



DELIVERABLE

1.3

Stakeholders engagement in nanotechnologies: areas and issues for a dialogue

*SUMMARY OF INTERVIEW FINDINGS,
WITH A FOCUS ON THE FOOD, HEALTHCARE AND THE ENERGY SECTOR*



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Abstract

The GoNano project aims at promoting responsiveness in research and innovation on nanotechnologies through societal engagement in three specific areas: food, health and energy. In the first phase of the project, about fifty stakeholders with different roles in the R&I value chain were interviewed. A part of these interviews was dedicated to discuss the main technological developments in the three sectors, in order to highlight the potential applications with significant impact on society and the issues that could be relevant to discuss in public debates. A second part of the interviews focused on experiences in co-creation, stakeholders' engagement and mutual learning in technology developments, and nanotechnologies in particular. This report describes the methodological approach of all the interviews, and the outcomes of the first set of interviews. Results of the second set of interviews are summarized in GoNano deliverable 1.1.

Interview findings include examples of applications using nanotechnologies in the sectors of food, health and energy, with particular focus on short to medium term product solutions. Both common, and sector specific issues have been identified. For example, interviews show that, for stakeholders, regulatory uncertainties on nanomaterials are almost equally relevant for all sectors, while aspects related to public and stakeholders' risk perception varies across sectors. Several aspects underlined by stakeholders are related to social impacts of technology developments of specific applications, and are not nano-specific.

Most of the experts interviewed show interest in being involved in dialogue activities, such as the one organized by GoNano.

The report is divided into six sections: introduction, methodology and panel description, one section for each of the three pilot sectors (food, health and energy), a section on cross-sectoral aspects, and a final part on stakeholders' expectations and interest in GoNano activities.

Table of Content

1.	Introduction	5
1.1.	Panel description	5
1.2.	Structure of the report	7
2.	Food sector	8
2.1.	Applications	8
2.2.	Key issues	9
2.3.	Questions to debate	9
2.4.	Stakeholders to engage	10
3.	Healthcare sector	12
3.1.	Applications	12
3.2.	Key issues	13
3.3.	Questions to debate	14
3.4.	Stakeholders to engage	15
4.	Energy sector	16
4.1.	Applications	16
4.2.	Key issues	16
4.3.	Questions to debate	18
4.4.	Stakeholders to engage	19
5.	Cross-sectoral aspects	20
5.1.	Innovation and RRI	20
5.2.	Nanotechnologies.....	21
5.3.	Dialogues	21
6.	Expectations and interest in GoNano	22
7.	Conclusions	25
8.	Annexes	27
8.1.	Interviews questions	27
8.2.	Interview participant details	29
8.3.	Interview information sheet.....	31
8.4.	Interview consent form	32

1. Introduction

The GoNano project aims to improve the responsiveness of research and innovation processes to public values and concerns, focusing on the application of nanotechnologies in the three sectors of food, healthcare and energy. This goal will be pursued through a structured co-creation process involving researchers, citizen and stakeholders, acting as change agents for the nanotechnology research and innovation system. Three co-creation “pilot” activities will be performed, one for each of the sectors, using a multi-step engagement process.

The aim of the semi-structured interviews analyzed in this report is to inform the work of the pilot activities, collecting:

1. experiences from representatives of previous EU and national engagement projects with respect to public and stakeholder engagement, co-creation exercises and mutual learning activities that aim to involve society in research and innovation;
2. views and perspective of experts on future nanotechnology developments and their potential impact on society, and the role of public and stakeholder engagement in improving research and innovation processes (with a focus on the food, healthcare and energy sectors)

The second group of interviews has also been instrumental to network with stakeholders that could support and participate in the pilot activities. The interview guidelines for groups one and two are reported in the annex. This report focuses only on the analysis of interviews related to the second group of interviewees. Information gathered from interviews related to the first group have been complemented by desk analysis of on-going EU and national engagement projects (GoNano task 1.1.) and overall results are reported in deliverable D1.1. of the GoNano project.

Analysis of group 2 interviews is complemented by a screening of policy initiatives on nanotechnologies from both governments and industrial networks, as performed in work package 5 of GoNano (deliverable 5.1). Moreover, a specific networking action will continue throughout the project duration to support and follow up connections identified and created from the interviews. All information collected will feed into the development of the methodology for the pilots (work package 2 of the GoNano project) and the work of the pilots (WP2, 3). Some interviews have also been edited as short videos that will be made available in the project website.

All partners of the GoNano project have contributed to the identification, selection, interview and analysis of results.

1.1. Panel description

Overall, a panel of more than 150 experts has been initially identified for the interviews, based on inputs from all partners of the GoNano project. A selection has been made considering relevance compared with the objectives of GoNano, expertise in the three sectors of application, and type of stakeholder. Additional criteria included ensuring a good country coverage and gender balance. The stakeholders involved in the first group of interviews include practitioners in RRI, co-creation and societal engagement, and policy makers and experts that have been involved in citizen’s debates on nanotechnologies.

The respondents of the second group have been selected within different categories of stakeholders, including R&I players (both companies and public research), R&I networks and European Technology Platforms, R&I sponsors, policy, civil society organizations and end-user representatives.

Overall, 46 interviews have been performed, involving people from 14 countries, 35% female and 65% male.

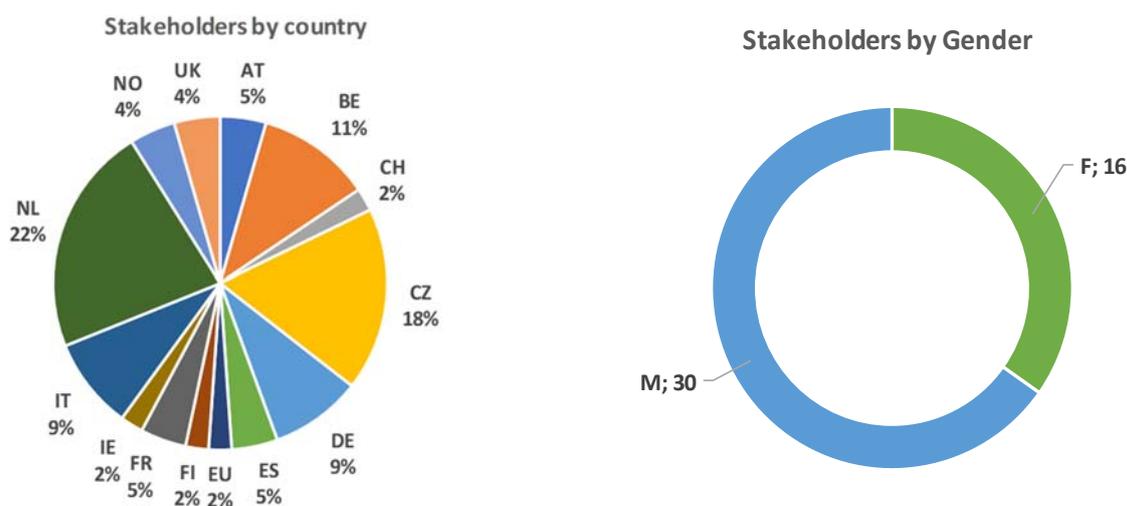


Figure 1: country and gender of stakeholders involved in interviews

Group one includes 19 interviews, representative in terms of the different type of stakeholders and expertise relevant for GoNano, as shown in the graphs. A description of the individual respondents in group one is given in Table 1 in the annex (identified by a progressive code ranging from G1.1 to G1.19).



Figure 2: type and expertise of stakeholders involved in group one interviews

Group two includes 27 interviews, representative in terms of the different type of stakeholders and sectors relevant for GoNano, as shown in the graphs. A description of the individual respondents in group two is given in Table 2 in the annex (identified by a progressive code ranging from G2.1 to G2.28).

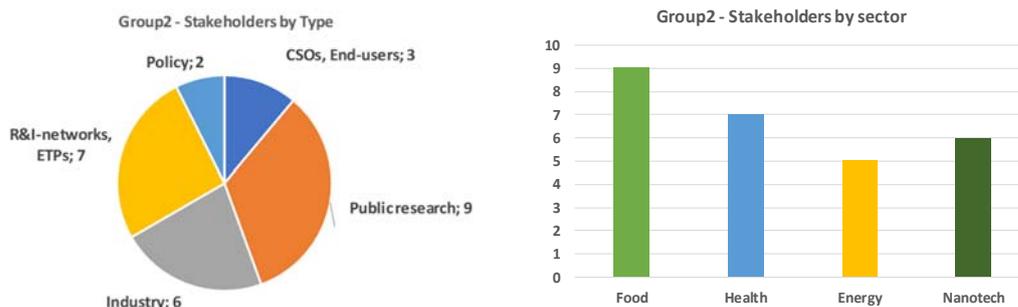


Figure 3: type and expertise of stakeholders involved in group two interviews

1.2. Structure of the report

Data collected in interviews related to group two (focus of this report) were related to the following aspects:

- Key expected developments in nanotechnologies, applications and examples of products and product scenarios to debate with stakeholders
- Relevant impacts on society, in terms of both (social ethical, legal) benefits and risks, examples of issues and topics to debate with stakeholders
- Stakeholders to engage in the dialogue
- Perspectives and interest in being involved in GoNano activities

A synthesis of information collected is reported in the following paragraphs, organized by the sectors concerned.

2. Food sector

2.1. Applications

The most relevant developments in nanomaterials and nano-related products that are enabling new applications in the food sector emerged from the interviews are:

- Nano-encapsulation
- Nanoparticles
- Nano-fibres
- Nano-membranes
- Nano-sensors
- “New type of food”: novel foods/ingredients, fortified foods
- Food packaging materials (food contact materials)
- Antimicrobial technologies: nano-activated photo catalyst, photo catalytic protective agents, antimicrobial films
- Lightweight and biodegradable materials

The number of applications exploiting nanotech developments in the food sector is limited, but the products that could be available on the market in the medium or long term will potentially have relevant impacts on society. These include:

- **Smart packaging** to improve food quality and safety and prolong shelf-life of fresh and processed products
Benefits: positive environmental impacts thanks to lightweight and biodegradable materials and the reduction of food waste along the entire food chain
Risks: nanoparticles migration and food contamination
- **Nano-filtering** (using nano-membranes/nano-fibers) for beverage and drink filtration (e.g. water, beer, wine, oil), nano-ultra filtration in waste water management and cleaning processes
Benefits: increased drinkable water availability, pollution reduction (e.g. in industrial processes of landfills) and water cycles closure
- **Novel ingredients/novel foods** with specific functionalities, such as increasing the content of healthy substances (e.g. vitamins, carotene), changing specific properties (e.g. reducing allergy risks), enable targeted delivery/release of nutrients. **Minimally processed food**, reducing the processing of foods in the production, storage and distribution phases.
Benefits: improved nutrition, reduced presence of additives and processing aids, improved food flavor, texture and appearance, make the product process more efficient
Risks: reduced safety when changing industrial processes
- **Plant protection products** for agricultural application to improve barriers on plants against microorganisms
Benefits: reduction in the use of pesticides and improved plant nutrition products (e.g. fertilizers), efficacy

2.2. Key issues

The interviewees identified specific societal issues that could be related to the use of nanotechnologies in the food sector, with particular focus on the applications and products identified above. Synthesizing outcomes of various interviews, most of them are related to the areas of communication and regulatory/safety aspects:

- **Communication:** need to provide balanced information to citizens on use of nanotechnologies to fill knowledge gaps and uncertainties
- **Regulatory, food safety aspects:**
 - need for standardization, classification and definition of NM (e.g. natural vs. engineered nanoparticles), regulation on novel food and labelling
 - Safety aspects of nanomaterials, in-depth safety testing (need to investigate long-term effects of nanoparticles in consumed food on human body and health)
 - Lack of technologies to detect nano-particles (e.g. to establish whether nano-particles from packaging could migrate in food)
 - Need to grant food safety in minimally processed foods, while reducing food processes

The majority of comments on the use of nanomaterials is related to food safety and human health, showing (at least in some cases) a polarization of views. Answers are mostly moderate, but there are some extreme views against the use of nanotechnology in food:

“...the path leading to development of food with nano-particles is destructive for human health. When nutrients are started to be modified in nano-scale, human body wouldn't be able to process and deal with them.” [Public research]

Other interviewees are convinced that nanotechnology in food is completely safe and that different opinions are only aimed at misleading the consumers:

“I would be interested in what the eco-terrorists and other activists say if also involved later on in your stakeholders workshops.” [Industry]

Someone focuses on education and communication as a way to provide adequate information and have a more balanced debate:

“It should also be considered that the way consumers perceive and deal with risks and benefits of the use of new technologies in food is also strongly cultural dependent.” [R&I networks]

The challenge of early identification of risks in technology development is also pointed out:

“Negative impacts are not known yet we are not aware of risks” [Policy]

2.3. Questions to debate

The interviewees proposed specific topics and aspects that could be relevant to explore and debate with citizens and stakeholders during the co-creation processes, in particular:

- potential impacts on human health, risks of food packaging materials and possible food contamination by nanoparticles

- distinction between nanostructures that naturally occur in food and those that are intentionally added or used in food processes for specific purposes
- current state of European policy and legislation (including issues of definition, methods for risk assessment, etc...)
- positive and negative impacts of having in place stringent normative frameworks on food
- consumers' willingness to accept higher costs for innovations without direct benefits for the consumers, but relevant benefits for the supply chain (e.g. longer food freshness) or the environment or society at large
- Use of nanotechnologies in organic food

Some telling comments from stakeholders include:

Areas and issues to debate:

"US regulation on novel food is less cumbersome than the EU one [...]. The result is that there are many novel food products on the market in the US than in EU. Is this providing more risks or more benefits to consumers?" [R&I-networks]

"[...] for example, the use of Titanium nitride to make food contact materials allows for 30% reduction in use of resources. Would consumer buy it despite higher costs?" [R&I-networks]

Interest and challenges regarding dialogue with citizens:

"...I think that engagement of stakeholders and citizens in development of nanotechnologies is redundant [...]. Researchers in nanofield should possess also ethical and moral qualities that would prevent them from developing potentially harmful nano-applications. As consumers themselves, researchers don't need input from general public." [R&I-networks]

"In general, I agree with communication and consultation activities during the phase of development of a nano-product. It is, however, a demanding and complicated process and I expect that only large companies [...] would be able to afford it." [R&I-public]

"The biggest obstacle I see in involvement of various subject of general public into the co-development processes of nano-products is the private nature of business R&D. The only relevant partners for businesses can be either research community or relevant bodies of state administration." [R&I-public]

"Food companies (large) are developing innovative products, more than novel products. They already use consumers' panels to evaluate their innovation and thus they might not see the added value of the GoNano initiatives." [R&I-networks]

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2.4. Stakeholders to engage

Interviewees suggested specific stakeholders that could be important to engage in dialogues on nanotechnologies in the food sector. These have been aggregated based on the categories identified in the GoNano communication and branding plan (D7.1):

Policy

- International authorities
- State authorities
- Policy makers

Research

- Research stakeholders
- Industry/agriculture stakeholders
- SMEs

R&I networks

- EU and National platforms on food industry/safety

Civil society networks, end-users

- Consumer associations
- NGOs

Two stakeholder categories identified by GoNano as relevant for the co-creation exercise, citizens and Science communication media, have not been indicated by interviewees.

3. Healthcare sector

3.1. Applications

According to the stakeholders, the most relevant developments in nanomaterials and nano-related products, enabling new perspectives in the nanomedicine sector are:

- Nano-materials (in general)
- Nano-encapsulation, with markers and coatings useful for selective and targeted release
- Nanosensors
- Nano- bio and synthetic tech (e.g. printing of organs and cell factories)

The most relevant impacts are expected from the application of these technologies in three areas:

- **Regenerative medicine** for the cure of diseases and injuries. Example of applications including devices for rehabilitation, use of bodily substance (e.g. stem cells, beta cell, etc) to regenerate tissues and organs, artificial organs, cells and tissues, smart skin patches for wound healing
Specific benefits indicated with respect to the examples include: cells from bodily substances provide cells even in absence of donors and with lower chances of rejection; regenerative medicine could lower the social, human and economic burden deriving from “post-acute phase” that an increasing number of people, in particular with ageing population, experience after severe diseases/injuries and could help them to recover to an autonomous life
- **Diagnostic and assistive medical devices** with improved features and functionalities, including minimally invasive systems, easier, faster, cheaper and more accurate measurements (for early stage detection). Example of applications include: minimally invasive insulin pumps, artificial pancreas constantly measuring the blood and automatically arranging insulin levels, tools for in-vivo evaluation of nanoparticle bioaccumulation
Specific benefits indicated with respect to the examples include: smaller devices, make the disease less visible and less apparent, it makes lives much easier, in particular for lifelong diseases, and prevent people from constantly feeling like a patient; nanosensors enable to measure a larger number of parameters (e.g. biomarkers from urine or breath) also in early stage diseases, thus allowing for strong prevention and making people more conscious about the influence of their life-style and environment on health
- **Targeted and personalized medical treatments**, in particular for cancer treatment.
Another example indicated is the use of principle of viruses, in order to design medicines that can be targeted more effectively.

All the stakeholders show very high expectations in terms of benefits of nanomedicine to address these areas of application. Though safety of medical treatment is indicated as a very important aspect, no specific risks have been mentioned in connection with nanomaterials.

One of the comments underlines the peculiar aspects related to risk perception (e.g. from patients) in the healthcare area and how this relates to more general issues on risk perception of nanotechnologies:

“The interesting question in the debate about nanotechnology is about trust and acceptance on a societal level. You do not want to get a polarized debate on nanotechnology, between believers and non-believers. [...] within the medical area these types of polarized discussions are less apparent as people have a much higher acceptance when the innovation can actually help them. So, there is a totally different risk perception on the same technology.” [Policy]

Some stakeholders underlined that the nanotechnologies in diagnostics will enable a paradigm shift that will bring the healthcare focus on prevention and on the early stage detection of diseases. Citizens will also change their behaviour:

“In the future we don’t even need doctors to analyse the results, but people can do this in their homes. [...] Therefore, we need to radically revise our healthcare system. In the future people need to be able to measure and have insights in their health, without necessarily going to the doctor. Hopefully with having insights in these measures people will also change their behavior.” [R&I private]

3.2. Key issues

The interviewees identified specific societal issues that could be related to the use of nanotechnologies in the healthcare sector, with a focus on the applications and products identified above. Synthesizing outcomes of various interviews, most of the issues are related to the areas of communication, regulatory and safety aspects and technical aspects in development of products:

- **Regulation and regulatory preparedness:**
 - the regulatory frameworks are developed too slowly compared to technological advancement (e.g. immunotherapy and stem cell technologies need a new regulatory framework).
 - A regulatory framework covering the aspects of “safe by design” products has to be developed
- **Safety:**
 - There is the need for standard strategies for the risk assessment and safety testing of nanomaterials; reliability and validity of the current toxicity testing methods should be improved
 - Debate on safety and guidelines is mostly expert oriented, not policy oriented, there is no social debate on nanotechnology
- **Communication**
 - Negative effects of a single nanomaterial, when not clearly communicated, could influence reputation of nanotechnology as a whole (e.g. evidences that titanium dioxide causes cancer and it does not dissolve once entering the body)
 - Policy makers and investors do not have sufficient knowledge about the innovations
- **Technical issues**
 - Production issues in employing nanotechnology concerning scalability, affordability, integration of new devices.

Issues concerning regulation and safety are the most frequent indicated by the stakeholders, though a comment clearly underline there are more prominent issues for societal debate in the healthcare sector:

“In our field societal debate is more about the power of different stakeholders, than on safety and acceptance.” [Policy]

3.3. Questions to debate

The interviewees proposed specific topics and aspects that could be relevant to explore and debate with citizens and stakeholders during the co-creation processes, in particular:

- The relationship with healthcare organization/structures and procedures, regulations, responsibilities, and cost coverage
- How to keep up with rapid developments in nanotechnology
- Ethical concerns related to people life and wellbeing, the way treatment/assistance is provided
- Ethical concerns deriving from the personalized nature of the treatments and the fact that responses can vary from patient to patient; need to provide clear information and make people conscious about these aspects
- Ethical questions arising from the use of external artificial organs (e.g. pancreas) or cells and tissues
- Ethical issues related to security and privacy aspects of new technologies, able to provide increasing ability to monitor biological and health parameters (e.g. sensor technologies). Key questions include: *What are the limits on what to measure, what to do with the data and who is the owner of medical data, in particular for severe diseases (e.g. when there is not cure for a patient)? Who holds the data? Will people change their behavior based on measurements? Will measurements invade people daily life?*
- Negative side effects are generally more accepted for severe disease (e.g. cancer) than for less severe or lifelong diseases (e.g. diabetes). However, safety, side effects, and use by vulnerable groups of population should be further discussed also for the former, such as for cancer
- Traditional nanomaterials (e.g. titanium and silver) are being developed into the “bio-nano” direction, seeing DNA as a chemical entity and this has to be debated because could encounter strong resistance from society
- The healthcare systems will be shifted to systems that will be mainly focused on preventing diseases, rather than curing them and self-diagnostics

The issue of access to and cost coverage of the introduction of new medicines and technology in the health system has also been mentioned, with differences depending from the healthcare system considered (public healthcare vs. private/insured healthcare):

*“As for cost coverage, once proved their effectiveness the cost of the treatments will be likely covered in the same way of the other therapeutic treatments/medical devices”
[R&I-networks]*

and those where insurance companies have a strong influence on the healthcare system:

“Actors such as hospitals and health insurance companies are important to include. They are important for making sure that an innovation is included in the health system. Especially insurance companies are very powerful in this regard in the Netherlands.” [End Users]

Some further telling comments from stakeholders include:

“The problems addressed can all have a high human, social, and economic cost and their solution/mitigation is in principle positive. [...] Impacts evaluation must be part of the research effort along the entire value chain.” [R&I-networks]

“It is important to understand that within the research projects the focus is on the working principles and mechanisms, not on the business case.”[End Users]

3.4. Stakeholders to engage

Interviewees suggested specific stakeholders that could be important to engage in dialogues on nanotechnologies in the healthcare sector. These have been aggregated based on the categories identified in the GoNano communication and branding plan (D7.1):

Policy

- Regulatory bodies, authorization institutes
- National Ministers and authorities
- Policy makers

Research

- Researchers from public research organizations and industry

Industry

- Industry and developers
- Companies, in particular companies integrating multiple technologies within devices
- Investors
- Cell factories
- Health-care providers, hospitals
- Health insurance companies
- Rehabilitation structures
- Pharmacies

Civil society networks, end-users

- Ethicists/ethical committees
- Citizen Society Organizations
- Patients
- Doctors
- Citizens

Two stakeholder categories identified by GoNano as relevant for the co-creation exercise, R&I networks and Science communication media, have not been indicated by interviewees.

4. Energy sector

4.1. Applications

The most relevant developments in nanomaterials and nano-related products that are enabling new applications in the energy sector emerging from the interviews are:

- Insulating materials
- Nano powered sensors/activators
- Isolated carbon nanotubes
- Quantum dots
- Nano-based silicon semiconductors (nanoelectronics)
- Nanostructures at material interfaces in batteries

These technologies are expected to contribute to the transformation of the energy sector from a fossil-based to a renewable-based sector. The most relevant impacts are expected from the application of these technologies in the following areas:

- **Energy generation.** Examples of applications include advanced photovoltaics, and small distributed devices able to harvest energy from the environment
Benefits: better performances and reduced costs with impact on economics and increased use of renewable energy
- **Energy Storage.** Examples of applications include batteries for electric transport, small and wearable devices, domestic generation, super-capacitors
Benefits: Better performances and reduced costs with impact on economics and increased use of renewable energy; decrease of transport environmental footprint
- **Energy efficiency.** Examples of applications include OLEDs, new insulating materials, Rapid charging devices
Benefits: reduced energy consumption and environmental impact, foster electric mobility
- **Internet of Things devices to support energy production, distribution and storage.**
Benefits: automation and control. Risks: cyber attacks

Stakeholders are conscious that device miniaturization and the transition to renewable energies is having a significant social, economic and environmental impact and the opportunities cover very different scenarios:

“challenges range from gigawatt generation for powering cities to microwatt generation to power small IoT devices.”[R&I-public]

4.2. Key issues

The interviewees identified specific societal issues related to the energy sector and the application of nanotechnologies. Synthesizing outcomes of various interviews, most of them are related to regulation, safety and ethical aspects and technical issues in development of products:

- **Safety and security**
 - Substitution of raw materials: nanotechnologies could substitute critical raw materials and convert production processes now employing toxic materials (e.g. replacing organic solvents with water in supercapacitors production)
 - Sustainability: some specific nanomaterials might have excellent performances but as well high environmental impact (e.g. in the production phase or at the end of life)
 - Potential health/environmental issues of nanoparticles/nanostructures (e.g. carbon nanotubes) associated in particular with the long-term degradation
 - IoT cyber-attacks affecting critical systems, including energy supply
- **Regulatory aspects**
 - Regulations in the energy sector are strict and adapt too slowly to energy technology advances, promoting fossil fuels and ignoring sustainability aspects
 - Possible risks in production processes, for example associated with operator's exposure to the degradation products of the new materials
 - Need for better classification of materials in REACH (e.g. graphene and carbon nanotubes often classed together)
- **Ethical/societal issues**
 - Equity and distributive justice in access to energy production. This includes potential social impacts of use of large scale systems and smaller distributed power generation (smart grid), and renewable sources (alone and in combination). Issues of costs, access, reliability, efficiency of systems, could influence the social impact (positive or negative) of these solutions on both individuals and society.
 - Geopolitical effects due to reduction in fossil fuels consumption and to changes in employment distribution (e.g. job concentration in few countries)
- **Technical issues**
 - Cost effectiveness of the fabrication and scale-up of nanomaterial based-technologies

In the Energy sector, there is a lower perception of potential risks for the consumers or the environment associated with the use of nanomaterials or nanotechnologies:

“Nano doesn't form particularly hazardous environmental or health threats. Particularly not if one compares to fuel etc. – we are not replacing risk-free, non-polluting materials. Moreover, nano is under control in solar panels and won't blend into the surroundings: the way nano is currently used in innovation to develop new solar panels, the nano particles are either encapsulated between pieces of glass or they merge into new structures in the process and ceases to be nano in the final product.” [R&I-networks]

Most of the interviewees, however, underlined the need for further investigations on potential risks of nanomaterials, as for example shown by this comment:

“We do need to be conscious of potential risks in the workplace where these materials are manufactured, and potential environmental impacts of these processes and any leaks or degradation products. Therefore, must analyze toxicology and full lifecycle. i.e. Responsible research is a must.” [Public research]

Also the need for more responsibility in innovation has been underlined, in order to avoid the errors done in the past:

“Stakeholders will be interested in anything that will make money or save them money. Stakeholders should also discuss how to address the “unknown” aspect of the safety of

nanotechnology. What processes need to be followed to avoid hazards or pollution when scaling-up nanotechnologies. Micro plastics is a good example of what we want to avoid with nanotechnology; ten years ago, only the benefits of plastics/micro plastics were considered and only now are we trying to resolve the issues with the unforeseen (ignored) pollution.” [R&I network]

Geopolitical issues are very relevant and likely will emerge in any type of debate related to the energy sector:

“The main societal effect will be big changes in employment and energy distribution. Jobs in energy production and distribution are jeopardized; new jobs are being created, but maybe in China. Europe needs a strong line of research and technological innovation to keep jobs.” [Industry]

4.3. Questions to debate

The interviewees proposed specific topics and aspects that could be relevant to explore and debate with citizens and stakeholders during the co-creation processes. Most of them refer to the broader impact of new energy systems on society and the daily life of people, and are not directly connected to nanotechnologies. Interviewees would like to explore and debate future energy models and their societal impact, including sustainability models, reconfiguration of generation, storage, distribution and usage of energy, impact on social organization and everyday lives (e.g. urban contexts, smart cities)

In particular:

- In the transition from fossil fuels to renewable energy large amount of safe storage will be required, determining a complete reconfiguration of generation and distribution and of how electricity is used. In private domestic energy generation, householders will no longer be willing to pay for the grid, but consumers should be aware that yet the grid will be needed as a backup or to power larger public installations.
- Electric charging stations for vehicles will replace petrol stations, and might cause problems both in power and storage
- Energy market: industries could be prone to sell the energy they will produce in periods they are not working (e.g. weekends)
- Promote open and transparent development of regulations, to ensure predictability of regulatory developments and provide security for investors

A respondent asks for a co-creation process that should be able to explore all the opportunities to develop a new economic and social model:

“The most important thing to explore would be the holistic blueprint of our future energy model.” [Public research]

Another interview pointed out the challenge of engaging industry in the energy sector in a dialogue:

“The focus should be put on getting industry involved, in the energy field industry is not so prone to collaborate and talk with Nano scientists, need to promote it as much as possible.” [R&I-public]

4.4. Stakeholders to engage

Interviewees suggested specific stakeholders that could be important to engage in dialogues on nanotechnologies in the energy sector. These have been aggregated based on the categories identified in the GoNano communication and branding plan (D7.1):

Policy

- Regulatory authorities
- Urban planners and city halls

Research

- Experts in marketing, social sciences, consumer's behaviors, user acceptance
- Academics (e.g. for simulations of future grids with industries)

Industry

- Investors in energy startups
- Industries, both producers and distributors
- Recycling industries

Civil society networks

- Consumers organizations
- NGOs related to environment and ecology

Three stakeholder categories identified by GoNano as relevant for the co-creation exercise; R&I networks, citizens and science communication media, have not been indicated by interviewees.

5. Cross-sectoral aspects

Stakeholders proposed a wide and heterogeneous set of issues to be discussed, relevant for all the pilots and the co-creation process within the GoNano project, that in this paragraph have been grouped in three areas: innovation and RRI, nanotechnology, dialogues.

5.1. Innovation and RRI

There are three relevant and broad issues emerging from interviews and concerning the technological innovation and the Responsible Research and Innovation.

Structural and economic aspects to facilitate networking and connection of stakeholders along the R&I value chain, and to bridge the gap from research to market.

Technological innovation is crucial to exploit research ideas and transform them in real products. However, there is a lack of cooperation and sharing of information amongst different actors along the R&I value chain, hindering the exploitation of research results.

There is a strong need to make research outcomes available to industry and industry networks, in particular for SMEs:

“[...] small and medium enterprises need new instruments in order to get in contact and connect in a smart way with value chains relevant for their business. This is a structural and economical issue, more than a technological one” [Industry].

This suggests that structural gaps within the R&I value chain could be overcome by fostering the transition to a “connection” economy, using ICT solutions to improve networking and matchmaking of interests of R&I actors and their supply chains.

Circular economy

Environmental sustainability, including a responsible use of resources, is an essential aspect of responsible innovation. This has been pointed out by several interviewees, in particular in the food and energy sectors. Issues related to circular economy refer in particular to three main aspects:

- Assessment of the entire Life cycle of new nanomaterials and in particular the End of Life, preventing and managing recycling problems. Favor cooperation between researchers, producers and recycling organizations.
- Substitution of hazardous materials with new materials (such as nanomaterials) ensuring similar or improved properties, both in products and along the production processes
- Development of regulation stimulating a sustainable innovation all along the supply chain

One interviewee recalled some past examples

“An example of the past has been the banning asbestos, CFC, Halons that led to the important innovation on advanced materials to substitute the impacting ones” [R&I network]

Responsible Research and Innovation as an ecosystem approach

RRI cannot be implemented effectively by single stakeholders, it needs a common effort by diverse actors along the whole R&I value chain. This opinion is shared by several respondents, and it is clearly pointed out in a comment from the energy sector:

“Responsible research cannot be effectively implemented just within one research group or even one institute, as at this level there is not the capacity to look at all aspects. It must be viewed and implemented at ecosystem level.” [Public research]

5.2. Nanotechnologies

Some cross-sectoral issues highlighted by interviewees regard broad issues concerning nanotechnology.

Distinction between nanomaterials and nanotechnology

There is often confusion between nanomaterials and nanotechnologies, especially in public debate and also within debates of some stakeholder groups, and this could generate misunderstandings. There is a need for better information and education to the general public:

“Even though, we often use the overarching term nanotechnology, it is good to make a distinction between nanomaterials and nanotechnologies. Often these terms are used intertwined and the general public might not distinct those from each other, but there is definitely a difference.” [Public research]

How to communicate nanotech

Several interviewees pointed out the lack of information, and misleading information, as factors responsible in generating hype and hopes on nanotechnologies:

“need to address “disinformation” both in terms of risk and expectations: researchers sometimes promise too much of a technology which then creates unrealistic expectations. Fear of the unknown or unsubstantiated claims about safety should be tackled somehow.” [Public research]

Some interviewees underlined the need to find ways to ensure that reliable information on use of nanomaterials is provided to stakeholders along the supply chain, and in particular to consumers.

5.3. Dialogues

Some interviewees provided views and ideas on how to organize dialogues and co-creation initiatives:

An important aspect in the design of societal engagement and co-creation exercises is to take into account of cultural and economic differences, in particular in sectors like food or health:

“...technologies can be both good and bad for society, and risks and benefits could drastically change depending from the context, cultural and economic aspects. A technology or product could be beneficial for someone but not for others. Regulation is a way to agree on the good and the bad for society and thus should be a reference for discussion.” [R&I networks]

Clear goals have to be set at the beginning, both for organizing and participating parties. The debate should always be coordinated by a third neutral party that is trusted by all the stakeholders and citizens.

“Engagement should be worthwhile, beyond talk shop with concrete deliverable coming out of it.” [CSOs/End users]

When talking about specific applications it could be useful introducing and explain also the working principles in order to avoid polarized debates

“You do not want to get a polarized debate on nanotechnology, between believers and non-believers, as we have seen with GMO.” [Policy]

Some stakeholders are skeptical about societal engagement. Some of them are convinced that they there is no need to take into account citizens needs and concerns or that they already do it the best way, as with consumer panels. For example, one of the respondents states:

*“[large manufacturing industry] has little need for direct interaction with citizens.”
[Industry]*

6. Expectations and interest in GoNano

Several positive expectations emerged from the interviewees about the GoNano activities. They can be summarized into four main areas.

Stakeholders:

- Meeting other stakeholders
- Ensuring a constructive dialogue between stakeholders, starting from common goals
- Involving SMEs, which innovation activities are connected to specific market demands, in particular SMEs not involved in nanotechnologies, exploring with them the potential applications of nanotechnology in their activities and interests
- Building mutual understanding and trust between stakeholders, cooperation and information exchange

Citizens:

- Improving the image of nanotechnology in the media and society by providing balanced information to wider public, educating on nanotechnologies, dealing with unimproved threats, which currently discredited the nanotechnology field in the eyes of many unformed citizens
- Encouraging researchers and innovators to take into account the consumers' needs and expectations, and to foster the design of products and services based on principles of circularity and economic, social, environmental sustainability
- Aligning the market towards the needs and expectations of citizens and society
- Pushing industry, research and policy-makers to take into account societal needs and concerns
- Understanding if and how citizens and stakeholders could play a role in addressing or foster the transition towards a “connection” economy
- Getting new ideas from people, discussing with consumers on future innovations
- Defining how the outcomes of research could be used for the benefit of society, how to better target R&I priorities for nanotech towards societal values and challenges (one of the respondents stated: *“investing in research on new food ingredients based on nanotech is a good way to use public money [...]?”*)
- Providing insights on the impact of technologies, and what products the consumers would need and buy in their everyday life

Methodologies:

- Finding innovative ways of understanding priorities of society
- Learning how co-creation activities can be applied in a more structural way
- Providing methodologies for RRI

Risk and regulation:

- Highlighting innovative ideas on how to understand risk perception
- Collecting suggestions for risk governance mechanisms
- Helping providing recommendations for policy makers and regulatory bodies

Interviewees interest in being involved in GoNano

Most of the interviewees are interested or very interested in being engaged in GoNano activities:

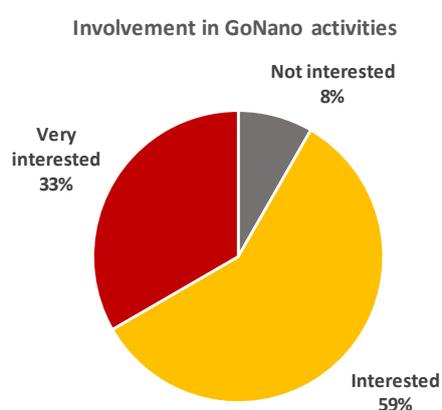


Figure 4: Analysis of stakeholders' interest in societal engagement activities and GoNano (Group two, question 6, 28 respondents)

The interested stakeholders, identified different ways to be involved in GoNano activities:

- Taking part in co-creation events, in particular workshops with stakeholders (several interviewees)
- Contributing to dialogue initiatives and public debates
- Organizing joint initiatives
- Being involved in longer term cooperation on popularization of nano and dissemination of GoNano activities and results
- Being informed about the outcomes of the project, the project documents, and the different perspectives of citizens and stakeholders gathered by the project
- Providing comments and feedbacks on GoNano results
- Help to identify areas to discuss with the wider public
- Reflecting on social needs and support definition of policy recommendations

Some respondents focused on the opportunity to get access to communication tools and showing successful cases:

“From the point of view of our members, it would be helpful to have simple and immediate communication tools (e.g. fact sheets, open days). Interesting themes to disseminate might include how to engage stakeholders, and successful cases of stakeholder and citizen engagement and co-creation.” [R&I-networks]

While one respondent declared that an interest in knowing the results because:

“...would love to see an analysis confirming that society wants a sustainable form of energy generation and use.” [R&I-public]

Only two interviewees are not interested in being engaged in GoNano activities:

“Definitely not! I would not curb your enthusiasm. But you can consider it from the GoNano project point of view. New technologies are not proposed it arise spontaneously from the advanced legal environment. The GoNano and hundreds other EU projects have a big disadvantage – it does not follow up the existing factual and legal state. The project teams do not have anybody who would be oriented. It forms self-proclaimed rules regarding the researched subject – the nanotechnology in our case. There are no experts who would know the existing status. They duplicate activities on one issue. Consortia are not coordinated and tend to draw surprising information (shocking information) the better chance for funding.” [Industry]

Even if some think that being invited to the stakeholder workshop could be useful for them:

“I think that GoNano is a rather useless project; nevertheless, you can still invite me to the stakeholder workshop. What I’d need the most is to convince about usability of the project. I think that collecting societal demands and values in a participative way of engaging 50 citizens is a non-sense as it is not a representative sample of a given population.” [R&I-networks]

The major part of the comments about the GoNano activities are, however, positive, and the goal of GoNano is underlined by several interviewees, in different ways. One of them stated:

“GoNano could help in providing recommendations for policy makers and regulatory bodies. It could also encourage researchers and innovators to take into account the consumers’ needs and expectations, and to foster the design of products and services based on principles of circularity and economic, social, environmental sustainability. Interaction between citizens and stakeholders is crucial to align innovation and market towards the needs and expectations of citizens and society”. [R&I-networks]

7. Conclusions

The GoNano interviews involved a selected panel of stakeholders with in-depth expertise on research and innovation on nanotechnologies, in particular in the food, healthcare and energy sectors. Representatives of R&I networks, public and private research, industry, policy makers, and end-users from several different countries in Europe have been involved.

Several **examples of applications and product scenarios** to debate with stakeholders and citizens emerged from the interviews. Most of them are expected to have a significant social impact, and are also aligned with acknowledged R&I priorities at policy and industrial level.

These include applications of nanotechnologies for smart packaging, nano-filtering, novel foods and plant protection products (food and agri-food sectors), and regenerative medicine, diagnostic and assistive medical devices, targeted and personalized medical treatments (healthcare), and energy generation and storage, energy efficiency and application of the internet of things (energy).

A wide and heterogeneous spectrum of views and opinions emerged from the interviews.

Key needs and concerns related to nanotechnologies include: Issues on health and safety of nanomaterials, and related risk assessment and testing activities; regulatory aspects, including classification of nanomaterials, and adequacy of regulation to technology development (regulatory preparedness); risk perception and communication with citizens and consumers about impacts (risks and benefits) of nanotechnologies, including aspects related to trust and misleading information; technical issues concerning scalability and affordability of new technologies and devices; use of nanotechnologies to support the circular economy and development of sustainable products.

Risk perception on nanotechnologies by consumers and the general public is seen by interview respondents as a significant aspect with respect to the food sector, while it is considered much less relevant in the healthcare sector (where potential perception of benefits outweigh risks) and in the energy sector (where awareness from both the public and stakeholders on the possible use of nanotech is seen as quite limited).

It should also be taken into account that in food (and food industry) risk perception is considered an essential aspect of product development for any type of innovation.

In the energy sector, apart from specific health and safety aspects of nanomaterials, most issues emerging from interviews are not specific of nanotechnologies.

These aspects are also reflected in the **questions suggested by stakeholders** to debate with citizens. Some of them are common to all the three sectors, and include the potential impact on human health of nanomaterials, the balance between risks and benefits and “knowns” and “unknowns” of nanotechnologies, and the discussion about the current state of European policy and legislation (on both the sector itself and on nanomaterials). Other questions are specific to the sector considered and the product examples provided by the interviewees.

In the food sector, examples of questions to debate include consumers’ behavior and interests, such as consumers’ willingness to accept higher costs for more responsible or sustainable products.

In the healthcare sector, examples include ethical issues connected to nanomedicine, and the relationship of innovation with the healthcare organization/structures and procedures, regulations, responsibilities amongst stakeholders, and cost coverage of healthcare treatments.

In the energy system examples include broader impact of new energy systems on society and the daily life of people, future energy models, including sustainability models, and the reconfiguration of generation, storage, distribution and usage of energy.

Reasons to engage in a dialogue with citizens, that emerged from interviews, include improving the image of nanotechnology in society, better understanding of how the outcomes of research could be used for the benefit of society, and how to better target R&I priorities for nanotech towards societal values and challenges, fostering industry, research and policy-makers to take into account societal needs and concerns, getting ideas on future innovations, and other aspects.

In terms of **stakeholders to engage in dialogue**, respondents suggested most of the different type of stakeholders along the R&I value chain, though with some differences amongst sectors: Policy makers and EU and national authorities (food, healthcare, energy), local authorities (energy), research and innovation players (food, healthcare, energy), R&I networks (food), industry (food, healthcare, energy) and in particular SMEs (food), investors (healthcare, energy), professional end-users (healthcare) and retailers (healthcare, energy), communication experts (energy), ethicists (healthcare), consumers associations and advocacy groups (food, healthcare, energy), patients and citizens (healthcare).

In terms of **interest in GoNano**, the majority of interviewees are interested or very interested in being engaged in project activities. Considering only group two interviews, these include more than twenty organizations amongst R&I networks (including ETPs), industry, policy makers and end-users, in line with the targets set by GoNano in terms of networking from the interviews activities.

Different ways for an effective cooperation have been suggested, from joint organization of initiatives, to participation in GoNano events, and support in disseminating and providing feedback to project results.

In conclusion, the analysis of interviews helped to elaborate suggestions to guide GoNano activities:

- Select both short, medium and long term (visionary) areas of application of nanotechnologies
- Evaluate societal impacts of the products/applications/sectors considered in the debate, taking into account that questions and issues of citizens are often not nano-specific
- Consider existing norms and regulations as necessary background information (and boundaries) of the debate
- Foster discussion on societal value and impacts on society of innovation, also beyond technical, market and risks (and risk perception) aspects
- Engage users and end-users, people interested and concerned with the specific sector, application and product considered
- Consider that some stakeholders (including in the public) might have controversial, biased and polarized positions
- Carefully understand benefit of all stakeholders, including the public, to participate in the dialogue (motivate people)

8. Annexes

8.1. Interviews questions

8.1.1. Group 1: Stakeholder engagement, co-creation, mutual learning:

GoNano interview about your experiences with public and stakeholder engagement, co-creation exercises and mutual learning activities that aim to involve society in research and innovation.

First part: your experience with engagement/co-creation/mutual learning initiatives

- 1. Which kinds of projects and initiatives have you been involved in, with engagement/co-creation/mutual learning aims?**
(both past and present initiatives; please select the most relevant one(s) in your view)
- 2. Which kinds of stakeholders did you involve? Please also indicate the level of expertise and knowledge of the stakeholders involved**
(e.g. lay people/citizens, professional stakeholders, suppliers, customers, researchers, etc.)
- 3. What were/are the aims of engaging stakeholders?**
(in particular: what kind of learning outcomes did/do you seek to achieve?)
- 4. What kinds of approaches were used, and why were they chosen?**
(in particular: how were different types of stakeholders, particularly citizens and professional stakeholders, brought together? At which stage of the research and innovation process and the project did you/will you engage stakeholders?)
- 5. Did the engagement/co-creation/mutual learning activities provide any kind of benefit?**
(tangible or intangible advantages/benefits to the project/initiative and its results)
- 6. Did you monitor/measure the impact of these activities? How?**

Second part: Your suggestions and recommendations on engagement/co-creation/mutual learning initiatives

- 7. Which processes/methods/activities do you think are most useful?**
- 8. Are there any recommendations you could offer?**
(regarding how multi-stakeholder engagement processes might be optimised for learning and responsiveness to societal needs)
- 9. If you were to run the project/initiative again, would you change anything? Why?**
- 10. Can you recommend any other good practices?**
(beyond the initiative we talked about)

8.1.2. Group 2: networking and areas for dialogue

GoNano interview on: future nanotechnology developments and their potential impact on society; the role of public and stakeholder engagement, and co-creation exercises and mutual learning initiatives in improving research and innovation processes (and how they address ethical and social implications).

First part: key topics to debate on nanotechnologies

1. **What are the most important current developments and issues in nanotechnologies from your institution's point of view? Why?**
2. **Based on your expertise, which types of nanotech applications do you think will have the largest impact on society in 5 to 10 years?** (possibly focus on the areas of food, energy, health)
3. **With reference to the application indicated, what could be the most relevant impacts on society, in terms of both (social ethical, legal) benefits and risks?**

Second part: societal engagement

4. **Could you think about examples of specific applications and product scenarios related to nanotechnologies you might like to discuss with stakeholders and/or citizens?**
(use cases, examples of the application of the product; examples from other stakeholder engagement initiatives; please possibly focus on the areas of food, energy, health)
5. **Which stakeholders do you see as most relevant to engage in a dialogue on these applications/product scenarios in order to improve research and innovation activities?**
(with the final aim to better align innovation with societal expectations and needs, making innovation products more desirable, safe, and ethically acceptable)
[note for interviewers: in addition to indicating the type of stakeholder, please also endeavor to get contacts for individual organizations, for engagement in GoNano]
6. **To what extent would you see it as beneficial to be involved in societal engagement activities related to nanotechnologies, such as the ones organized by GoNano?**
7. (with reference to the previous question) **What would you need/expect from engagement in the GoNano initiative?**

8.2. Interview participant details

A summary table of the respondents to group1 and group2 interviews is reported below, including indication on the type of stakeholders, expertise, sector, country, gender

Group 1 interviews (summary of outcomes of these interviews is reported in deliverable D1.1.)

Code	Type of stakeholder*	Expertise**	Country	Gender
G1.1	End-users	RRI-experts	BE	F
G1.2	End-users	Policy	IE	M
G1.3	End-users	Societal engagement	NL	M
G1.4	Policy	Policy	FR	M
G1.5	Policy	Policy	NO	M
G1.6	R&I-private	Co-creation practitioners	BE	M
G1.7	R&I-private	Co-creation practitioners	DE	F
G1.8	R&I-private	RRI-experts	FI	M
G1.9	R&I-private	Co-creation practitioners	NL	M
G1.10	R&I-private	RRI-experts	UK	F
G1.11	R&I-public	nano-debates experts	AT	F
G1.12	R&I-public	RRI-experts	AT	F
G1.13	R&I-public	Co-creation practitioners	BE	M
G1.14	R&I-public	Societal engagement	DE	M
G1.15	R&I-public	RRI-experts	IT	M
G1.16	R&I-public	nano-debates experts	NL	F
G1.17	R&I-public	science communication	NL	M
G1.18	R&I-public	RRI-experts	NO	F
G1.19	R&I-public	Societal engagement	UK	F

Table 1. Group 1 panel description: code, type of stakeholder, expertise, country and gender.

*Types of stakeholder taken into account for interviews (following the classification of the GoNano Dissemination and Communication Plan): CSOs/End-users, Public research, Industry, R&I networks, Policy makers

**Expertise taken into account in Group 1 interviews: nano-debates experts, RRI experts, co-creation practitioners, societal engagement experts, policy

Group 2 interviews

Code	Type of stakeholder*	Sector**	Country	Gender
G2.1	End-users	Health	NL	M
G2.2	End-users	Food, Cosmetics, Health	BE	M
G2.4	R&I-networks	Nanotech	IT	M
G2.5	R&I-networks	Food	NL	F
G2.6	R&I-networks	Energy	NL	M
G2.7	Policy	Nanotech	EU	F
G2.8	Policy	Health	NL	M

G2.9	Policy	Nanotech	CH	F
G2.10	R&I-networks	Food	BE	M
G2.11	R&I-networks	Health	IT	M
G2.12	R&I-networks	Food, nanotech	CZ	M
G2.13	R&I-networks	Food, nanotech	CZ	M
G2.14	R&I-networks	Energy	UK	M
G2.15	R&I-private	Health	IT	F
G2.16	R&I-private	Energy	DE	M
G2.17	R&I-private	Energy	FR	M
G2.18	R&I-private	Nanotech, food	CZ	M
G2.19	R&I-private	Nanotech, Energy, Health	CZ	M
G2.20	R&I-private	Nanotech	ES	F
G2.21	R&I-private	Health	NL	M
G2.22	R&I-public	Energy	ES	M
G2.23	R&I-public	Food	CZ	M
G2.24	R&I-public	Food	CZ	F
G2.25	R&I-public	Food	CZ	M
G2.26	R&I-public	Food	CZ	M
G2.27	R&I-public	Health, Energy	NL	M
G2.28	R&I-public	Health, nanotech	NL	F

Table 2. Group 2 panel description: code, type of stakeholder, sector, country and gender.

*Types of stakeholder taken into account for interviews ((following the classification of the GoNano Dissemination and Communication Plan): CSOs/EndUsers, Public research, Industry, R&I networks, Policy

**Sectors: Food, Health, Energy, Nanotech

8.3. Interview information sheet



GoNano Information Sheet - Workpackage 1 interviews -

What is the GoNano project?

GoNano is a Coordination and Support Action funded by the European Union under the NMBP Programme of Horizon 2020, Grant Agreement n° 768622. It brings together 10 partners from all over Europe with the aim to align future nanotechnologies with societal needs and concerns by enabling co-creation between citizens, researchers, industry, civil society organisations, and policy makers across Europe. The project started in September 2017 and will run for three years. For more information on the project objectives and the consortium, please see <http://gonano-project.eu/>

Aims of the research

GoNano aims to improve the responsiveness of research and innovation processes to public values and concerns. In order to do this, we want to learn lessons regarding mutual learning and public responses to nanotechnology from prior public engagement initiatives. To that end, we are interested in hearing about your views and experiences on: future nanotechnology developments and their potential impact on society; the role of public and stakeholder engagement, and co-creation exercises in improving research and innovation processes (i.e. how these initiatives could help to address ethical and social implications of R&I)

This interview will be part of a series of approximately 50 interviews with researchers, industry representatives, experts in communication and social sciences, policy makers, civil society representatives and citizens across Europe, conducted by GoNano project partners between January and March 2018.

What does your participation entail?

The interview will take approximately one hour. During the interview, you will be asked about your ideas and experiences with societal engagement on nanotechnologies.

The interview data will be used as input for the design and planning of the co-creation activities in GoNano. The interview data will be stored securely. The interviews will be anonymized to ensure confidentiality. Access to the primary data will only be granted to individuals directly involved in the analysis of the interviews.

The interview results will be summarized in a public report. The report will present aggregate findings from the interviews; the report may include quotations from interviews, but these quotes will not be attributable to individual respondents. This report will be submitted as a deliverable to the European Commission. It will also be used as input to subsequent GoNano activities, and may be used as the basis for news articles, other reports or a research publication.

You have the right to withdraw at any time without prejudice and without providing a reason. If you have any further questions, or if you would like to withdraw, please contact

Interviewer: ...

8.4. Interview consent form



GoNano Informed Consent Form - Work package 1 interviews -

I, the undersigned, confirm that I have read and understood the information about the project, as provided in the information sheet. I have been given the opportunity to ask questions about the project and my participation. I voluntarily agree to participate in the project. I am aware that I can withdraw at any time without prejudice and without providing a reason. The procedures regarding confidentiality (e.g. use of names, pseudonyms, anonymization of data, etc.) and the expected use of the data for research, publications, sharing and archiving have been clearly explained to me. I understand that other researchers will have access to this data only if they agree to preserve the confidentiality of the data and if they agree to the terms specified in this form.

Participant:

Name of Participant	Signature	Place	Date
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Interviewer:

Name of Interviewer	Signature	Place	Date
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