereas technology-push policies are favoured for young technology fields, application-pull policies tend to be applied to more mature fields. The shift in public policies goes hand in hand with the notion of nanotechnologies having developed into an almost omnipresent "enabling technology", which in itself is however not in the focus of public attention.

The described developments of nanotechnologies and of the public discussion can be described as a self-reinforcing circle: Less nano-specific STI policies lead to less public attention and focus on public perceptions – and ultimately, to less nano-communication.

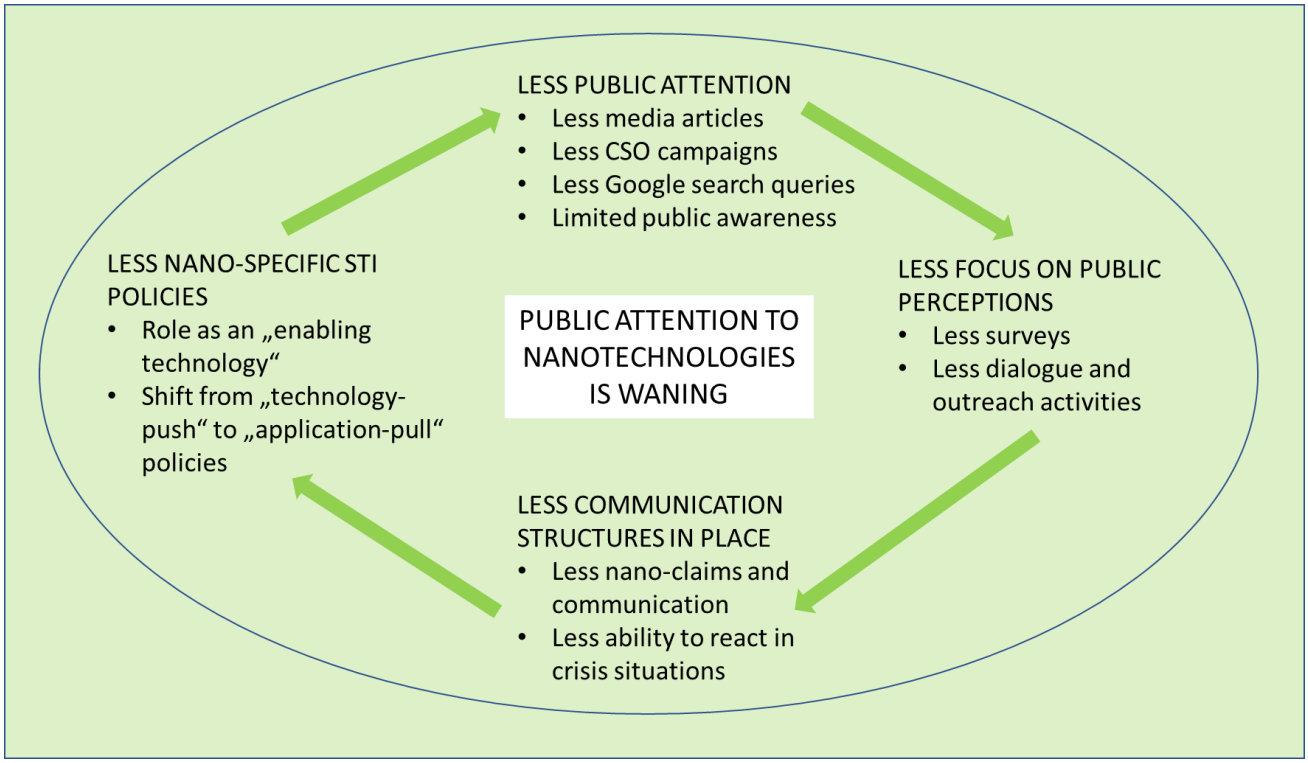

Figure 3: Waning public attention to nanotechnologies

Some experts interviewed in task 3.1 do however not confirm that the public interest on nanomaterials would have completely disappeared. Laypeople-oriented information platforms such as the European Union Observatory for Nanomaterials (EUON) or DaNa 2.0 have gained more visitors in the last years, although the visitor numbers have not rocketed. At the same time, representatives of the information platforms point out that the interests of the visitors have somewhat changed: Rather than searching for general information on nanomaterials, they pose more specific questions on the risks and safety of individual materials or applications. This goes in line with the aforementioned shift in STI policies and the decline of nano as a buzzword.

Although the public perceptions have remained positive, the position of nanomaterials under the public radar poses certain risks. Thanks to their diversity and role as an enabling technology it is hard to imagine that nanomaterials as a whole would become subject to extensive public criticism. However, because of the diversity, it is possible that some nanomaterials return to the focus of (negative) public attention.

This has to some extent already been the case with titanium dioxide (TiO_2), although the public discussion has not primarily been nano-specific. TiO_2 has been produced industrially for more than 100 years and used extensively in cosmetics, pharmaceuticals and in food under the classification E171. In May 2015 it became subject for public debate, as the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) handed in an application to European Chemicals Agency (ECHA) for classifying TiO_2 in a more severe category (1B) of carcinogenicity. After the European Food Safety Authority (EFSA) in its scientific opinion concluded that E171 could no longer be considered as safe when used as a food additive (EFSA 2021), EU Member States agreed in October 2021 on a proposition of the EC to ban E171 from all food products.

In this context it can be discussed *how much laypeople really need to know about nano.* The fact that most Europeans know very little about nanotechnologies easily leads to the conclusion that all Europeans should be provided with more information about them. At the same time, it can be argued that there is no inherent need for laypeople to know about technological developments that are anyhow regulated by European public institutions. Furthermore, different information channels on nanomaterials – starting from the European Union Observatory for Nanomaterials (EUON) – already exist and anyone interested can access these platforms. However, in times of sensationalist media, polarizing debates on social media and the emergence of new civil society actors and so-called "influencers" the need for reliable, transparent information on risks and benefits of nanomaterials is by no means disappearing. Everyone interested should have the opportunity to make informed choices based on scientific knowledge. In order to fulfil this task, the existing communication channels need to be reviewed and complemented, if required.

3.3.3 Recent developments in the public discussion of emerging technologies

The breakthrough of internet has opened new possibilities for civil society actors to initiate broader public discussions and for laypeople to participate in them. Online-based campaigning platforms such as Avaaz, Campact, Change.org, iPetitions or the EC's European Citizens' Initiative have made it possible for laypeople to start and spread petitions European-wide or even globally. Start-ups develop and launch apps that help to scan consumer products according to different criteria and link concrete products to public information on their chemical ingredients (e. g. CosmEthics or ToxFox). In 2021, the EU itself reached out to Europeans simultaneously in all member states and asked for their concrete recommendations for its future in the "Conference on the Future of Europe" (EC 2021).

The emergence of social media has however led to most profound changes in the public discussion of technological developments. Different celebrities, bloggers and even private persons gain double-digit million online audiences for their messages on Instagram, TikTok, Twitter or YouTube – audiences that many public, private and civil society organisations would be envious of. Considering the constantly growing level of digital media consumption, such social media "influencers" have gained considerable relevance in marketing products and brands (Wielki 2020). Whereas posting online to a significant audience can be seen as a "minimal requirement" for influencers, Gorécka-Butora et al. have provided a more extended definition: "influencer is an opinion leader, who, with his or her credible actions – currently conducted more and more often on the Internet – inspires trust, engages and convinces the addressees of his or her communication to make specific choices, such as those related to shopping, nutrition or worldview" (Gorécka-Butora et al. in Wielki 2020).

During the COVID-19 pandemic and the public discussion on COVID-19 vaccines, at the latest, different influencers and influencer marketing have gained more and more relevance in political and technological discussions as well. Different influencers have posted their views on the severity of the pandemic and on the necessity of vaccination, drawing on very diverse sources, scientific knowledge and worldviews.

Furthermore, public institutions, anti-vaxxers and politically motivated parties all tried to win influencers over to their side for conveying their messages. In the US, the White House reached out to more than 50 YouTubers, TikTokers and Twitch streamers with the request to help promote the vaccine, and state and local governments initiated similar campaigns with "local micro influencers" with 5.000 to 100.000 followers (New York Times 2021). In Germany, the federal government adopted a similar influencer strategy, which was however widely criticized for a lack

of authenticity and backfired under negative media coverage (FAZ 2021). Finally, both in Germany and France, influencers were offered money for spreading false information on deaths caused by the Pfizer/BioNTech vaccine – trails leading to Russia (Guardian 2021).

Whereas direct causation between influencer marketing and getting vaccinated is yet to be shown, the potential of influencers cannot be neglected. The influencer marketing platform HypeAuditor has analysed their possible impact via Instagram in Germany. According to HypeAuditor (2021), between January and August 2021, over 2.000 German influencers with more than 1.000 followers published a total of 9.077 Instagram posts with hashtags related to COVID-19 vaccination. In total, these posts reached an audience of almost 18 million people – over 20 per cent of the German population. Keeping in mind that over two thirds of Instagram users are aged between 13 and 35 years (Statista 2021) – and thus belong to age groups that are more and more difficult to reach by means of traditional media – the potential of influencer marketing in these age groups as immense. In Germany, 30 percent of 18-to-24-year-olds cite social media as their most important source for news, with the proportion rising constantly (Hölig & Hasebrink 2020).

Wielki (2020) and Bause (2021) both attribute the relevance of social media influencers not only to their large audiences, but also to the issue of trust: Influencers who share similar worldviews and values as people following them and who consciously construct a community-like environment on their social media channels, are often considered peers. They are seen as authentic, part of the same social group or even "people like myself". At the same time, many studies point out that information shared by peers is trusted stronger than information from unknown (or even official) sources. Accordingly, politically oriented social media influencers with distributed or self-produced political content may strengthen or considerably challenge political and scientific communication of public institutions.

What kind of implications do these developments then have for the public discussion of nanomaterials? The breakthrough of social media communication and campaigning platforms has made it possible for a much larger number of actors to strengthen and raise issues to the public agenda. In addition to established CSOs, who traditionally have been the "voice" of the civil society, laypeople now have the tools for starting and strengthening discussions or campaigns that may well go viral in today's social media society. Unlike professional CSOs, laypeople however do not necessarily share the principles of technical risk assessment. As discussed above, they are often rather influenced by object-related, sociodemographic and psycho-social factors. This leads to more unpredictability in terms of public discussion and agenda-setting by the civil society: Domains that were previously left for scientific experts are discussed by people with limited scientific background.

At the moment nanomaterials are not in the focus of social media discussions or most influencers. However, considering the diversity of nanomaterials themselves and their individual uses, it is possible that some nanomaterials or applications gain more public attention or direct criticism. For crisis situations, appropriate communication structures need to be in place so that institutions such as the NRGC may respond to issues from the civil society and changes in the public opinion.

3.4 Recommendations for public communication by the NRGC

In the light of above, possibilities for public communication by the NRGC were discussed in qualitative expert interviews with representatives of the industry, civil society and public authorities.

For the interviews, a case was first made for involving professional CSOs directly in the NRGC. As CSOs represent legitimate interests of the European public, their involvement would contribute to the quality of work and the legitimacy of the NRGC. As all interview partners fundamentally agreed on this notion – although the structure and objectives of the possible Council were still under discussion – the following recommendations pertain *lay-people-oriented public communication*.

1. **The NRGC should provide scientifically sound foundations for informed choices.** The possible public communication by the NRGC should be in alignment with its overall mission: Fostering safe and sustainable development, use and disposal of (products containing) nanomaterials in Europe. In this sense, the communication should provide scientifically sound foundations for a transparent public discussion on nanotechnologies and nanomaterials. For laypeople, this means in the end being able to make informed choices. Interested persons should be able to receive sound information and not have to resort to dubious sources.

2. **The NRGC should not duplicate existing initiatives.** As laypeople-oriented information platforms on nanotechnologies (EUON, DaNa 2.0) already exist in Europe, setting up another consumer information platform by the NRGC is however not needed. Rather, the Council should support the existing initiatives, link and refer to them on its website.

3. **The NRGC could monitor public discussion on nanomaterials and nanotechnologies and provide foresight.** At the moment nanomaterials and nanotechnologies are viewed mostly in a positive or a risk-neutral way. The recent discussion on the regulation of titanium dioxide (TiO_2) serves however as an example that individual nanomaterials might become focus of public attention in the future. The NRGC could support the work of stakeholders by means of "horizon scanning" and identify possible emerging topics. In addition to expert debates, such monitoring should include mass and social media as well.

4. **Based on this monitoring function, the NRGC could react to emerging topics and communicate what is known about the risks and safety of different nanomaterials in the context of their benefits.** Many interviewed stakeholders point out a need for more nanomaterial-specific communication in addition to the basic information on nanotechnologies already available. The representatives of existing information platforms also confirm that the website visitors more and more often pose specific questions on the safety of individual materials or applications.

   The aforementioned horizon scanning would allow the NRGC to communicate in a dynamic way and provide information on topics currently discussed in the public. Building on its planned portal, the NRGC could compile and communicate what is known about the safety of different nanomaterials – especially in situations when specific materials attract more public attention. The communication should not place nanomaterials under general suspicion, but in a nuanced, yet easy-to-understand way describe the current knowledge about the safety and risks of the material in question. The "knowledge base" of the German platform DaNa counts as Best Practice.

5. **The NRGC could develop and use easy-to-share information formats.** In addition to the topical communication described above, the NRGC could complement the existing information platforms with new, easy-to-share information formats. Smartphone-compatible infographics, factsheets or explanatory videos reach often wider audiences than traditional websites.

6. **The NRGC could use social media.** Presence on relevant social media platforms is a prerequisite for effective dissemination of information. Here a distinction can be made between platforms predominantly used by experts (Twitter, LinkedIn) and laypeople (Facebook, Instagram, YouTube, Reddit): Whereas the former can be used for disseminating the work of the NRGC to the expert community, the latter can serve as platforms for laypeople-oriented topical communication. Social media presence would also allow laypeople to get easily in touch with the council, although engagement in discussions on social media platforms by the council staff should be considered carefully.

   In addition to established platforms, monitoring of emerging social media is also advised. TikTok serves as an example: After an explosive increase in active users, political content on the platform has increased as well – making the platform more and more relevant for different institutions. Even though the platform would not today be relevant for public discussion on nanomaterials, this might change.

7. **The NRGC could pay attention to influencers.** On social media, institutions rarely enjoy the most attention. Heavily followed YouTubers or TikTokers have audiences many public institutions can only dream of, especially in younger age groups. For this reason, even the White House in 2021 reached out to such "influencers" in order to promote COVID-19 vaccines. Although nanomaterials hardly are a topic for most influencers, a similar logic can be applied: YouTubers or Bloggers focusing e. g. on consumer or health issues attract considerable audiences and serve as multiplicators – for more or less founded views. If (individual) nanomaterials would gain strong public attention, influencers taking part in the discussion would play an important part and could be provided with specific information.

8. **The NRGC should make its laypeople-oriented communication available in different European languages.** Whereas the expert community can be informed in English, language is always an issue if the general public – especially less-educated groups – are addressed. The information directed at laypeople should therefore be made available in as many European languages as possible.

9. **The NRGC should allocate resources for its communication activities.** All the possible aforementioned activities, from horizon scanning to topical communication and development of new information formats, require personnel resources. Depending on formats chosen, the scientific expertise of the NRGC would need to be complemented with journalistic and graphic design competences. If the council would become active in laypeople-oriented communication, resources should be allocated for this task.

10. **The NRGC should have its communication activities evaluated regularly.** The evaluation of communication activities is not always straightforward: If fostering transparent public discussion on nanomaterials is seen as the primary goal of the Council's communication activities, this cannot be measured just by mere numbers of press releases, social media posts or subscribers. Rather, a qualitative evaluation of the Council's role in the public discussion on nanomaterials – also compared to other institutions active in public communication – is called for.

11. **The NRGC should be transparent on itself.** On its website the Council should provide easy-to-understand information on "Who we are" and "What we do". It should be pointed out that the trustworthiness of the NRGC in the eyes of the public is strongly coupled with its mandate and organisation. When information about nanomaterials is considered,

European citizens trust scientific organisations, national health and safety authorities and NGOs most. The involvement of these stakeholders adds directly to the credibility of the Council. Beyond that, a science-based way of working and transparency on the working mechanisms (how the NRGC would come to its conclusions or recommendations) are important.

As many Europeans mistrust the industry when it comes to nanomaterial safety, it needs to be noted that the services the NRGC might offer to the industry can also affect its credibility in the public's mind. The NRGC should be fully transparent about its services and funding and to organisationally separate its public communication activities from its possible consultancy work.

The previous recommendations were formulated by task leader DIALOG BASIS as a synthesis of the interview results. Although the recommendations were sent to the interviewed experts for consolidation, they do not necessarily represent the opinions of all individual experts involved.

3.5 Evaluation and conclusions

Any public communication by the NRGC depends on the aims and strategy the Council would adopt. The aforementioned communication activities would furthermore need to embedded in the Council's structure: Effective public communication requires allocation of necessary resources and qualified staff. As discussions on the possible structure and implementation of the NRGC were ongoing at the time of writing of this deliverable report, the recommendations could be reviewed once these are clarified. Ultimately, they should be consolidated in the overall communication strategy and "civil society pillar" of the council.

In general, two audiences – with different interests – can however be identified for the NRGC and its communication activities:

- **Stakeholders from the industry, public authorities, scientific organisations and CSOs** count as primary audience of the NRGC. They would need to be informed about its work, the services, tools and recommendations the NRGC would provide.
  The general public on the other hand cannot be expected to be widely interested in the work of the Council. If the NRGC is to communicate to the general public, the focus of this communication should be set on the safety and risks of nanomaterials in relationship to the benefits of these materials.

Although it would be possible for the NRGC to communicate exclusively towards the expert community and stakeholders, in this deliverable report it has been argued that the NRGC would do wise to monitor public discussion and communicate towards the general public as well. Not only would this strengthen the existing information channels in the sense of allowing informed choice, but also contribute to trust and societal acceptability of nanomaterials and related products.

4 Deviations from the work plan

There were no deviations from the work plan.

5 Performance of the partners

The deliverable report was compiled by DIALOG BASIS, task leader for the T3.1 of Gov4Nano. The working process as well as the questions for the in-depth interviews, individual interview partners and findings were discussed in regular telephone conferences of Gov4Nano's WP3, where the WP partners provided valuable feedback for the analysis.

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7 List of abbreviations

ANSES: French Agency for Food, Environmental and Occupational Health & Safety

BfR: German Federal Institute for Risk Assessment

EC: European Commission

ECHA: European Chemicals Agency

EFSA: European Food Safety Authority

CSO: Civil society organisation

GMOs: Genetically modified organisms

KET: Key enabling technology

NRGC: The risk governance council for nanotechnologies

RAC: Committee for Risk Assessment

RRI: Responsible Research and Innovation

STI: Science, Technology and Innovation (policies)

TiO2: Titanium dioxide

Appendix: Questionnaire of the in-depth interviews

- How do you assess the current public discussion on nanomaterials, nanotechnologies and their applications in Europe?
    - Are there any ongoing public discussions on specific applications or topics related to nanotechnologies that you consider relevant?
    - Although nanotechnologies are at the moment perceived more positively than many other emerging technologies – or at least in a risk-neutral way – it is possible that individual applications of nanotechnologies can quickly become focus of public attention. Do you agree on this statement? What kind of topics or arguments could emerge in the future?
    - Based on your experience, which factors could lead to sudden changes in current public attitudes?
- How do you assess the public information on nanomaterials, nanotechnologies and their applications that is currently available in Europe? Both in terms of content and formats/media? Do you see general or specific needs? Are there any significant gaps or bottlenecks?
    - Considering safe development of nanomaterials, how / what should be communicated to the general public on their risks?
- How do you assess the changes that take place in other spheres of public discussion ("fake news" debates, emergence of social media, online campaigning platforms, YouTubers and "influencers")? Do you see implications for the public discussion on nanomaterials, nanotechnologies and their applications?
    - Is there a need for more reliable sources of information on nanotechnologies – either for consumers or the aforementioned influencers and multiplicators?
- Do you see a need or a role for the NRGC in terms of public engagement on nanotechnologies?
    - How could the NRGC possibly support transparent and informed public discussion on nanotechnologies?
    - How could it be ensured that the NRGC is seen as a reliable and trustworthy source of information?
- Are there examples you would consider "best practices" of modern public communication of technological innovation (especially in terms of social media) – also from other technology fields?
    - Are there any examples of successful modern crisis communication – e. g. after unforeseen events, accidents, unexpected concerns or fake news, or whatever could be?

The interviews were carried out as semi-structured interviews: In addition to the questions listed above, topics that were brought forward by the interview partners were discussed further with follow-up-questions.