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Citizen needs and values in relation to nanotechnology in food, energy and health: A report form citizen workshops in the Czech Republic, Spain and the Netherlands

GoNANO DELIVERABLE 3.2

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Partner responsible:	Technology Centre CAS (TC CAS)
Compiling author(s):	Lenka Hebáková and Marek Pour, Technology Centre CAS Lise Bitsch, Danish Board of Technology Foundation
Contributing author(s):	Craig Richmond, Boaz Kogon and Paul Wright, Royal Melbourne Institute of Technology; Anne Dijkstra and Sikke Jansma, University of Twente; Lise Bitsch, Danish Board of Technology Foundation; Daan Schuurbiers, De Proeffabriek; Ulrike Bechtold, Institute of Technology Assessment
Quality assurance:	Lise Bitsch, Danish Board of Technology Foundation
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1 SUMMARY OF THE REPORT

Nanotechnologies – the purposeful engineering of matter on the atomic or molecular scale – have given rise to great expectations in recent years, unlocking new research opportunities in areas as diverse as energy, healthcare, electronics, food and construction¹. At the same time, concerns have been raised about possible unintended consequences of particular uses of nanomaterials.

GoNano is an EU-funded initiative aiming to explore how nanotechnology research and innovation can become more responsive to societal needs and values. It does so by enabling co-creation between citizens, industry, civil society organizations, policy makers and researchers within the areas of food, health and energy. GoNano builds on previous efforts in public engagement and new technologies to develop a pilot project in each of the nanotechnology research areas: health, energy and food. The pilot projects will engage with citizens, researchers, professional users, civil society organisations, industry, and policy makers in a continuous process of deliberative workshops and online consultations to co-create research aims and concrete suggestions for future nanotechnologies.

Three thematic deliberative and envisioning citizen workshops on food, energy and health formed the first step of the co-creation process. The goal of the workshops was to inform citizens on nanotechnologies and possible future application areas in order to facilitate their reflection on wishes, needs and concerns. The citizens' inputs form the basis for understanding social needs and values, and for working with professional stakeholders to align future nanotechnology applications with these societal values and needs. The citizen workshops were held during the autumn of 2018 in the three pilot countries: the Czech Republic (Food), Spain (Energy) and the Netherlands (Health)². Video impressions of the workshops are available on the project website and on YouTube³ (see Figure 1).

Participants in the three citizen workshops were active and motivated, they were able to discuss possible application areas of nanotechnologies, and they formulated a number of common wishes and messages. Their messages and wishes were very often illustrated and/or accompanied with a model of a possible nanotechnology application (see the National Reports which are attached to this report as Annexes I-III).

¹ Nanotechnology, or rather 'nanotechnologies' considering the variety in this domain, refers both to materials and products enabled by nanotechnology as well as the technologies and processes to construct these materials and products. Various definitions circulate, but a common feature is the focus on understanding and manipulating matter at the dimension of 1-100 nanometres.

² The GoNano pilot partners are: University of Twente (UT), Technology Centre of the Czech Academy of Sciences (TC CAS) and Royal Melbourne Institute of Technology (RMIT). The lead partner on the coordination of citizen workshops is Technology Centre of the Czech Academy of Sciences (TC CAS).

³ YouTube: [Workshop RMIT](https://www.youtube.com/watch?v=fhvHGk1qcyM&feature=youtu.be) (<https://www.youtube.com/watch?v=fhvHGk1qcyM&feature=youtu.be>), [Workshop UT](https://www.youtube.com/watch?v=rLRYo7C069Y&feature=youtu.be) (<https://www.youtube.com/watch?v=rLRYo7C069Y&feature=youtu.be>), [Workshop TC CAS](https://www.youtube.com/watch?v=evDJHNYD1jl&feature=youtu.be) (<https://www.youtube.com/watch?v=evDJHNYD1jl&feature=youtu.be>)

GoNano website: <http://gonano-project.eu/> (under 'Activities')

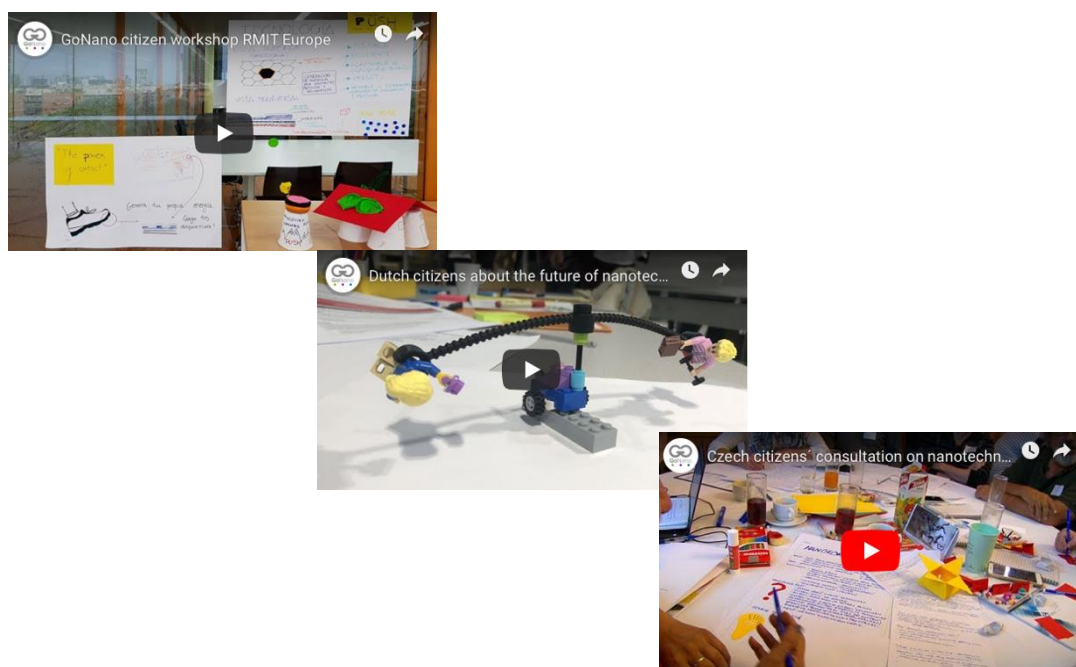


Figure 1 - The GoNano video impressions of the citizen workshops. The citizen workshops were the first step in a facilitated co-creation process aiming to align nanotechnology innovations with societal needs and values.

The social needs and values that we see across all three nanotechnology application areas in food, energy and health are summarised in the table below. In general, the discourse from the citizen workshops reproduced well-known repertoires of optimism and concern: public perception studies consistently show that European citizens are cautiously optimistic about nanotechnologies. They have positive expectations; however, they also have concerns about the risks to human and environmental health, and to societal well-being in general. Citizens generally indicate that they feel poorly informed about the topic and welcome more consumer-oriented information⁴ (Davies et al. 2009; Shelley-Egan et al. 2018). The results from the citizen workshops suggest that citizens recognise and appreciate the promise of nanotechnologies, but they also realise that benefits might not follow automatically from scientific progress (Davies et al. 2009). The DEEPEN project reached a similar conclusion in 2009⁵. In terms of benefits, citizens pointed to a number of desirable applications that would reduce the use of food and energy, increase health and well-being, or make water more available to more people (especially in the third world). Their recognition that benefits might not follow automatically from technology development is seen in them asking the relevant stakeholders to make sure that nanotechnologies do not harm our natural environment or the human body.

⁴ See also the Eurobarometer report: Public opinion on future innovations, science and technology of June 2015.

⁵ The DEEPEN project was a European project exploring ethical challenges posed by nanotechnologies https://www.dur.ac.uk/geography/research/research_projects/?mode=project&id=241. NanOpinion marks another preceding project studying public opinion on the future of nanotechnologies <https://nanopinion-edu.eu/?lang=en>.

The table presents an overview of the social needs and values coming from the citizen workshops on food, energy and health.

Social needs / values	Food	Energy	Health
Sustainability (development, consumption)	x	x	x
Affordability	x	x	x
Accessibility	x	x	x
Human health	x	x	x
Trust			x
Environmental protection	x	x	x
Respect for nature	x	x	
Family (future generation)	x		
Responsibility	x	x	x
Safety	x	x	x
Reliability	x	x	x
Openness	x	x	x
Wellbeing	x	x	x
Transparency	x	x	x
Recycling (circular economy)	x	x	
Water protection	x	x	
Freedom of choice		x	x
Privacy (data)			x
User-centric			x
Prevention			x
non-pervasiveness			x
Empowerment			x
Appreciation of professional role/judgement			x
Ease-of-use			x

A number of values and needs cut across all the citizen workshops. They include sustainable development and consumption, human health, environmental protection, safety aspects, affordability, and accessibility. Citizens expressed various values and needs when it comes to nanotechnologies in food, energy and health. The wideness of these values and needs can be explained by their origins in both fears and a general understanding of the great potential that nanotechnologies have. The more specific requirements are mostly connected to safety, the environment, human health and well-being, affordability, and accessibility of future technologies. The outcomes of the citizen workshop form design requirements for the professional stakeholders.

Next step in the GoNano co-creation process:

Co-creation workshops with stakeholders: The workshops will build on the information gathered from the citizens' workshops in the areas of energy, food and health. Participants with varying backgrounds will identify and evaluate how the needs and values expressed by citizens in the first round of workshops can be used as design requirements for research and innovation trajectories.

When and where:

- 12 February: [Diabetes workshop at Twente University in Enschede \(NL\)](#)
- 21 February: [Energy workshop at RMIT in Barcelona \(ES\)](#)
- 28 February: [Food workshop at TC CAS in Prague \(CZ\)](#)
- 5 March: Nanosensor workshop at Twente University in Enschede (NL)
- 7 March: Health workshop Twente University in Enschede (NL)

2 INTRODUCTION: ENABLING RESPONSIVENESS TO SOCIETAL NEEDS, VALUES AND CONCERNS IN NANOTECHNOLOGY RESEARCH AND INNOVATION

Nanotechnology⁶ has been hailed as the next industrial revolution, comparable to electrification or the steam engine, providing unparalleled technological and social progress in almost any field imaginable. It was to provide radical advances in medical diagnosis and treatment⁷, electronics (Allan, 2003), cheap sustainable energy (Cientifica, 2007), environmental remediation (Joo and Cheng, 2006), more powerful IT capabilities (Anton et al., 2001), and improved consumer products (Maynard et al. 2006). The societal advantages foreseen by the growing capacity to control matter at the nanoscale led Nobel laureate Richard Smalley in June 1999 to proclaim that:

"The impact of nanotechnology on the health, wealth, and lives of people will be at least the equivalent of the combined influences of microelectronics, medical imaging, computer-aided engineering and man-made polymers developed in this century."

Whether or not these promises and expectations will hold true, they have served to generate considerable investment. Despite these high hopes for nanotechnologies (or indeed because of them), expectations and investments have been accompanied by expressions of doubt and concern ever since the ignition of the nano-boom in the early years of the 21st century. Concerned scholars have argued that if this emerging technology is indeed as revolutionary as promised, it would be wise to assess its wider ethical and societal ramifications. In addition to uncertainty about the human and environmental health risks of nanoparticles (Dunford et al., 1997; Poland et al., 2008; Federici et al. 2007) and regulatory challenges, nanotechnology was feared to pose deeper ethical challenges with respect to human enhancement, equity, privacy and security. Leaving aside the question of whether these ethical issues are essentially 'new' or rather reiterations of an ongoing debate, large numbers of scientists, ethicists and policy makers of the early 21st century appeared to agree that nanotechnology wasn't quite 'business as usual' and called for assessment of the ethical, legal and social dimensions of nanotechnology. Moreover, failure to address the broader ethical and social dimensions of nanotechnology was generally feared as an approach that would unleash a 'social backlash' against nanotechnologies, similar to what was seen for genetically modified crops in Europe. As the UK Royal Society and Royal Academy of Engineering nanotechnology report of 2004 noted:

"As recent debates in the UK and elsewhere demonstrate, developments in science and technology do not take place in a social and ethical vacuum. Widespread discussions of issues such as nuclear energy, agricultural biotechnology and embryonic stem cells illustrate this point

⁶ Nanotechnology, or rather 'nanotechnologies' considering the variety in this domain, refers both to materials and products enabled by nanotechnology as well as the technologies and processes to construct these materials and products. Various definitions circulate, but a common feature is the focus on understanding and manipulating matter at the dimension of 1-100 nanometres.

⁷ Nanoforum (2009) Nanotechnology for healthcare. Available at: <http://www.nanoforum.org/educationtree/healthcare/healthcare.htm>.



only too clearly. ... Given this backdrop, it seems highly likely that some nanotechnologies will raise significant social and ethical concerns.”

Although the assumption that nanotech will be ‘the next GM’ has been contested (Sandler, 2006), the potential for a social backlash against nanotechnologies encouraged policy makers to demand attention for the broader dimensions of nanotechnology research, development, and production; including its effect on human and environmental health and safety throughout the life cycle. The European Commission began working early on with governance question of nanotechnologies: In 2004, the European Commission already recognised the need for responsible development of nanotechnologies in its communication ‘Towards a European strategy for Nanotechnology’, where it stressed that:

“Nanotechnology must be developed in a safe and responsible manner. Ethical principles must be adhered to and potential health, safety or environmental risks scientifically studied, also in order to prepare for possible regulation. Societal impacts need to be examined and taken into account. (p.3)”

The 2008 EU ‘Code of Conduct for Responsible Nanoscience and Nanotechnologies’, with its emphasis on responsible development and responsible research, was a response to the uncertainties of risk and the novelty of nanotechnology at the policy and institutional level. The code was a precursor to the idea of RRI as a policy agenda and general concept for governance of research and innovation. Nanotechnologies are therefore one of the first science and technology research areas where practitioners have also experimented with the implementation and development of RRI in science and technology research in practice. The notions ‘responsible innovation’ and ‘responsible development’ have since become key terms in policy debates around nanotechnology in the EU and the US. Large companies in the food and beverages sector have also engaged in dialogues with stakeholders⁸.

Importantly, responsible research and innovation practice in nanotechnology innovation and development implies increased responsiveness to public values, needs and concerns (Stilgoe et al. 2013; Owen et al. 2013). Earlier attempts to facilitate this type of responsiveness in nanotechnology R&I identified particular barriers to responsiveness: lack of profit incentive, low perception of urgency, competing interests, and lack of specificity in engagement⁹. The implementation of responsible governance of nanotechnologies thus faces many challenges.

This report presents the first step of a co-creation process (Bechtold et al. 2018) designed with the aim of 1) Turning lessons from past projects into action; 2) showcasing an early-stage, state-of-the-art, continuous citizen and stakeholder engagement process, which takes into account gender and differences in culture and communication traditions across the EU; 3) developing networks of professional stakeholders and publics that express trust in each other and have the enthusiasm and capacity to carry the agenda of responsibility in development forward.

⁸ Chemical companies that have engaged in dialogue include BASF, Dupont, Evonik Industries and Unilever.

⁹ Lessons learned in the FP7 NanoDiode project (2013-2016), points taken from confidential evaluation report. Partner 2, DPF was partner in the NanoDiode project.

2.1 LEARNING FROM PAST PROJECT ON CREATING CONDITIONS FOR RESPONSIBLE PRACTICES IN NANOTECHNOLOGY R&I

The GoNano methodology itself was based on prior experiences with public engagement, stakeholder engagement and co-creation carried out within the scope of EU research projects and national initiatives. The analysis of Shelley-Egan et al., 2018, found that:

- Discussions should be specific enough to affect the decisions of the actors, identifying specific courses of action
- Participants need to be intrinsically motivated in order to get involved
- There needs to be a shared goal that drives collaboration between stakeholders; there has to be a 'matter of common concern'
- Collaboration should take the form of a joint enquiry
- Clarity of purpose is essential: collaboration should focus on issues the public is concerned about and on what useful information could be gleaned from
- Participants must see the added value of these interactions in relation to their own goals and objectives
- Citizens should be facilitated to have a genuine influence on something that is important to them rather than something on which they may have no influence or interest at all
- The specific dynamics of sectors should be taken into account when developing co-creation processes

Taking this into consideration, the citizen workshops were prepared on the back of interviews with key stakeholders from European Technology Platforms (ETPs), industry, business and research (Pimponi et al., 2018). The purpose of which was to align discussions at the citizen workshops with the interests and research areas of the professional stakeholders.

Furthermore Shelley-Egan et al. 2018 found that a clear problem diagnosis in terms of analysing what issues are at stake is essential for good co-creation processes. The GoNano project addressed this aspect by analysing the issues at stake in terms of the moral norms and values that could be challenged by new nanotechnology applications in food, energy and health. Furthermore, the issues were put into everyday-life situations to make dilemmas tangible and relatable to the citizen participants (Bitsch et al., 2018).

The co-creation process is designed as a continuous and iterative process involving several steps. Citizens, as well as stakeholders, are guided to be more responsive to each other's needs and concerns and to facilitate mutual learning, increased understanding and trust among the different groups. In addition to the lessons learned from previous projects, the co-creation process is also designed to reflect on the role of gender and diversity and culture.

2.2 THE GONANO CITIZEN WORKSHOPS

The GoNano project aims to improve responsiveness to societal needs, values and concerns through a co-creation process between citizens, researchers, industry, civil society organisations, and policy makers across Europe (Bechtold et al. 2018). The process combines a series of face-to-face workshops with an online meeting space to strengthen cooperation among and between different

actor groups. Three thematic deliberative and envisioning citizen workshops formed the first step in the process and provided the input for the first stakeholder workshop. In the first stakeholder workshop, citizens and professional stakeholders will work on suggestions for how nanotechnologies could be designed to align with the citizens' values, needs and concerns.

The citizen workshops were organised in three different countries in order to gain insight on the importance of cultural differences for the organisation of citizen engagement events, as well as for the overall co-creation methodology¹⁰.

2.2.1 Aim and methodology of the citizen workshops

The aim of the workshops was to enable the citizens to come together, to consider and commonly reflect on specific nanotechnology applications. The outcome would thus be an overview of citizens' needs, values and concerns related to future nanotechnologies and their application in the areas of food, energy and health. The workshop participants formulated the following outputs:

- Initial feedback on the nanotechnology application areas;
- Wishes – preferences related to the future applications of nanotechnologies in food, health and energy;
- Requirements and principles that the citizens want technology developers to comply with or consider when they develop new nanotechnology applications in food, health and energy;
- Messages to policy makers and specific stakeholder groups related to nanotechnology applications in food, energy and health.

In addition to the concrete outcomes of the day, the workshops were also designed to:

- Collect diverse groups of citizens together and to get as representative a sample as possible;
- Inform participants about three possible application areas of nanotechnologies in food, energy and health and allow their voice to be heard on related wishes and concerns;
- Enable citizen participants to create suggestions for nanotechnology product/applications;
- Recruit citizens for participation in the first stakeholder workshop.

The participants of the citizen workshops were guided in a process of envisioning and co-creating suggestions for the early stage of nanotechnology research and innovation that would live up to their needs. Prior to the workshop, all participants received an information package¹¹. Participants worked in small groups and with the help of a moderator throughout the day. Outcomes of their discussions were recorded using an online tool¹². The moderator's role was to make sure every participant was able to contribute to the debates at the tables, to take notes, and to make sure key points of discussions were recorded in the online tool. In terms of the composition of participants, organisers worked with the aim of collecting 48 participants from different backgrounds based on various demographic criteria (gender, age, education, economic activity, place of residence).

¹⁰The GoNano pilot partners are: University of Twente (UT), Technology Centre of the Czech Academy of Sciences (TC CAS) and Royal Melbourne Institute of Technology (RMIT). The lead partner on the coordination of citizen workshops is Technology Centre of the Czech Academy of Sciences (TC CAS).

¹¹ The information packages can be found here: <http://gonano-project.eu/information-material-citizen-workshop/>

¹² The Online tool is part of the GoNano co-creation platform. In project terms this part of the platform is referred to as 'EngageSuite'.

The general set-up of each workshop followed the phases as shown in Figure 2.

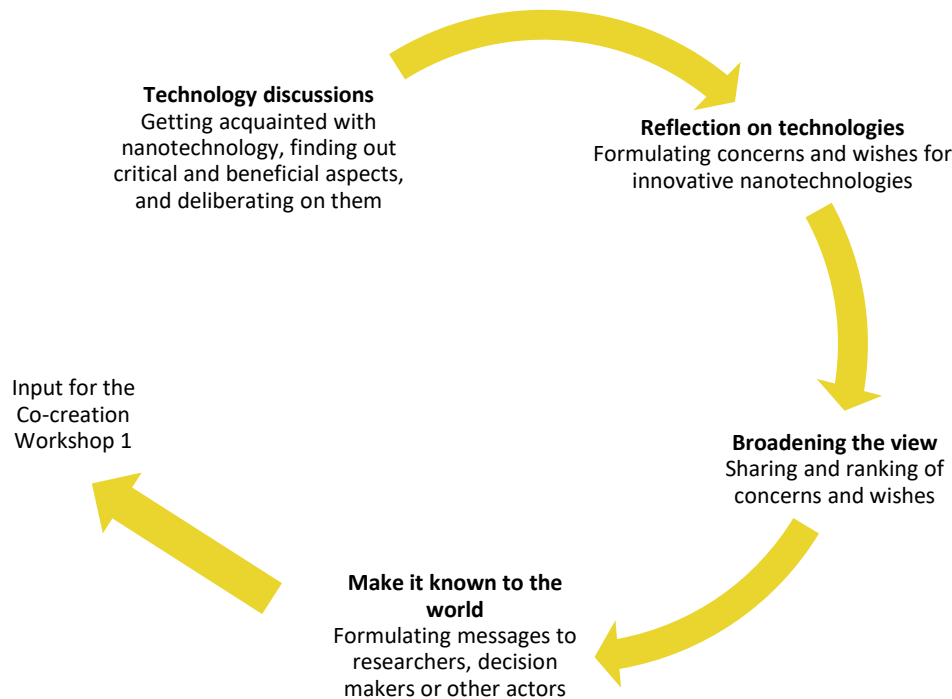


Figure 2 – shows the phases guiding the organisation of the citizen workshops

In the first phase, the moderator introduced the participants to the themes and scenarios in the information material and the participants took time to discuss them together. In the second phase, individual wishes were formulated by all participants, presented at the tables, and then some of the wishes were chosen to be elaborated further. Participants formulated and modelled/illustrated their 'ideal technology' based on the most popular wishes. The most popular table wishes, sometimes illustrated and/or even accompanied by a model of a nanotechnology application, were then prioritised by all participants via a plenary vote. In the third phase, participants formulated messages to various stakeholder groups (policy makers, researchers, media, business, NGOs/CSOs). A questionnaire was handed out to all citizen participants following the workshop and the results of these questionnaires are analysed in Annex IV. The outcomes of the national workshops are presented in Annexes I, II and III.

Table 1 – gives an overview of the three citizen workshops and their main characteristics¹³.

Where and when	Number of participants (m/f)	Characteristics of participants
Nanotechnologies in Food, The Academy of Sciences of the CR, Prague, Czech Republic, October 20, 2018	48 (24/24)	Balanced across gender, age, education, economic activity, and place of residence.
Nanotechnologies in Energy, Royal Melbourne Institute of Technology Europe, Barcelona, Spain, October 26, 2018	21 (6/15)	Majority female, highly educated and mostly from urban centres, wide age range.
Nanotechnologies in Health, DesignLab, University of Twente, the Netherlands, November 24, 2018	50 (27/23)	Most demographic criteria were fulfilled, except for the level of education. Citizens were mainly higher educated, a few middle-educated, but no lower-educated people participated in the citizen consultation.

In the following we first present the results of the citizen workshops (Chapter 3), before we reflect on the similarities and differences in needs, values and concerns between topics areas and in relation to findings from other engagement projects on nanotechnology (Chapter 4). We also present suggestions on how the results could feed into the next step of the co-creation process: co-creation workshops with professional stakeholders and citizens. Finally, we present the evaluation of the workshops. The detailed analysis and evaluation of the country meetings can be found in Annexes I, II, III and IV.

¹³ Details on recruitment and characteristics of participants in each of the citizen workshops can be found in Annexes I, II and III.

3 CITIZEN VIEWS ON NANOTECHNOLOGIES IN FOOD, ENERGY AND HEALTH

In the following sections we briefly summarise results from the citizen workshops on nanotechnology in food, energy and health. We describe the wishes, messages and requirements of the citizen participants and highlight the values expressed in their results.

3.1 NANOTECHNOLOGIES IN FOOD: RESULTS FROM THE CZECH CITIZEN WORKSHOP

The Czech participants painted a complex picture of the potential of nanotechnology in future food. Benefits such as clean water using nanofilters were described as the most understandable and desirable by the participants. Many described clean water as an issue connected to **global climate change**, and as an issue of the **quality of water**, and proposed a solution on all levels: households, local, national as well as global. The second most desirable solution – smart food packaging – was described as an attractive solution to global challenges with plastics (and microplastics). Some participants thought that they could contribute to a more effective food production system that would be less damaging to the environment, and also that they could enable food to be transported over longer distances. The participants also described nanotechnology in food as a possible contribution to furthering human health, healthy ecosystems and nature (Figure 5 and Figure 4 show two of the many suggestions produced in the Czech citizen workshop).



Figure 3 – Participants at the Czech citizen workshop on nanotechnologies in food.

In terms of desirability of specific nanotechnology applications in food, the participants ranked possibilities as follows: 1) nanofilters (and water), with 86 out of 276 votes¹⁴; 2) smart food packaging, with 83 of 276 votes; 3) novel foods, with 68 of 276 votes; 4) a control and safety system for nanotechnology applications in food, with 39 of 276 votes.

¹⁴ 276 votes were given overall.

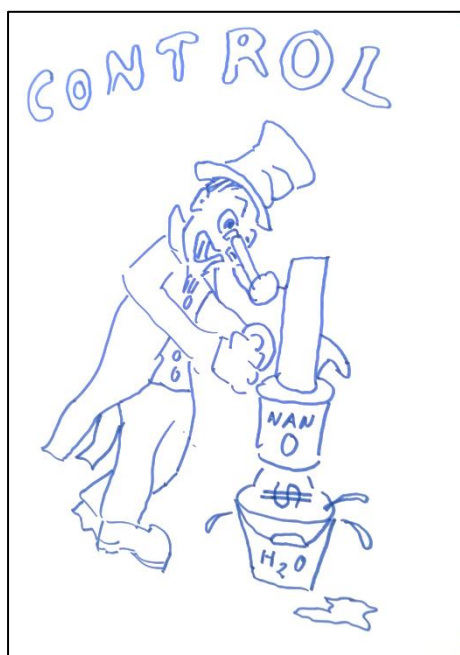


Figure 5 – An illustration of a control mechanism proposed by citizens

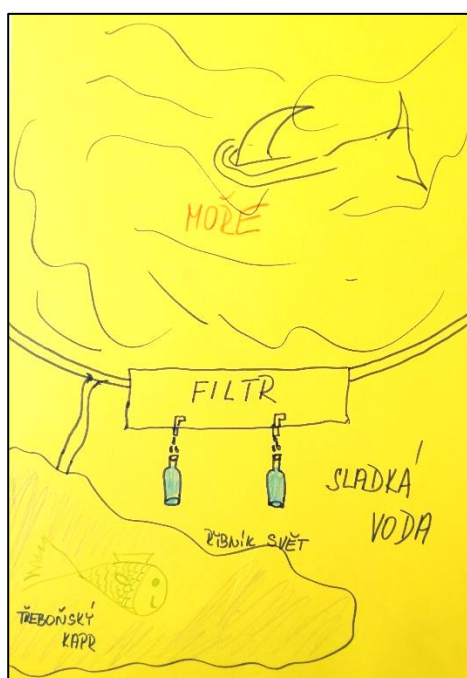


Figure 4 - Illustration of a desalination mechanism filtering sea water into potable water

The citizens pointed to a number of requirements for **acceptability** and **sustainability** of nanotechnology in food. Some citizens stressed the general need for sustainable consumption, mainly in the sense of supporting local foods. Any potentially harmful effects on future generations of humans, especially those caused by novel food products, should be investigated and avoided. That is probably why novel foods were perceived as the most controversial of all the given applications. Some participants were concerned about how they would affect future generations, and some were simply sceptical of novel foods because they may affect the social and cultural aspects of food preparation.

During the consultation it seemed that the wider spread an application was, the more (re)assurance the citizens require. Some participants proposed that this (re)assurance can be obtained when the purpose of the product is well articulated (e.g. a product for people with allergies or sportsmen) and the product is well labelled and well presented. For many citizens it was important (1) to be assured that nanotechnologies in food are safe to use, that they do not harm the human body and ecosystems, and (2) that nanoparticles do not accumulate in the food chain. Some participants thus required certification systems – labelling of novel foods with e.g. a NANO label. In general the Czech participants were enthusiastic about products that can be considered innovative, e.g. substitutes for plastics, and they believed such products should be supported and pushed forward (incl. financial support). They Czech citizens also emphasised that new nano-food products should be **affordable**.

Some participants believed that when the design criteria are met and the safety of the technology is well communicated and presented, then nanotechnology would be widely accepted. However, this seems to be contrary to other evidence that indicates informing a population does not necessarily lead to greater acceptance of new technologies (Bucchi & Neresini, 2002; Wilsdon & Willis, 2004).

Table 2 – shows the wishes and messages developed during the Czech citizen workshop and the values mentioned or implied in those wishes and messages.

Keywords	
Wishes	<i>Clean water, available water, food protection, control system, system rules, biodegradability, safety, testing, food chain, nanoparticles, increased shelf-life, large potential, substitute for other technologies, substitute for chemistry, climate change solution.</i>
Messages	<i>Safety and control of the technologies, certification system, sustainable consumption, ethical and socially responsible entrepreneurship, the role of media in informing, financial support of true innovations, sustainability, global solution of clean water lack.</i>
Values	<i>Innovation, sustainability, accessibility, affordability, responsibility (e.g. ethical and socially responsible entrepreneurship), accountability, information, transparency, control, recycling, family, health, wellbeing, long-term sustainability, safety, rules, organic/biodegradable materials, nature.</i>

3.2 NANOTECHNOLOGIES IN ENERGY: RESULTS FROM THE SPANISH CITIZEN WORKSHOP

The Spanish citizens' discussion of nanotechnology and energy applications was strongly tied to a discourse on respect for, and preservation of, our environment; in addition to requirements of affordability for the end user. The citizens pointed to a number of application areas where they think nanotechnologies can play a role: (1) capturing and converting energy (e.g. solar and kinetic) to electrical energy for storage and use; (2) different ways of adapting structures around the home to make use of renewable energy, for example, building Integrated Photovoltaics; (3) home climate systems that control the atmosphere around the home and also inform inhabitants of usage in simple terms; (4) smart home appliances and operating systems; (5) general technologies or products that are more sustainable and do not adversely affect health or the environment. In the context of energy (in their homes and even in their personal devices and clothes), there were few limitations as to how and where nanotechnology could be implemented, so long as it is of benefit to the end-user. Such limitations and benefits derive from the social needs and values of the participants. For example, the need to reduce energy usage in the home could be driven by the desire to respect and help the **environment**; however, the more likely driver is the cost benefit to the end-user. The limits of acceptability for nanotechnologies seemed to depend very much on perceived levels of safety and sustainability, which generates a need for developers to take them into account for new technologies to be successfully adopted by the public.



Figure 6 - Participants at the Spanish citizen workshop on nanotechnologies in energy.

The citizens' individual messages to the developers of nanotechnologies were in most cases not addressed to specific stakeholder groups; however, the messages could be categorised by theme: **environment and sustainability**, **health and safety**, and **social aspects**. Messages related to the environment and sustainability called for products, R&D processes, and manufacturing processes to be more sustainable and not endanger the environment. Ways in which citizens proposed this could be achieved were by investing more in sustainability, paying more attention to the types of materials one works with, reducing waste, reducing programmed obsolescence, recycling more, and making things easier to maintain. Ultimately, they think we need to move towards a circular economy, where we consider both the economic and environmental benefits of recycling items. Health and safety was only lightly touched upon; however, that should not be interpreted as a lack of importance. If anything, it is actually the opposite – the safety of any product or process is paramount for its acceptance in society but there appear to be sufficient levels of trust in the safety measures and rules and regulations in place within Europe for it not to worry the citizens. A contrasting argument can therefore be made for the comments on the environment and sustainability, in that more participants commented on this topic because it is important to them but they feel it is not perceived to be of value to the other stakeholders, and hence the need to tell them and to ask for more legislative support of green policies. Following this train of thought, the social aspects that were important to the group of citizens, and that the stakeholders should take note of are: new technologies should be **socially and economically accessible**; both public and private investment is encouraged; **public engagement** and **transparency** is vital for educating the public and building trust; large organisations and policy makers should promote research into new technologies; scientists should not just publish for the sake of publishing without actually solving problems; and organisations should look more at the needs of humanity and not so much at the capital their ideas can generate.

Table 3 - shows the wishes and messages developed during the Spanish citizen workshop and the values mentioned or implied in those wishes and messages.

Keywords	
Wishes	<i>Energy capture, energy conversion, energy storage, home climate systems, smart appliances, sustainable products.</i>
Messages	<i>Environment, sustainability, waste reduction, recycling, programmed obsolescence, circular economy, health and safety, socially accessible, economically accessible, public investment, private investment, public engagement, transparency, ethics in research.</i>
Values	<i>Sustainability, waste reduction, recycling, durability, transparency, openness, ethical research/research practices, health, safety, accessibility, dialogue, safety, efficiency.</i>

3.3 NANOTECHNOLOGIES IN HEALTH: RESULTS FROM THE DUTCH CITIZEN WORKSHOP

In general, most participants could see the potential of monitoring devices, early-diagnostic devices, and regenerative medicines. They saw benefits in the prevention of diseases, unburdening the patient, and how different technologies could improve people's wellbeing. However, they also mentioned a number of concerns, messages and wishes to take into account when further developing nanotechnology in health. These can be divided in four areas: (1) nanotechnology in general, (2) accessibility and autonomy, (3) reliability and interpretation of data, and (4) privacy and security of data. Within these areas, various social values could be deduced (marked in bold), with social needs linked to them.



Figure 7 - Participants at the Dutch citizen workshop on nanotechnologies in health.

Little attention was given to ‘nanotechnology in general’; however, when citizens addressed it, they thought nanotechnologies should be developed in a **safe and sustainable way**. Participants emphasized the particular importance of not harming a **person’s health** with regard to invasive technologies such as nanochips and regenerative medicines. Additionally, a few participants emphasized that nanotechnology in medical technologies should be **environmentally friendly**. Overall, participants saw many more advantages than disadvantages for the potential applications of these technologies.

Privacy and security in the collection, storage, and sharing of data were also often mentioned in relation to monitoring and diagnostic devices. Citizens thought it was very important that the various parties involved in the process of data collection were **transparent** about what would happen with the data. Citizens also emphasized that in the design of a smart device, security and privacy should be one of the leading principles. Furthermore, they emphasized that an individual should be the **owner of his or her own data** and should be given **autonomy** over decisions of data collection, monitoring, storage, and sharing. This ownership model should be customisable, as everyone could have different wishes and needs in this regard.

Accessibility and autonomy were often addressed when discussing the different technologies. Citizens emphasized that healthcare should be affordable and accessible for everyone; nanotechnology could be an enabler for decreasing the costs. Citizens also addressed that medical technologies should not polarize society. They posed some concerns regarding diagnostic and monitoring devices that were designed to be used by citizens, which could lead to a digital divide in society between people who are able and willing to use these devices and people who are not. In case of regenerative medicines, citizens mentioned the potential divide between religious and non-religious people. Most citizens thought religious values should not be leading in the development and implementation of health technologies. Nevertheless, they did emphasize that there should always be always freedom of choice and a variety of treatment options available.

Reliability and interpretation of data were often mentioned in relation to monitoring and diagnostic devices. Citizens emphasized that even though ‘home-monitoring’ and ‘home-diagnostic tests’ could increase emancipation of citizens and decrease the costs of the healthcare system, it could also cause stress for an individual and potentially lead to misinterpretations. Citizens questioned whether being constantly aware of health indicators would lead to an increase in wellbeing. They suggested taking this into account in the design principles and to only alert the patient/user when anomalies are detected. Additionally, citizens emphasized the importance of reliable data, and educating users about how to interpret this data and how to handle a margin of error. A large number of citizens underlined that they would not want to exclude the medical professional in the diagnosis and treatment of diseases. They thought the medical professional should act as a moderator between the device and the citizen or patient. The professional should analyse and interpret the data (remotely) and warn the individual in cases where anomalies were detected.

Keywords, representative of the wishes and messages mentioned by the participants, are presented in Table 4:

Table 4 - shows the wishes and messages developed during the Dutch citizen workshop and the values mentioned or implied in those wishes and messages.

Keywords	
Wishes	Autonomy, accessibility, privacy and security, invasiveness (invasive vs. non-invasive devices), aim (preventive vs. curing devices), material (biological solutions vs. smart materials), agency (individual or healthcare professional).
Messages	Transparent, trust, needs citizens/consumers, wellbeing, security, privacy, responsibility, safe by design, different alternatives, decrease costs, regulate, facilitate innovation, preventive healthcare system, educate and inform.
Values	Autonomy, accessibility, affordability, privacy, security, trust, reliability, wellbeing, responsibility, user-centric, regulation, education, information, prevention, non-pervasiveness (of application), empowerment, potential, innovation, appreciation of professional role/judgement, ease-of-use.

4 IMPLICATIONS FOR CO-CREATION BETWEEN CITIZENS AND PROFESSIONAL STAKEHOLDERS

In general, the discourse from the citizen workshops reproduced well-known repertoires of optimism and concern: public perception studies consistently show that European citizens are cautiously optimistic about nanotechnologies. They have positive expectations; however, they also have concerns about the risks to human and environmental health and to societal well-being in general. Citizens generally indicate that they feel poorly informed about the topic and welcome more consumer-oriented information¹⁵ (Davies et al. 2009; Shelley-Egan et al. 2018). The results from the citizen workshops suggest that citizens recognise and appreciate the promise of nanotechnologies, but they also realise that benefits might not follow automatically from scientific progress (Davies et al. 2009). The DEEPEN project reached a similar conclusion in 2009¹⁶. In terms of benefits, citizens pointed to a number of desirable applications that would reduce the use of food and energy, increase health and well-being or make water more available to more people (especially in the third world). Their recognition that benefits might not follow automatically from technology development is seen in them asking the relevant stakeholders to make sure that nanotechnologies do not harm our natural environment or the human body.

Throughout the three workshops, citizens highlighted the need to engage in dialogue on the impacts of nanotechnologies. A number of characteristics of the technology application correlated with the strength of the need to engage in dialogue:

- The more widespread or the closer to a person's body a technology application would be, the stronger the need the citizens expressed for dialogue and information (the Nanodiode citizen survey held in 2014 found similar results)¹⁷
- The less obvious a technology application's contribution was to solving a societal need or challenge, the more questions the citizens would have about the application. E.g. participants could understand nanotechnologies in health applications as a solution to a specific disease more easily than the preventative benefits of modified foods.

Engagement by any stakeholder with publics on nanotechnologies would need to appreciate the strength of the narratives on a new development like nanotechnologies. Engagement activities that recognise and provide legitimate space for the concerns and uncertainties of publics in relation to the promised benefits of a new technology will have a much higher chance of success (Davies et al. 2009; Moore et al. 2018; Bucchi & Neresini, 2002; Wilsdon & Willis, 2004). Such approaches are in contrast with what professional stakeholders perceive as the need to explain and convince publics of the safety of nanotechnologies (Pimponi et al. 2018). Organisers of workshops with professional stakeholders need to be aware of this point.

¹⁵ See also the Eurobarometer report: Public opinion on future innovations, science and technology of June 2015.

¹⁶ The DEEPEN project was a European project exploring ethical challenges posed by nanotechnologies https://www.dur.ac.uk/geography/research/research_projects/?mode=project&id=241. NanOpinion marks another preceding project studying public opinion on the future of nanotechnologies <https://nanopinion-edu.eu/?lang=en>.

¹⁷ <http://www.nanodiode.eu/project/citizen-survey-and-in-depth-interviews/>

In addition to providing space for recognition of the citizen narrative on benefits and concerns, the further co-creation process of this project must take into account the values expressed in the messages and wishes from the citizens. For governance of nanotechnology development and innovators, the results from the citizen workshops are particularly interesting as they point both to desirable ends (reduce the use of food and energy; increase health and well-being; make water more available to more people, especially people in the third world) and to important needs that should be safeguarded in implementation (avoid harm to environment and humans; avoid polarisation in society; ensure accessibility and affordability; ensure nanotechnologies develop under public scrutiny and in dialogue with societal stakeholders and publics; support a circular economy; reduce waste; increase recycling; ensure sustainability; safeguard privacy and security, ease of use and maintenance). The full list of values from the three workshops is given in Table 5.

Table 5 – Overview of the societal needs and values coming from the GoNano citizen workshops.

Social needs / values	Food	Energy	Health
Sustainability (development, consumption)	x	x	x
Affordability	x	x	x
Accessibility	x	x	x
Human health	x	x	x
Trust			x
Environmental protection	x	x	x
Respect for nature	x	x	
Family (future generation)	x		
Responsibility	x	x	x
Safety	x	x	x
Reliability	x	x	x
Openness	x	x	x
Wellbeing	x	x	x
Transparency	x	x	x
Recycling (circular economy)	x	x	
Water protection	x	x	
Freedom of choice		x	x
Privacy (data)			x
User-centric			x
Prevention			x
non-pervasiveness			x
Empowerment			x

Appreciation of professional role/judgement			x
Ease-of-use			x

Many **values and concerns** are similar across the three countries and topics, a finding which in itself supports the need to take the citizen narratives seriously in our further co-creation process.

4.1 EVALUATION OF THE CITIZEN WORKSHOPS

At the end of the citizen workshop, every participant received a questionnaire. As part of evaluating the success of the events and our methodology for co-creation, the questionnaire was designed to test three key criteria:

- Perceived increase in knowledge and understanding of nanotechnologies,
- Trust and mutual understanding among the participants,
- Co-creation

The questionnaire filled out at the citizen workshops served both as a baseline measurement (e.g. trust in various stakeholders and expectations in co-creation process), and as an evaluation-measurement (e.g. organisation of workshop and increase of knowledge and understanding). It consisted of several constructs (consisting of three or four items) and a few single-item questions, all based on five-point-Likert scales. An English questionnaire served as the main document, and all questions were translated to the language of the pilot country (Dutch, Czech, and Spanish). Every construct that was included in the questionnaire had a Cronbach's Alpha which was 0.70 or higher and is therefore reliable (Field, 2005). See more on the evaluation results in Annex IV of this report.

The citizen workshop was to be a space for citizens to discuss nanotechnology in an easily accessible yet balanced and open way; voice their needs, values and concerns; and to provide creative input to the design of nanotechnology in food, energy and health. It was also supposed to encourage the participants to continue their involvement with the co-creation process beyond the workshop, and to take into account gender and differences in culture and communication traditions across the EU. The desired outcomes were to have a list of wishes for future nanotechnology developments, a set of requirements and messages directed to specific stakeholder groups, and a list of needs and values produced from the citizens' comments during the discussions.

Judging from the data collected on the day through the online tool, other note-taking methods, and the post-workshop evaluation questionnaire; the workshops achieved their aims and fulfilled the desired outcomes:

- Diverse groups of citizens were gathered at each of the three events to get representative samples of population for capturing relevant input for the stakeholder workshops;
- Representatives of the wider public were informed about three possible application areas of nanotechnologies in food, energy and health and their voice was heard on related wishes and concerns;



- The research partners were able to take on the social needs and values, from the citizens' wishes and concerns in this report, to the relevant stakeholders together with direct messages from citizens;
- The process of the day enabled participants to create product/application suggestions as planned;
- Representatives of the citizen workshop will have a chance to take part to the stakeholder workshop as well to make sure their input is taken on board and reflected upon by the stakeholders.

The above findings show the procedural objectives of the citizen workshop were achieved. Further reflection on the substantive outcomes (e.g. learning from our experience working with the method of the workshops and the connections between the outputs on the work planned in the next step of the co-creation process) and evaluation will follow once we have concluded all the steps in our methodological set-up.

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Results from deliberating and envisioning workshop with citizens

NATIONAL REPORT – FOOD – CZECH REPUBLIC

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Partner responsible:	Technology Centre CAS (TC CAS)
Compiling author(s):	Lenka Hebáková and Marek Pour, Technology Centre CAS
Contributing author(s):	Sikke Jansma and Anne Dijkstra, University of Twente Craig Richmond, RMIT
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1. INTRODUCTION

The aim of the workshops is to enable the citizens to come together to commonly reflect on specific nanotechnology applications and provide their needs and concerns, so that the future nanotechnology applications are aligned with these. More specifically, the workshop participants formulated the following output:

- Initial feedback to the nanotechnology application areas;
- Wishes – preferences related to the future applications of nanotechnologies in food
- Requirements and principles that the citizens want technology developers to comply with or consider when they develop new nanotechnology applications in food
- Messages to specific stakeholder groups related to nanotechnology applications in food

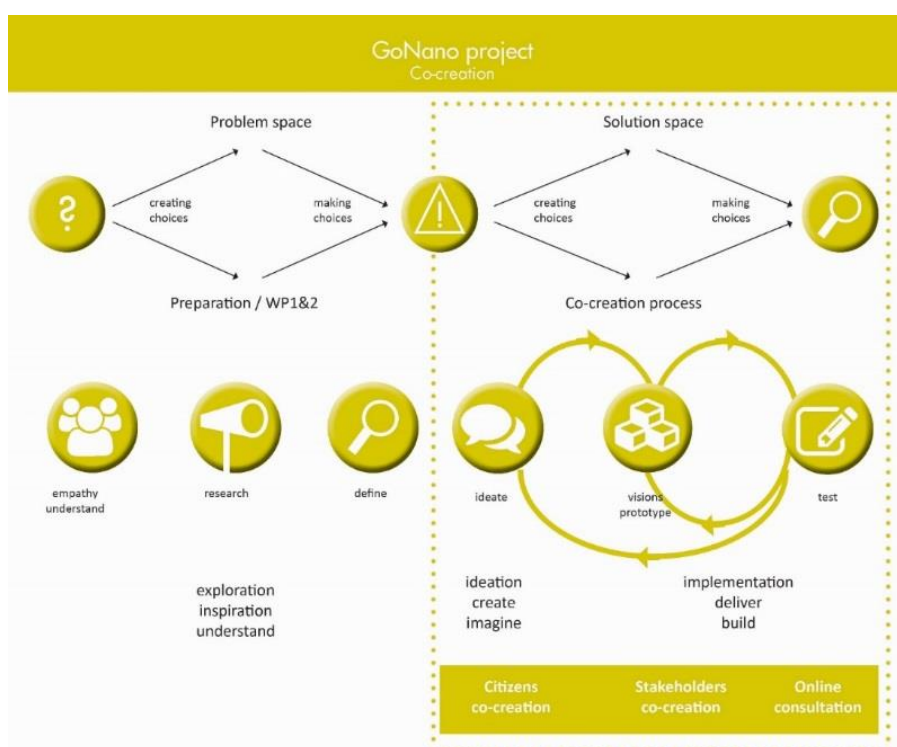


Fig 1 GoNano project co-creation process¹

The deliberate and envisioning workshops with citizens were held during October and November 2018 in three pilot countries: Czech Republic (application of nanotechnologies in food), Netherlands (nanotechnologies in health) and Spain (nanotechnologies in energy). The citizen workshop focused on nanotechnology applications in food was held on October 20, 2018 in Prague.

TC CAS in cooperation with a recruitment company managed to obtain the desired number as well as structure of citizens as the population sample, which aimed to be as diversified as possible when it comes to various indicators, specified well before the event in a recruitment strategy (see Annex 1). Well before citizens got the Information material explaining nano in the three thematic areas of food (smart packaging, nanofilters and novel food). During the whole day of the precisely designed

¹ <http://gonano-project.eu/wp-content/uploads/2018/06/co-creatie-GoNano.pdf> (2018-07-24)



explorative workshop citizens widely discussed pros and cons of nano in food and elaborated their individual wishes and concerns; voted for the best wishes by the table as well as in the plenary and elaborated some of their ideas on applications and products in a very creative manner. Finally, they formulated messages for various stakeholder groups.

Quite an amount of the participants expressed their interest in the following process, a few of them agreed on future consultations with the experts. However, the overall acclaim was mainly or almost absolutely positive as far as the feedback goes – both in terms of a questionnaire and in terms of a feedback on the place. E.g. 35 people out of 48 opted in for receiving more information on the GoNano co-creation process and outcomes in the future. Some of the participants also opted in for the future online and stakeholder consultations.

2. NANOTECHNOLOGY APPLICATION AREAS IN FOOD

The outcomes of expert interviews (D1.3) revealed the most relevant areas of development in nanomaterials and nano-related applications or products that are enabling new applications in the food sector. Three specific applications that could be available on the market in the medium or long term potentially having the most relevant impacts on society were identified (see below). At the deliberate and envisioning workshop, citizens provided reflections to each area as well as their views about how to integrate ideas for future development of the applications of nanotechnology that are aligned with citizens' needs and values, as specified below.

2.1. SMART FOOD PACKAGING

This application is to improve food quality and safety and prolong shelf-life of fresh and processed products. Scientists imagine nanotechnology will lead to smart food packaging in biodegradable materials with e.g. anti-microbial, anti-fouling, stain-resistant, water repellent properties. In addition, nanosensors in the food packaging may in the future detect contaminated food and warn you by showing a red dot on the package. Overall, these properties could be used for the so-called “customer specific” packaging solutions. Benefits include: extended shelf life, improvement of food security, and reduction of the environmental impact from production and degradation of food packaging. Risks: nanoparticles migration and food contamination.

Initial citizens' feedback:

Smart food packages should be self-degradable and biologically degradable. They should replace plastics, they should be alternatively recycled, composted and/or used for the production of energy. They should increase the shelf life of the packaged food especially for uses such as long trips, natural disasters, space missions, for customers with a low availability of grocery stores. Some of the participants were afraid of the possible price increase in such goods. Others thought that the use of nanotechnologies would lead to “natural” differentiation of customers. Price would, according to many, have a special importance for (some) groups of customers. The participants also appreciated that smart food packages seem as a good opportunity for companies. They propose that producers of smart packaged goods could be supported financially. Necessity of a promotion of nanotechnologies



was also addressed. According to some, intelligent packages could be firstly promoted by the international market chains.

However, it is essential, that the packages are well marked and standardized. Participants expressed the necessity of a research on influence of nanoparticles on human body and how the particles are being processed in the food chain – they mentioned the necessity of testing and controlling, especially in case of mass distribution. Participants expressed their doubts concerning the absence of experience with nanopackaging and the fear of possible misuse and unsafety. Participants were also curious (as they were feared) to what particles would nanotechnologies degrade themselves and for which foods are they appropriate: The packages should protect the food against the external influences (UV light, soaking, bacteria contamination). The smart packaged food could also react to specific needs of a customer; it could e.g. switch the advertisement on the packaging dynamically.

Some of the participants were quite sceptical about smart food packaging as they saw it as a parallel to the plastic “boom”. They were also claiming that packaging overall should be as limited as possible, and the foods should be consumed near to its place of origin. Some participants were sceptical about political representation, corporations and entrepreneurs. Smart food packages could be risky for farmers, since the long-term shelf life of smart packaged food could decrease the food consumption, on the other hand smart packages would also decrease the ecological burden.

2.2. NOVEL FOODS

These are 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), enabling targeted delivery/release of nutrients. It is also 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 flavour, texture and appearance, makes the product process more efficient. Risks: reduced safety when changing industrial processes.

Initial citizens' feedback:

The advantages of Novel foods are grounded in their (time) effectivity – they could be helpful to sportsmen, top management, they could be used in health care and astronautics. The shelf live would be prolonged. Novel foods would contain vitamins and other added substances leading to improvements in human health as they would replace food supplements, they could be used by people affected by allergies, they would attract new customers. Enriched foods could compensate bad taste or they could either have a specifically desired taste. Some participants thought that nanotechnologies could substitute chemicals in the process of growing; they would also absorb the harmful substances in organism. Nanotechnologies could on the one hand help with the lack of food and with more effective production of food. On the other hand, participants were afraid that this effectivity could lead to overpopulation of the planet. Novel foods were also perceived as a parallel to GMOs by some. The most often worry about the possible impact on health was the disruption of cells and the accumulation of the nanoparticles in the organism. The participants also warned about the current inexperience and the necessity to set rules and to condition future development by



further testing. The importance of an information campaign was mentioned. A fear of possible worsening of the look of the foods was also discussed.

Novel foods were from all the given topics the most controversial one. “Adjusted” food was to some a worrying idea connected to concerns about future generations. One of the simpler reasons of scepticism was also the exclusion of the social function of cooking. Therefore, participants required certification systems – they would appreciate labelling the novel foods with e.g. NANO label on the same base as the label BIO is used. Labelled novel foods would be better recognizable – some claimed that also a different price would lead to the same results. A specific proposal was a design of an “empty” food, which could be e.g. put in a flavour of your own choice. This could be also appreciated (incl. visual appearance changes) by children.

2.3. NANOFILTERS

Filtering with nanomembranes / nanofibers for purification of drinking water and beverage is already providing low-cost solution for water purification in some developing countries. Nanofilters can remove bacteria, viruses, heavy metals and organic materials from water and other liquids.

Initial citizens’ feedback:

Nanofilters received mainly positive feedback – according to participants they seem the most understandable and well known application of nanotechnologies so far. They have a potential to accelerate the technological progress and at the same time bring about a broad range of use: they could lead to a cleaner water and to a decrease of its price, they could be used instead of chemical treatment. Nanofilters were mostly referred to water: they would filter given substances such as hormones and medicine residues. A potential group of customers would be e.g. parents with their children. However, it would be necessary that nanofilters do not remove the needed particles as well (e.g. in oceans) and that they preserve the taste of the water: filters should remove only the unhealthy substances, not the desired ones such as minerals, they should not lead to a “dead water”. Some participants therefore saw the usual water cleaning technologies as a more careful approach. From the global point of view nanofilters could deal with the lack of water and its bad quality – e.g. via desalinization of the sea water (through mobile devices on boats) or via decontamination of the soil, ocean cleaning. Nanofilters could play an important role in resolving ecological problems and could lead to a better management of water and reusability of the contaminated water in the third world (or also e.g. to solve oil spills).

In households, nanofilters could replace plastics and reduce their consumption. They would also serve as filters for food and beverages industry (e.g. beer and wine) or in case of protection of foods in fridges and areas that do not concern food primarily – filtration of cigarettes, or filtration of the air pollution from power stations, light smog, exhaust fumes. In general, there was a consensus on the special importance of filters in food sector and beyond... However, an important question was the price of such filters, would they be affordable? The abundance of quality water could depend on it.

The overall number of the expressed fears was lowest among all the three applications. Most frequently, fears concerned the unknown consequences of the usage, impossibility of control and misuse. Fear of nanoparticles release, the longevity of nanofilters and a question what would happen to the collected waste and used filters. There was also a concern about the nanofilters being threat to some lobby groups since the new technologies threaten the well-established ones. The necessity of strict laws, research financing and testing of possible impacts on health was mentioned. The participants also made an appeal to other people to not count on nanotechnologies to solve everything.

3. CITIZENS' PREFERENCES TO THE NANOTECHNOLOGY APPLICATIONS IN FOOD

Participants at the deliberating and envisioning workshop formulated a number of wishes, principles and rules related to the future applications of nanotechnology in food. Below is the list of them, ranked according to their perceived importance and relevance. The voting was carried out at the workshop by its participants.

These ideas came from individual wishes which were firstly discussed at each table and then voted for or agreed on. However, as they do not reflect all of the given wishes, we present the summary of the individual wishes below the main outputs.

Wish 1	Nanococktail	Number of votes:
		42
Reference to the application area: Novel foods		
Description: This product is a complex nutrient providing customer with a complex diet. The quantity of the nutrient equals one swallow. The content of the nutrient is optimized for a certain group of people, it is possible to personalize it. The package (can, capsule, gift package) has specific colors, it is selfcleaning and selfdegradable.		
Quality of the technology: <ul style="list-style-type: none">Cheaper production in the case of a canMore expensive production in the case of a selfdegradable (biodegradable) package		
Given use of the nanotechnology deals with the according problems: <ul style="list-style-type: none">The effectiveness of packages contributes to smaller amount of overall wasteDecreases emissions during the production and waste managementDecreases the time needed for the preparation of cocktailHelps to increase the profit of the companies decreasing the overall sickness rate and increasing the overall effectivity of the employeesIt supports the possibility of shortening the working hours (with increased effectivity), which would mean cost savings in electricity, comodities etc.Decreasing importance of the traditional medicines		
Situations to-be-used in:		

- Critical situations – wars, floods, earthquake, epidemics
- In hospitals, institutions for long-term sicknesses, senior houses
- For prevention in schools and nursery schools
- In stressful work positions – workers (in car industry, Amazon etc.), at the ministry (politicians), mobile operators workers, bank officers
- Top sportsmen
- Maintaining a good health condition

Target groups:

- Men, women, children, sportsmen, pensioners, ill (according to further specifications) and other specific groups of people



Wish 2 Control of misuse of nanotechnologies in food

Number of votes:

39

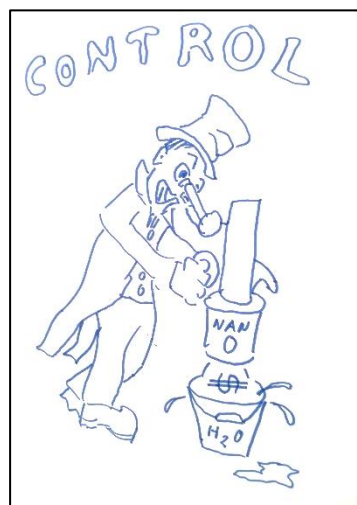
Reference to the application area: General wish

Description:

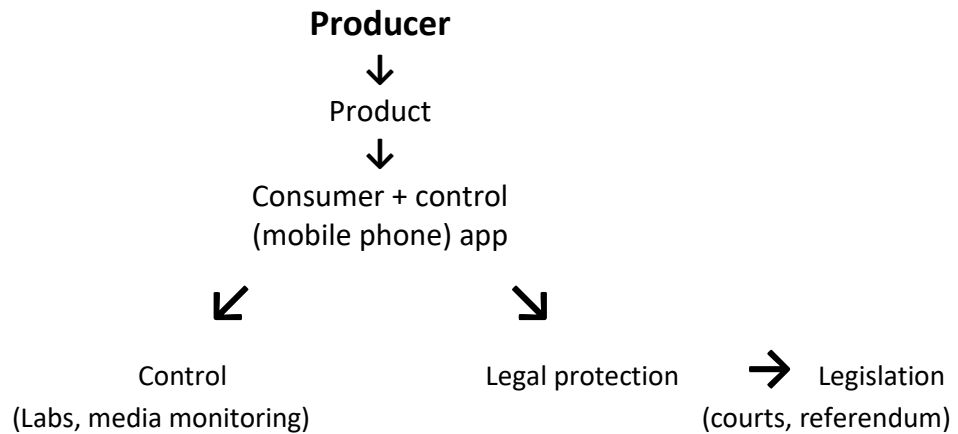
It is necessary to develop control mechanisms in parallel to the development of nanotechnologies – mainly through generally used mobile applications, from which it is possible to transfer the data to control labs. Outcomes from this analysis might be used as an input to a state supervision which would regularly present its findings in media for potential legislative changes. These changes shall lead to control and ensuring impossibility to misuse the technologies. In case of wider / national impact of nanotechnologies (e.g. on water cleaning) it is necessary to make such decisions through a referendum.

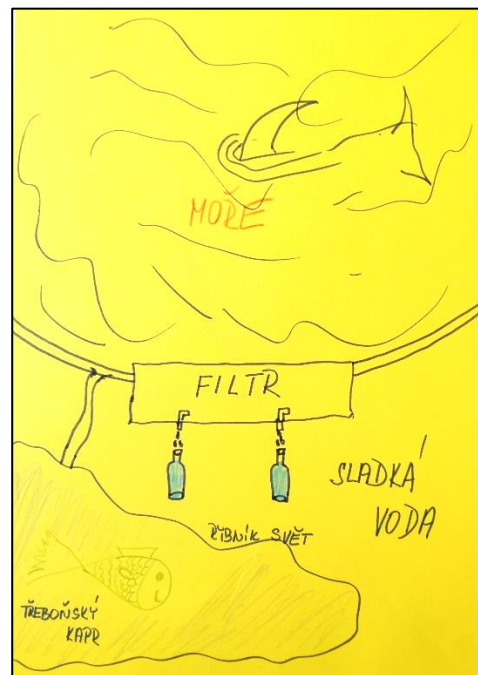
These technologies and their potential side effects must be eliminated in order to avoid:

- collapse of the system in emergency situations
- latent contaminations of the system by nanotechnologies as well as
- wider / national effects of such technological failures.



Control system, based on subsidiarity – on the level of the smallest self-governing units as possible, shall be functional for this purpose.



Wish 3	Desalinator 3000 – Filter for desalination the sea water	Number of votes:
		35
Reference to the application area: Nanofilters		
<p>Description:</p> <p>This product reacts on growing lack of drinking and service water and limited (bad) access to water in general, mainly due to climate change. Desalinator 3000 can desalinate the sea water and remove its pathogens thanks to the use of nanofilters. A related application is nanofilter for cleaning the contaminated water.</p> <p>It's use is wide:</p> <ul style="list-style-type: none">• Citizens of the third world, affected by catastrophic drought• Submarines crews as a tool for gaining the drinking water• Agriculture• Urban environment: maintenance of green areas as well as streets• Industrial production• Prospectively: afforestation of the Sahara		
		

Wish 4	Super Water	Number of votes:
		34
Reference to the application area: Nanofilters		
<p>Description:</p> <p>This product is a multi-functional Nanofilter for the water filtration. It is independent on any energy source, user friendly and affordable. Filter can be portable. It's function is to:</p> <ul style="list-style-type: none">• Produce high quality drinking water• Edit it according to requests (add minerals, vitamins, ions, ...) <p>Use and benefit:</p> <ul style="list-style-type: none">• All the population• It shall solve the lack of water in the future (it shall prevent from possible global conflicts) <p>This Nano filter can be used for all, even service water. Anyway, it is necessary to ensure it's 100% health harmlessness and find out the real impact on human health and environment (cumulation of nanoparticles, life cycle of nanoparticles).</p> <p>It will be possible to ecologically eliminate the Nano filter after the lifetime date.</p>		

Wish 5	Drink Without Worries	Number of votes:
		29
Reference to the application area: Intelligent food packages		
Description: <p>This product is a food package ensuring longer durability of food. It is resistant, recyclable (usable more times), decomposable (nanoparticles accelerate the decomposition process) and it's shape adapts to concrete foodstuff. Product is affordable.</p> <p>It's further functions are the following:</p> <ul style="list-style-type: none">• It indicates the end of durability of the food to the customer through a change of colour of the packaging• It controls it's own harmlessness• It avoids secretion of harmful substances <p>It's use has a positive effect on environment thanks to (i) lower material demands (and through that also lower materials consumption), (ii) lowering the amount of other packages, mainly plastic ones. In the end it leads therefore to lowering of ecological trace, eliminates the transmission of substances from packages to the food.</p> <p>Target groups:</p> <ul style="list-style-type: none">• Sportsmen and sportswomen• Children		



Reference to the application area: Intelligent food packages

Description:

This product is a smart package which can be used mainly in the food area, where people produce all food packages. The plastic bottles, sachets, bags etc. will not be used anymore. This nano-package is able to monitor the durability of the product (in the form of colour scale of the traffic lights).

By using this product, there is no remaining waste (namely plastics) – it is 100 % recyclable, it can be used in composting where it biologically decomposes and it becomes fertilizer.

The time of its durability is possible to regulate according to the type of product and the way of its usability thanks to so called accelerator in a powder form, which enables the package to decompose within a few months).

Product is a benefit for:

- End users (quick orientation in the time of durability products)
- Store chains (dtto)
- Farmers (source of fertilizer)
- Next generations (sustainability of landscape, inner waters will not be contaminated by pesticides)



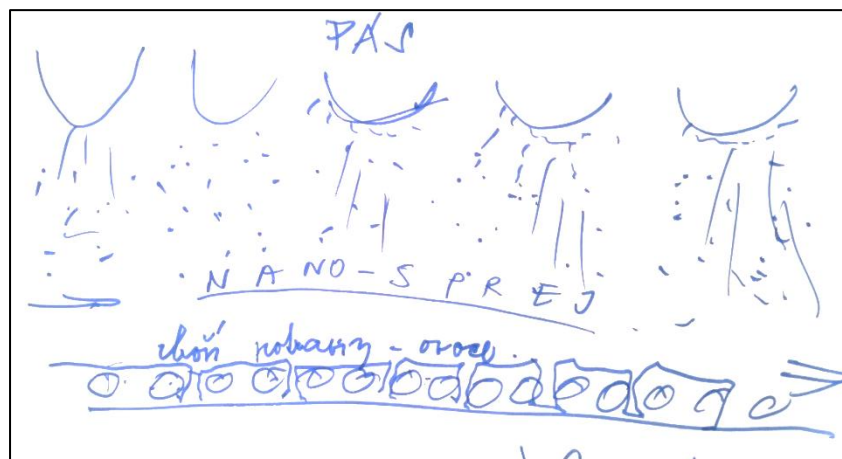
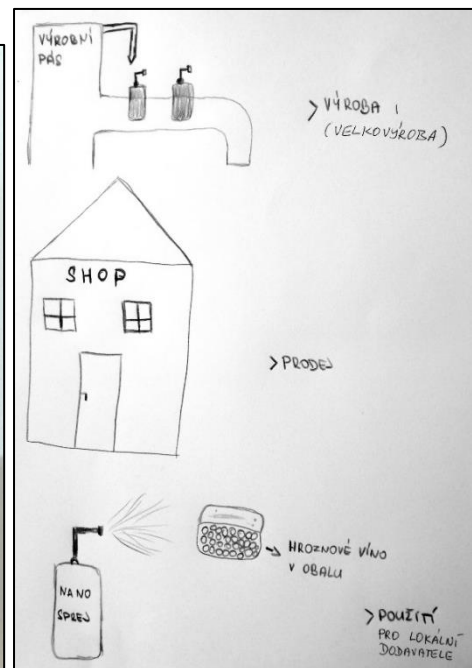
Reference to the application area: Intelligent food packages

Description:

The product is recyclable (decomposable) type of food package in spray, which aims at ensuring quality and durability of food during transport). By its character it will also contribute to lowering negative impacts on the environment. Package is affordable for wider public.

Usage (based on various food types) mainly during natural disasters in affected areas:

- Spray on food packages
- Spray on food itself



Reference to the application area: Novel foods

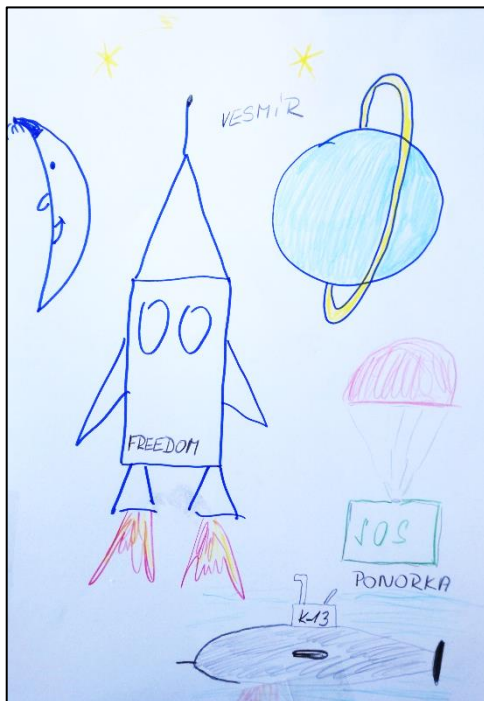
Description:

Product is a novel type of food in form of small cubes of standart size, various colours a various flavours, packed in nano foils.

Advantage of this novel food is the simplicity of their transport, storage, harmlessness, balance and variety of the content, simple and quick preparation, durability and low weight.

Usage:

- Deliveries for Integrated rescue system units
- Deliveries during catastrophes
- Deliveries for the army
- Expeditions
- Prospectively it can be used in ordinary life. Also the product can be modified to the form of nano cigarettes.



Wish 9	Clean water for everyone	Number of votes:
		17
Reference to the application area: Nanofilters		
<p>Description:</p> <p>This product (nanofilter) has wide usage – from central level as filter for cleaning wastewater to local level as filter cleaning water in households.</p> <p>Nano filter is affordable for the majority of population and it is used on the following levels:</p> <ul style="list-style-type: none">• Central / national, on the level of wastewater treatment plant and waterworks.• Industry – nano filters would be legally binding for business companies (mainly in chemical and automotive industry) and for power stations. In this case the nano filters would not be used just for the water filtration but they would have even wider usability – they would avoid leakage of pollutants from chimneys and they would be added to every car.• Households – every house will have its own water cleaner with nanofilters which will filter even the rain water. Nano filter will get rid of viruses, bacteria and mechanical impurities from the water. <p>Filter works the way that at the same time it keeps healthy minerals in the water. This product is affordable for people from developing countries or people living in worse and more demanding conditions.</p> <p>This product will significantly contribute to global solution of water cleaning and it will decrease the expenses for the availability of drinking water. It will also contribute to decrease of health risk caused by bad quality of water.</p>		

These elaborated envisioning wishes from all the tables stem from a large number of specific **individual wishes** – these were most frequently connected to: (1) Nanofilters and clean, potable and available water in terms of use in households, water cleaning systems and also as a solution for the global climate changes. (2) Intelligent food packages that would protect the food, improve the nutrients, conserve the food to prolong its shelf life and also to protect the environment through being made of self and biodegradable materials. (3) Control and safety systems were mentioned. A need for strict rules and standardization was the third most frequent wish. (4) Novel “superfoods” were introduced as a reaction to a need of specific groups of people: patients in hospitals, top sportsmen and managers etc. (5) Other individual ideas were also connected to the improvement of health and the environment both considering food only and considering other aspects as well.

4. MESSAGES TO STAKEHOLDERS

At the end of the session, participants were asked to formulate specific messages to stakeholders that would reflect all their ideas and concerns. These are presented respective to given stakeholders:

Researchers should listen to the needs of public; they should develop new methods for water cleaning and provide people with abundance of water. They should prolong the shelf life of foods and eliminate the harmful substances inside. Harmless fertilizers should be developed, plants that don't need much water. Passive nano-protection against pests should be developed, nanotechnologies for pollination of plants, packages that can be composted. At the same time,

researchers should honestly inform about their results. Participants had fear that nanotechnologies in foods are yet not that discovered. Researches should therefore treat nanotechnologies as carefully as possible. Researchers should play an active role when it comes to creation of regulations. The research of nanotechnologies should be publically supported and financed – by the rich states, EU etc. Lawmakers should make the incorporation of the new technologies easier. Science, research and business shall be more connected. A new inspiration and thoughts could be developed then. Science and research could be connected with capital in form of investment funds to start-ups etc. Researches should play an active role during the creation of legislation.

Researchers and **producers** should bear in mind that new and innovated products have to serve consumers and that they should not have negative impact on the living standards and the environment. Politicians and producers should act responsible from the society's point of view. Technologies should be safe and they should protect the environment. Producers should not misuse the cheap labour for the sake of low costs. Intelligent packages should be sold at a reduced price. Nanotechnologies should be available to everyone. In case of availability of ecological packages, plastics should be banned. During production anything that can be considered natural should not be interfered with. "Nano industry" should also dispose of a "risk fund" for possible future impacts of nano-products (compared to plastics). At the same time industry and researches should communicate with each other. Producers should bring about price accessibility of the new and innovated products and they should behave in an ethical way. Entrepreneurs should not prefer the economic gain against the societal benefits – they should encourage the corporate socially responsible strategies, they should cooperate on the development, bigger investments into the company research, they should observe the public opinion during the development – production should take into account the wishes of customers and equal the supply and demand. The entrepreneurs should be freed from tax in case of nanotechnologies.

Policy makers should support and invest into research. Simple and clear legislation should make the implementation of new technologies easier. Law makers should support food beneficial to health, there should be an interdepartmental work group created. A control system developed on the national level should be introduced, so there would not be any misuse. The main concern of the politicians in case of new laws should be people.

The state should support larger availability of nanofilters to citizens. Nano filters should be available in countries with lower purchasing power. Mass availability could also lead to lowering down of prices. At the same time a campaign for use of nanotechnologies should be started, and that mostly from the side of the national governments than EU, against which are the citizens mostly sceptical. Nanotechnologies in food should be legislatively taken care of and the wide public should be informed.

Media should inform about Nanotechnologies in an honest way – opinions and fears of the wide public should be taken into account. Independent agencies and media should react to it and they should inform the public. The information promotion should start in schools already. People are interested in these topics and they want to contribute to it.

Development and testing of nanotechnologies should be put under public scrutiny. New ways and innovations should be verified and they should be in favour of all citizens. Participants were afraid

that nanotechnologies would lead to the same consequences as the production of plastics: Actors should mind the future and future generations. Technologies should be compared with others and negative impacts of using nanotechnologies should not be neglected. All the possible risks should be eliminated as it also should be invested in how to prevent the risks in all possible areas of application. All the actors should proceed as one.

5. SUMMARY

All three nanotechnology applications in food shared several mutual concerns. Probably the biggest one was the safety of nanotechnologies – one of the most common fears were those of a possible proliferation of nanoparticles into the nature and into the human body (mostly smart food packaging and novel foods) and all of the unknown consequences we are yet not aware (disruption of cells, accumulation of nanoparticles in bodies). Further use and development of nanotechnologies in food should therefore be conditioned by further testing and research: the necessity to understand to what particles would the nanoproducts dissolve seemed crucial to many. Others also thought that the nanoproducts should guarantee their self-degradation and recyclability / compostability as nanotechnologies (e.g. smart packages) evoked some resemblance to the plastic boom and as there was quite a wide consensus on the possibility to replace plastics and chemicals (e.g. in growing food) by nanotechnologies. A transparent system of controlling and setting rules should be set.

Participants were afraid of a price increase throughout all of the applications – especially in humanitarian cases of affordable clean water in the third world, for some in cases of foods or packages. People were less afraid under condition that products would be strictly labelled as NANO and therefore differentiated from others (price incl.). Considering financial point of view, producers using e.g. smart packages substituting plastic packages could be e.g. financially supported. Researchers should be also financially supported. Costumers should be in every case transparently and well-informed about the progress and products.

Smart food packages were perceived as a promising substitute of plastics, they would be welcomed under the condition of self-degradation, that they would increase the shelf-life of the foods and protect them or that they would signalize the possible contamination of food. Most of the specific product ideas of participants were those that were connected to smart food packages (and nanofilters as these were often connected).

Nano filters received mostly positive feedback as for some they seemed as the most important use. They could play a major role in providing potable water in the countries where it is needed – they would filter water into potable water, they could help to desalinate water (however also e.g. beverages). An important concern was the price of such water, that the filtered water would be “over filtered” and a concern about what would happen with the waste from the already used filters.

Novel foods seemed to be the most controversial (and negatively received) of all the applications. Products and further development should be well communicated and the products should be tested and well-labelled. On the other hand, novel foods seemed to have a great potential to contain all the needed (and added) for people who need effective, quick or special food (e.g. sportsmen, astronauts, allergic people).

The most often addressed stakeholder groups were:

1) Researchers

...should play an active role in terms of control system and safety, they should be sure that the products don't harm the environment and they should come with new innovative ideas, so they solve some key issues (such as lack of clean and potable water).

2) Producers

...should make sure that they behave in an ethical way and that the products they produce are available and affordable. Socially responsible entrepreneurship should be supported.

3) Policy makers

...should support research with investments. The products and inventions should be easily implemented and a control system / system of rules with respect to people should be developed.

4) State

Nanotechnologies should be made available in the developing countries. A campaign for the use of Nanotechnologies should be initiated – informing of the wide audiences. Appropriate laws should be proposed.

5) Media

...should play a key role in informing both about positive and negative aspects of Nanotechnologies. Information should be also presented through the education system.

6) Others

All stakeholders overall should proceed as one to effectively deliver new ways to develop Nanotechnologies, to encourage innovations as they should also mind all the possible negative impacts.

ANNEX 1: COMPOSITION OF PARTICIPANTS

Actual Recruitment			Required Recruitment		
	Number of Participants	Share		Number of Participants	Share
Gender			Gender		
Male	24	50%	Male	24	50%
Female	24	50%	Female	24	50%
Age			Age		
18-29	12	25%	18-29	12	25%
30-45	15	31%	30-45	14	30%
45-60	11	23%	46-60	12	25%
60+	10	21%	60+	10	20%
Education			Education		
Elementary, Apprenticeship	17	35%	Elementary, Aprreniceship	16	34%
Secondary education	15	31%	Secondary education	16	33%
University	16	33%	University	16	33%
Size of the Residence area			Size of the Residence area		
Up to 5 000 inhab.	14	29%	Up to 5 000 inhab.	15	30%
5 000 to 89 999 inhabitants	15	31%	5 000 to 89 999 inhabitants	14	30%
Over 90 000 inhab.	19	40%	Over 90 000 inhab.	19	40%
Region			Region		
Prague	15	31%	Prague	16	34%
Central Bohemia	16	33%	Central Bohemia	16	33%
Other	18	38%	Other	16	33%
Economic activity			Economic activity		
Student	5	10%	Student	7	15%
Retired person	9	19%	Retired person	5	10%
Unemployed	1	2%	Unemployed	2	5%
Housewife/husband	3	6%	Housewife/husband		
Employee	24	50%	Employee	24	50%
Self-employed; Entrepreneur	5	10%	Self-employed; Entrepreneur	10	20%
N/A	1	2%	N/A		

Overall number of Participants:
48

ANNEX 2: EVALUATION RESULTS

At the end of the envisioning workshop a questionnaire was handed out. The questionnaire is part of a larger evaluation instrument aiming to evaluate the whole co-creation methodology of the GoNano project. The questions were based on the KPI's Knowledge and understanding; Trust and mutual understanding and Co-creation as formulated in the proposal. A more detailed report in which also the results of the three countries compared is available separately (see Annex IV).

2.1. KNOWLEDGE AND UNDERSTANDING

A total of 48 citizens participated in the workshop and completed a questionnaire. Participants indicated that they were little informed about nanotechnology prior to the workshop ($M = 2.13$; $SD = 0.80$), but the indicated knowledge on nanotechnology after the workshop was significantly higher than before ($M = 3.38$; $SD = 0.92$; $p = .00$). Of all participants, 75% thought they were more informed about nanotechnology after the workshop than prior to the workshop, and 25% did not indicate an increase in knowledge. Also, most participants agreed that the workshop contributed to improving their understanding of nanotechnology in general ($M = 3.75$; $SD = 0.53$) and of nanotechnology for food applications in particular ($M = 3.92$; $SD = 0.54$). For both questions respectively 70% and 80% of the participants agreed that their understanding improved after the workshop.

Participants indicated that they hardly engaged in nanotechnology prior to the workshop ($M = 1.91$; $SD = 0.76$). They sometimes heard, read or watched information about nanotechnology ($M = 2.51$; $SD = 0.88$), but hardly searched for information about nanotechnology ($M = 1.94$; $SD = 1.07$), and almost never participated in meetings about nanotechnology ($M = 1.28$; $SD = 0.85$). After the workshop, there was a need to obtain more information about nanotechnology ($M = 3.58$; $SD = 0.52$).

Participants reported a moderately positive attitude on nanotechnology ($M = 3.6$; $SD = 0.51$). In line with this, they saw more benefits than risks with the development of nanotechnology ($M = 3.7$; $SD = 0.5$).

2.2. TRUST AND MUTUAL UNDERSTANDING

Participants assessed actors differently when it comes to trust in whether these actors will deal with nanotechnology in a responsible way. Researchers were trusted the most, while policy makers were trusted the least (See Table 2.1). Also, expectations of how actors will deal with the outcomes of the citizen workshop in the co-creation process, were the highest for researchers, and the lowest for policy makers (see Table 2.1). Nevertheless, the expectations showed a smaller difference than the scores on trust.

With regard to self-efficacy, participants were moderately confident about their ability to act when something happens related to nanotechnology ($M = 3.53$; $SD = 0.54$).

Trust and expectations

Actor	Level of trust: mean (SD)	Expectations: mean (SD)
Researcher	3.94 (0.67)	3.90 (0.93)
Policymakers	2.47 (0.72)	2.69 (1.01)

Industry/companies	2.94 (0.98)	3.19 (1.01)
Civil society organizations	3.03 (0.85)	3.09 (0.80)
Consumer organizations	3.40 (0.84)	3.42 (0.85)

2.3. Co-CREATION

The participants were very positive about the organization of the citizen workshop ($M = 4.29$; $SD = 0.45$). They were also positive about the quality of the group discussion with a mean score of 4.49 (0.56), and 35% of the participants giving the full score to every item in this construct. Participants were also positive about the quality of the output, but slightly less than on the other constructs ($M = 4.10$; $SD = 0.48$).

About one fifth of the participants answered at least one of the open questions (suggestions for the organization of the workshop or final remarks). Most suggestions were about making sure that nanotechnologies and nanoparticles do not cause any harm and are safe enough for the human health as well as for the environment ("Please, pay more attention to the consequences of nanoparticles use when it comes to the environment. Applications will be simply generated by the market..."). Most remarks were about the gratitude of the organization of the workshop and getting information on nanotechnologies in general as well as more concretely in the area of food.

Results from deliberating and envisioning workshop with citizens

NATIONAL REPORT – ENERGY – SPAIN

Work Package:	WP3 – Envisioning and Deliberating with Citizens
Deliverable number:	3.2 – Annex II
Partner responsible:	Technology Centre CAS (TC CAS)
Compiling author(s):	Craig Richmond, Paul Wright and Boaz Kogon, RMIT
Contributing author(s):	Lenka Hebáková and Marek Pour, TC CAS Sikke Jansma and Anne Dijkstra, University of Twente
Quality assurance:	Lise Bitsch, Danish Board of Technology Foundation
Planned delivery date:	12/18
Actual delivery date:	02/19
Dissemination level:	PU

1. INTRODUCTION

The approach of the GoNano co-creation process is focused on the application of nanotechnologies in health, food, and energy; and combines a series of face-to-face workshops with an online meeting space. In order to achieve this goal, GoNano aims to strengthen co-operation among different actor groups. Envisioning workshops form the first step of the co-creation process (Fig 1), involving citizens (i.e. lay people).

The aim of the workshops is to enable the citizens to come together to commonly reflect on specific nanotechnology applications and provide their needs and concerns, so that the future nanotechnology applications are aligned with these. More specifically, the workshop participants formulated the following output:

- Initial feedback on the nanotechnology application areas
- Wishes – preferences related to the future applications of nanotechnologies in energy
- Requirements and principles that the citizens want technology developers to comply with or consider when they develop new nanotechnology applications in energy
- Messages to specific stakeholder groups related to nanotechnology applications in energy

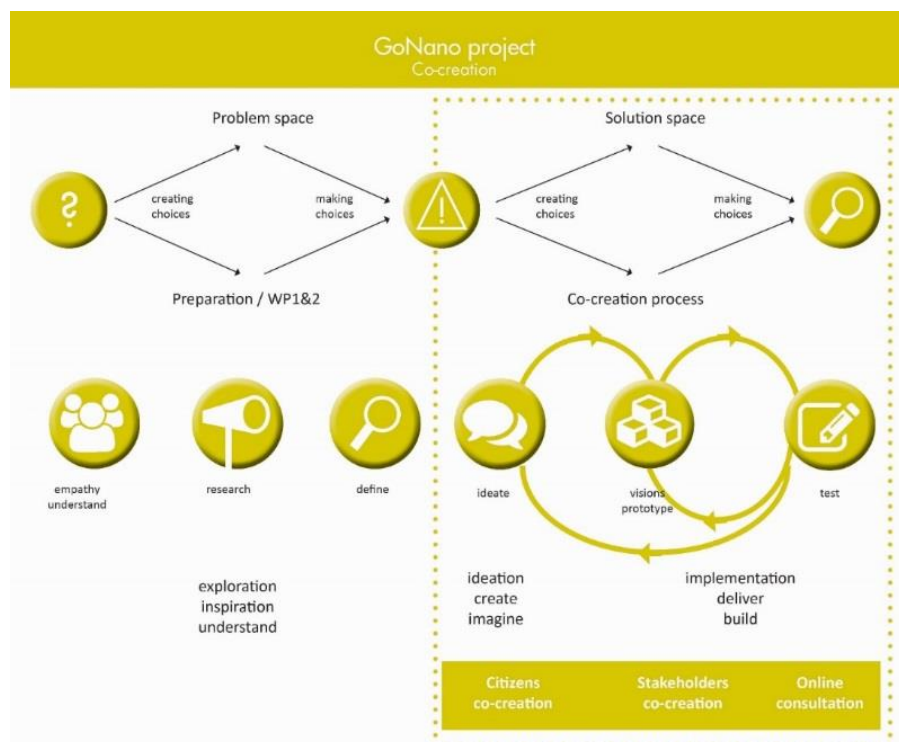


Fig 2 GoNano project co-creation process²

The envisioning workshops with citizens were held during October and November in three pilot countries: Czech Republic (application of nanotechnologies in food), Netherlands (nanotechnologies

² <http://gonano-project.eu/wp-content/uploads/2018/06/co-creatie-GoNano.pdf> (2018-07-24)

in health) and Spain (nanotechnologies in energy). The citizen workshop focussed on nanotechnology applications in energy was held on October 26, 2018 in Barcelona.

2. NANOTECHNOLOGY APPLICATION AREAS IN ENERGY

The outcomes of the expert interviews in WP1 (reported in D1.3) revealed some of the most relevant areas of development in nanoscience, nanomaterials, and nanorelated applications or products. These areas were then grouped under three themes: green energy production, portable energy devices, and energy in the home. The three themes were the result of a consultation process involving the pilot partners, WP leaders, and the project coordinators; and were chosen to cover the relevant areas of development whilst being accessible to lay participants (reported in D3.1). The concepts were presented to the workshop participants in the form of an information booklet with the aim of bringing them up to speed and focussing them on the issues at hand without instilling any bias. At the envisioning workshop, citizens reflected on each area and gave their views about how to integrate ideas for developing future nanotechnology applications and research.

2.1. GREEN ENERGY PRODUCTION

Text from information booklet:

Imagine a future with flexible solar panels, which were only possible to manufacture due to the incorporation of ultra-thin layers (nano-layers) of light absorbers, or a paint full of semiconductor nanoparticles that could convert any surface into a photovoltaic panel. The widespread use of such technologies could help reduce our dependence on fossil fuels, and thus help reduce the emission of CO₂ and other greenhouse gases.

Initial citizens' feedback:

Green energy technology was largely seen as a good thing and received a lot of positive comments, with most negative comments being focussed on how we are not promoting it enough or taking advantage of it. Some of the benefits mentioned were that it is eco-friendly, it can improve energy efficiency and reduce contamination, it can improve our autonomy, and it can lead to a better quality of life.

"Green energy use is vital for the sustainability of the planet and it is important that it receives support from governments and businesses."

These technologies have to compete with non-renewable energy practices to become commercially viable but when multinationals invest in this field and politicians support it with legislation, it will grow rapidly and begin to establish itself. More is needed to increase the public's knowledge of the benefits of green energy, as a higher demand from society will also boost the uptake of these technologies. Some ways to help with this may be to make them more user friendly and perhaps making them smaller or easier to integrate with current technologies and practices.

Some of the more negative comments expressed were: Economic interests (of stakeholders) are preventing the development of renewable energy technologies. Large companies and technology developers have a conflict of interests in that the motivation to investigate the environmental and health impacts are not on the same level as the drive to develop a technology and make a profit.



There are clear short-term benefits, but uncertainty surrounding the long-term. Where does the product go after use? – need better recycling practices and strategies to maximise product utility and lifespan. And finally, some fears were shared:

“The stress and harm to the health of the population and the environment that this type of technology can provoke worries us. We already see effects from continuous contact with Wi-Fi networks, electricity, etc.”

2.2. PORTABLE ENERGY DEVICES

Text from information booklet:

What if we could harvest the energy we produce when we walk and drive around every day? You could, for example, have nanofibers integrated into your clothes. The clothes would transform the energy produced by walking into electrical energy for powering your cell phone or smart watch. And what if the batteries in your cell phone had a higher storage capacity, a shorter charging time, or a longer shelf-life? More efficient batteries could prolong the useable life of our electronic devices, and therefore reduce the waste coming from them.

Initial citizens' feedback:

The discussions surrounding portable devices mainly centred on battery technology. Batteries were regarded as being safer nowadays so people are not as afraid to use them. This could be due to better safety regulations, as one particular citizen pointed out:

“I am under the impression that all these technologies are much better regulated than before. In Europe they are highly regulated so we do not worry about them so much.”

And when citizens judged batteries to be safer, they wanted longer lifespan and better recyclability. One could therefore infer that there is a desire for sustainability but not above or at the expense of performance or safety. When introducing nanotechnologies into batteries (and other devices), the developers should analyse and demonstrate that their inclusion does not increase the risks to health and the environment – a practice that some participants did not think was in place at the moment. A specific example of “conflict minerals”, with the use of Coltan materials was also mentioned; people want ethical materials and products, and don't want materials that cause or support conflicts.

Some citizens pointed out the overuse of batteries and the need to reduce our energy use overall:

“We shouldn't waste energy as much as we do at the moment... It is absurd to put batteries in bicycles; they are already ecological. This is a step backwards; these are gadgets that use energy when it's unnecessary.”

Other participants pointed out that it is not always clear where our energy is coming from and that we need to be informed about this. For example, we are not being informed about how ecological the electric cars, nor the methods used to power them, are. One will gradually reduce emissions through the introduction of electric cars if the electricity used to charge electric cars comes from renewable sources.



Finally, along the lines of personalised energy, the concept of producing energy from our body movement was popular and suggestions included that such devices should be comfortable and ideally would not have any wires.

2.3. ENERGY IN THE HOME

Text from information booklet:

Today you can harvest and store your own electrical energy at home, using solar panels and large batteries like the Tesla Powerwall, but nanotechnology could make it possible to create and store energy in places you never imagined. You could install “smart windows” with a special nano-coating that would keep your house cool in Summer and warm in Winter – and generate electricity at the same time. The electricity could be stored in the structure of your house: the bricks in the walls, in wireless charging coils on the floor, on the kitchen worktop and in the furniture. Your smartphone and laptop could then be charged automatically no matter where you left them.

Initial citizens’ feedback:

As in the previous discussions, when discussing *Energy in the Home*, the comments strayed toward more general themes rather than being directly related to specific issues with nanotechnology. In general, people wanted more efficient devices so they can use less energy and pay less. They gave some examples of how this might be done: taking advantage of renewable energy (sun, wind, wave, geothermal, etc.), moving from passive to active homes, designing homes to be cooler in summer and warmer in winter, recovery and reuse of energy, and piezoelectric flooring.

Some citizens felt that they could use their energy more efficiently if they had more autonomy and control, coupled with better education on energy use and simpler pricing formats, e.g. € per use. On the contrary, others were concerned about increased automation for fear of becoming over-dependent on technology and losing privacy through the constant monitoring and data sharing needed for autonomous systems.

“I would like to be able to personally manage the energy use in my home so that it would be used more efficiently.”


Concerns were raised over the intermittency of electrical power as we introduce more renewables; some citizens wanted to know if nanotechnology could somehow help cover the gaps where we need energy but aren’t producing so much, i.e. at night and during winter. Specific examples given were a fridge that had some sort of in-built storage capacity, intelligent devices that work without a traditional electrical source, and electro-domestic appliances that can be charged and don’t need to be plugged in.

As a general set of rules for developing or introducing new technologies for energy, people thought that they should respect the environment, be safe, and be fair (public amenity, not private; no gender imbalance; accessible to old, young, poor and rich alike).

“Technology that is easy to understand and accessible to all ages and is accessible to the whole world... Always consider safety for new technology.”

3. CITIZENS' IDEAS FOR NANOTECHNOLOGY APPLICATIONS IN ENERGY

Participants at the envisioning workshop formulated several wishes for the future applications of nanotechnology in energy. They are listed below, and grouped by thematic relevance, while their order of appearance is based on perceived importance, measured through votes cast by the participants during the workshop. The first four wishes were produced by each of the four tables of participants working in groups, with the most popular wish being identified by a plenary vote. The other wishes were produced separately by the individuals at each table, with the most popular of those wishes forming the basis of the group wish.

Wish 1	Title: PUSH (Power Unit Surface Hub)	Number of votes: 13
Reference to the application area: (Portable energy devices / Green energy production)		
<p>Description:</p> <p>The power of contact! Generate your own energy. Power your devices.</p> <ul style="list-style-type: none"> • Generates energy through contact, pressure, or movement. • Flexible. • Resistant. • Adaptable to any size. • Versatile. • Sensitive to different modes of movement and grades of pressure. • Nanostructured materials. • Multilayer system contains a protective isolating layer, a contact layer, a pressure sensing layer, conducting gel layers, and a storage layer. 		

Wish 2

Title: MES (Mobile Energetic Sheet)

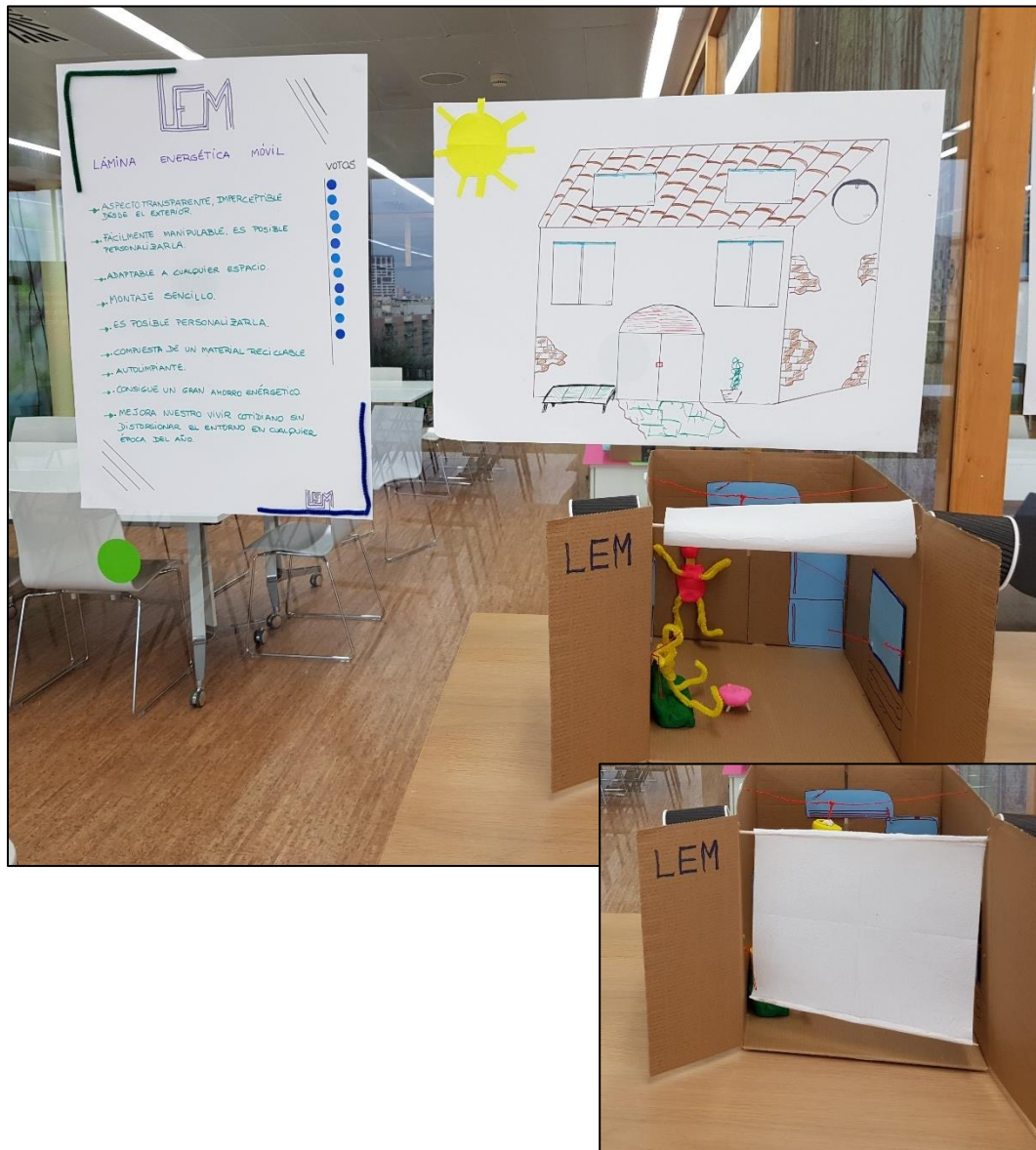
Number of votes:

11

Reference to the application area: (Energy in the home / Green energy production)

Description:

- Transparent appearance, unnoticeable from outside.
- Lightweight and rollable.
- Easily to use and possible to personalise.
- Adaptable to any space.
- Easy to mount.
- Made from recycleable materials.
- Self-cleaning.
- Blocks infra-red. Capures solar energy. Results in huge energy savings.
- Improves our daily lives without disrupting the surroundings at any time of the year.

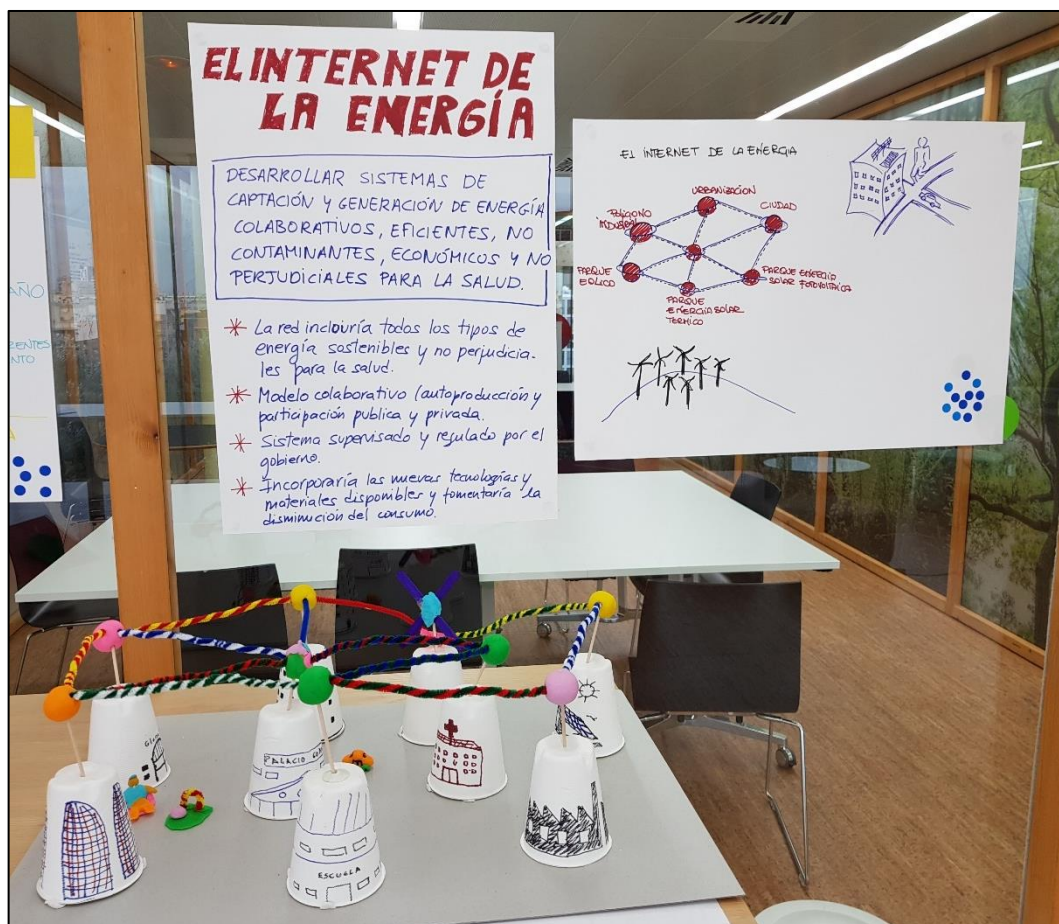


Reference to the application area: (Green energy production)

Description:

Develop energy generating and energy harvesting systems that are collaborative, efficient, economical, non-contaminating, and not harmful to health.

- The network includes all types of energy that is sustainable and not harmful to health.
- Collaborative model (autoproduction plus public and private participation).
- System supervised and regulated by the government.
- Incorporates the latest materials available and encourages reduced energy consumption.



Wish 4

Title: Save Water (initial title: Smart-Eco-Live)

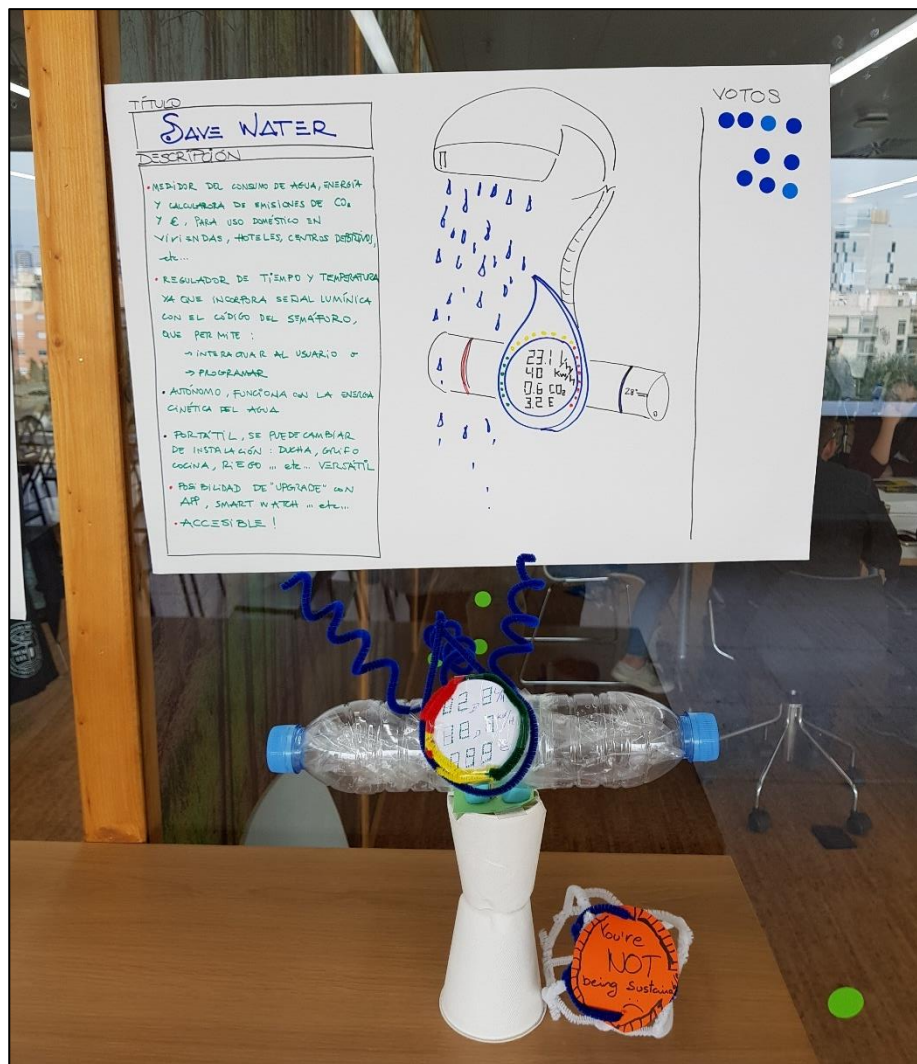
Number of votes:

9

Reference to the application area: (Energy in the home / Green energy production)

Description:

- Meter for measuring consumption of water and energy, and calculator of CO₂ emissions and costs (€).
- For domestic (and commercial) use in homes, hotels, sport centres, etc.
- Regulates time and temperature through its traffic-light indicator system, which also allows user interaction and programming.
- Automated and works using the kinetic energy of the flowing water.
- Portable and versatile: One can easily move it from one place to another e.g. shower, kitchen tap, garden hose, etc.
- Programmable: Possibility to enhance with the additional App and smart watch compatibility.
- Economically accessible.



These elaborated wishes stemmed from a large number of **individual wishes** expressed at each table. These individual wishes were most frequently (i.e. on multiple occasions) connected to: (1) capturing and converting kinetic energy (e.g. body movement and transport) to electrical energy for storage and use. (2) Different ways of adapting structures around the home to make use of renewable energy sources e.g. Building Integrated Photovoltaics. (3) Home climate systems that control the atmosphere around the home and also inform inhabitants of usage in simple terms. (4) *Smart home* appliances and operating systems. (5) Technologies or products that are more sustainable and do not adversely affect health or the environment. Less frequently (i.e. a single occurrence), the following wishes were mentioned: (i) Heat regulating socks, (ii) magic paint, (iii) speakers that are charged by the sound they produce, (iv) nanofilters, (v) nanoparticle nutrients for plants, (vi) intelligent clothing, (vii) health monitoring chip, (viii) smart pills, (ix) cures for illnesses.

4. MESSAGES TO STAKEHOLDERS

The citizens wrote individual messages to the developers of nanotechnologies. Whilst in most cases no specific stakeholder groups were addressed, the messages could be categorised by theme: environment and sustainability, health and safety, social aspects.

i) Environment and sustainability

I want sustainable products, with no programmed obsolescence and easy maintenance.

Research activities should respect the environment and not exhaust natural resources.

Energy production should not endanger the environment.

I want recyclable products. All components of products should be recyclable.

I want batteries that last longer, are more sustainable, and are highly recyclable.

We must minimise the environmental impact. Today's products generate too much waste.

The materials used should be sustainable. i.e. have a use beyond their original function.

I want production processes with lower environmental impact.

Researchers should pay more attention to the types of materials they work with so their manufacturing processes are safer and more sustainable.

I think we should invest more in sustainability. It is an area of research for the common good.

We should focus research towards sustainable development on a global level.

We have to move towards a circular economy. We need to consider the environmental benefit of recycling items and/or reducing programmed obsolescence.

ii) Health and Safety

We need more control over safety.

We should create healthy environments that are not damaging to our health.

I want products that are not harmful to health.

iii) Social Aspects

Large organisations and political parties should promote research into new technologies.



I think advances in these areas should be accessible to everyone.

Technology developers should think less about the economic benefits and more about the social impact.

These new technologies have to be accessible to everyone. Reasonable cost.

The conditions for research and manufacturing should be socially acceptable.

New applications in energy should be oriented more towards basic needs for the majority.

There should be more public investment.

There should be more co-creation, more opinion from citizens.

Scientific research should be more transparent.

Scientists should not just publish for the sake of publishing without actually solving problems.

Organisations should look more at the needs of humanity, not so much at the capital their ideas can generate.

There should be more interdisciplinarity in research: Research groups should be more diverse or they should organise events or collaborations to complement their research.

Technology developers should use more practical language.

There should be an independent international body dedicated to looking after the common interests of the people.

There should be independent research agencies.

5. SUMMARY

The participation by the citizens during the technology discussions, and throughout the day in general, was very high. Participants shared their opinions freely and maintained a lively but well-mannered debate at all times. From our analysis of the notes taken during the workshop, there were some observations of important points or general trends that are worth highlighting: Recycling and sustainability obviously featured strongly in the discussion on *Green Energy Production*; however, references to these themes were also frequent in the other two discussion sessions on *Portable Energy Devices* and *Energy in the Home*. Whilst indicating their importance, they weren't necessarily perceived to be more important than the other points raised; for example, during the discussion on *Portable Energy Devices*, it was evident that safety and performance (and possibly cost) ranked higher when judging battery technologies. The citizens who attended the workshop were aware of the importance of increasing energy efficiency and the use of renewables, while reducing energy consumption and waste, with more/better recycling, etc. However, they were not so well informed of the role that nanotechnology can play in these areas. They said more needs to be done to educate the public, so they are better equipped with the knowledge they need to make the right choices about their own energy use and the technologies they adopt in the future. Participants also requested that companies and governments invest more in research and activities that are safe, sustainable, and fair; which may help to improve the evidently low levels of trust in these particular stakeholder groups. Almost all of the citizens were very satisfied with their experience of the workshop and believed that their opinions and ideas would be taken on board when presented at the stakeholder workshop.

ANNEX 1: COMPOSITION OF PARTICIPANTS

Gender	Percentage / absolute numbers				
	- in the population ³	- at the citizen workshop			
		Plan		Reality	
		%	Abs.	%	Abs.
Women	51.9%	50	25	71	15
Men	49.1%	50	25	29	6
Age groups	Percentage / absolute numbers				
	- in the population ³	- at the citizen workshop			
		Plan		Reality	
		%	Abs.	%	Abs.
18-24	6%	16	8	5	1
25-34	13%	30	15	9	2
35-49	26%	30	15	48	10
50-59	15%	12	6	19	4
60+	25%	12	6	19	4
Type of population	Percentage / absolute numbers				
	- in the population ⁴	- at the citizen workshop			
		Plan		Reality	
		%	Abs.	%	Abs.
Population living in cities	40%	60	30	85	18
Population living in smaller towns	50%	30	15	15	3
Population living in countryside	10%	10	5	0	0

³ http://www.ine.es/prodyser/espa_cifras/2018/index.html

⁴ https://www.fbbva.es/wp-content/uploads/2017/05/dat/cuadernos_FBBVA_51espana_web.pdf

Education	Percentage / Absolute numbers				
	- in the population ⁵	- at the citizen workshop			
		Plan		Reality	
		%	Abs.	%	Abs.
Primary/Lower- secondary	39%	40	20	15	3
Upper-secondary	40%	40	20	9	2
Tertiary education (incl. PhD)	21%	20	10	76	16
Economic activity	Percentage / Absolute numbers				
	- in the population ^F <small>ejl! Bogmærke er ikke defineret.</small>	- at the citizen workshop			
		Plan		Reality	
		%	Abs.	%	Abs.
Employee/Employer/self-employed person (public and private sector)	47%	50	25	57	12
Student	3%	10	5	5	1
Retired person/on leave	30%	30	15	24	5
Unemployed person	10%	10	5	14	3

Note that due to the low attendance, the socio-economic selection criteria identified for the recruitment strategy could not be applied; therefore, optimal diversity within the group was not achieved.

⁵ http://www.ine.es/prodyser/espa_cifras/2018/index.html

ANNEX 2: EVALUATION RESULTS

At the end of the envisioning workshop a questionnaire was handed out. The questionnaire is a part of a larger evaluation instrument aiming to evaluate the whole co-creation methodology of the GoNano project. The questions were based on the KPI's Knowledge and understanding; Trust and mutual understanding and Co-creation as formulated in the proposal. A more detailed report in which also the results of the three countries is compared is available separately (see Annex IV).

2.1. KNOWLEDGE AND UNDERSTANDING

A total of 21 participants filled in the questionnaire. Participants indicated that they were little informed about nanotechnology prior to the workshop ($M = 2.14$; $SD = 0.96$), but the indicated knowledge on nanotechnology after the workshop was significantly higher than before ($M = 3.40$; $SD = 0.68$; $p = .00$). Of all participants, 80% thought they were more informed about nanotechnology after the workshop than prior to the workshop. Also, most participants agreed that the workshop contributed in improving their understanding of nanotechnology in general ($M = 4.24$; $SD = 0.54$) and of nanotechnology for energy applications in particular ($M = 4.24$; $SD = 0.63$). For both questions 80% of the participants agreed that their understanding improved after the workshop.

Participants indicated that they hardly engaged in nanotechnology prior to the workshop ($M = 1.88$; $SD = 0.77$). They rarely heard, read or watched information about nanotechnology ($M = 2.35$, $SD = 1.14$), hardly searched for information about nanotechnology ($M = 2.10$; $SD = 1.07$), and almost never participated in meetings about nanotechnology ($M = 1.14$; $SD = 0.66$). After the workshop, there was a need to obtain more information about nanotechnology ($M = 4.13$; $SD = 0.51$).

Participants reported a positive attitude on nanotechnology ($M = 4.03$; $SD = 0.44$). In line with this, they saw more benefits than risks with developing nanotechnology ($M = 3.89$; $SD = 0.59$).

2.2. TRUST AND MUTUAL UNDERSTANDING

Participants considerably trusted researchers, consumer organizations and civil society organizations in that they will deal with nanotechnology in a responsible way. They also trusted policy makers but to a lesser extent. Industry/companies were trusted the least (See Table 2.2)., Expectations of how actors will deal with the outcomes of the citizen workshop in the co-creation process were the highest for researchers, and the lowest for policy makers (see Table 2.2).

With regard to self-efficacy, citizens indicated that they were confident about their ability to act when something happens related to nanotechnology was above the mid-point scale of 3 ($M = 3.7$; $SD = 0.52$).

Trust and expectations

Actor	Level of trust: mean (SD)	Expectations: mean (SD)
Researcher	4.43 (0.68)	4.38 (0.74)
Policymakers	3.24 (1.14)	2.95 (1.02)
Industry/companies	2.95 (1.28)	3.19 (1.29)
Civil society organizations	3.76 (0.83)	3.50 (0.83)
Consumer organizations	4.05 (0.92)	3.71 (1.06)

2.3. CO-CREATION

The participants were very positive about the organization of the citizen workshop ($M = 4.32$; $SD = 0.38$). They were also positive about the quality of the group discussion, with a mean score of 4.79 (0.32), and 62% of the participants giving the full score to every item in this construct, and the quality of the output of the workshop ($M = 4.46$; $SD = 0.44$).

About one third of the participants answered at least one of the open questions (suggestions for the organization of the workshop or final remarks). Most of them gave their gratitude for participating in the workshop. One suggestion was made about increasing the dissemination activities of the workshop in advance, and another one about coming up with more specific examples of nanotechnology in energy during the workshop.

Results from deliberating and envisioning workshop with citizens

NATIONAL REPORT – HEALTH – THE NETHERLANDS

Work Package:	WP3 – Envisioning and Deliberating with Citizens
Deliverable number:	3.2 – Annex III
Partner responsible:	University of Twente
Compiling author(s):	Sikke Jansma and Anne Dijkstra, University of Twente
Contributing author(s):	Lenka Hebáková, Technology Centre CAS Marek Pour, Technology Centre CAS
Quality assurance:	Lise Bitsch, Danish Board of Technology Foundation
Planned delivery date:	12/18
Actual delivery date:	02/19
Dissemination level:	PU

1. INTRODUCTION

The approach of GoNano co-creation process is focused on application of nanotechnologies in health, food and energy and combines a series of face-to-face workshops with an online meeting space. In order to achieve this goal, GoNano aims at strengthening co-operation among and between different actor groups. Deliberate and envisioning workshops with citizens form first step of the co-creation process (Fig 1), involving citizens (i.e. lay people).

The aim of the workshops is to enable the citizens to come together to commonly reflect on specific nanotechnology applications and provide their needs and concerns, so that the future nanotechnology applications are aligned with these. More specifically, the workshop participants formulated the following output:

- Initial feedback to the nanotechnology application areas;
- Wishes – preferences related to the future applications of nanotechnologies in health
- Requirements and principles that the citizens want technology developers to comply with or consider when they develop new nanotechnology applications in health
- Messages to specific stakeholder groups related to nanotechnology applications in health

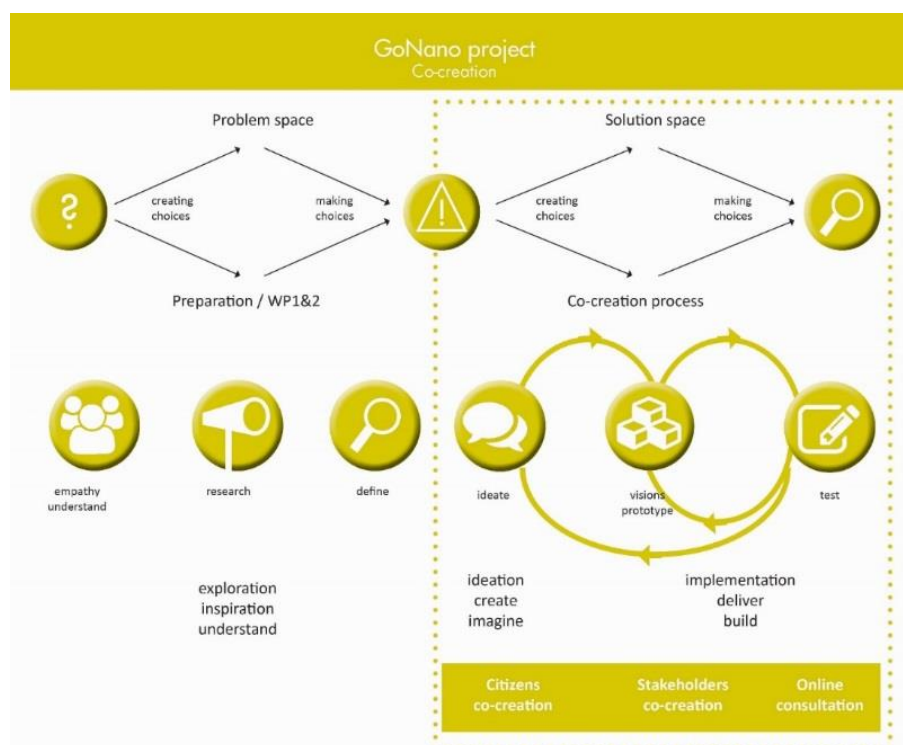


Fig 3 GoNano project co-creation process⁶

The deliberating and envisioning workshops with citizens were held during October and November 2018 in three pilot countries: Czech Republic (application of nanotechnologies in food), Netherlands (nanotechnologies in health) and Spain (nanotechnologies in energy). The citizen workshop focused on nanotechnology applications in health was held on November 24, 2018 in the Designlab at the University of Twente in Enschede.

⁶ <http://gonano-project.eu/wp-content/uploads/2018/06/co-creatie-GoNano.pdf> (2018-07-24)

The University of Twente managed to obtain the desired number of participants. To have 48 citizens participating in the workshop, the aim for recruitment was 55 citizens, as it was expected that 10% would not show up or cancel last-minute. In total, 50 participants participated (3 cancelled last-minute, 2 did not show up). The population sample was diverse among various demographic variables (age, employment, residential area), except for educational level. Even though, during the recruitment of lower educated people were specifically targeted, mostly higher educated participants registered for the workshop. An explanation for this might be the complexity of the subject and term 'nanotechnology', which could have scared off lower educated people. A week before the citizen consultation, participants received an information package, in describing nanotechnology applications in three thematic areas of health (monitoring devices, early diagnostics, and regenerative medicine). At the day itself, in the morning, citizens discussed pros and cons regarding these technologies and formulated wishes. During the lunchbreak, citizens visited the nanolab. In the afternoon, citizens further developed the two most popular wishes for applications and products at their table in a creative manner.

Quite a number of the participants expressed their interest in the following process, six people asked after if they could participate in future consultations with the experts, and multiple citizens addressed their interest for future information about GoNano and nanotechnology in health. The overall acclaim was absolutely positive as far as the feedback goes – both based on the results of the questionnaire and by personal feedback.

2. NANOTECHNOLOGY APPLICATION AREAS IN HEALTH

The outcomes of expert interviews (D1.3) revealed the most relevant areas of development in nanomaterials and nano-related applications or products that are enabling new applications in the health sector. Three specific applications that could be available on the market in the medium or long term potentially having the most relevant impacts on society were identified (see below). At the deliberate and envisioning workshop, citizens provided reflections to each area as well as their views about how to integrate ideas for future development of the applications of nanotechnology that are aligned with citizens' needs and values, as specified below.

2.1. MONITORING DEVICES FOR HEALTH

These applications are based on sensor technologies and focus on instantly measuring blood values in the body, and thereby creating a clear picture of an individual's health status. Based on these measurements influence of behaviour on health can be measured, indicators of potential diseases can be analysed, and a personal medical file can be kept. Also, devices can be used for people who have a shortage of particular components (e.g., diabetes patients). A monitoring device can be linked to an automatic insulin pump. Scientists imagine that these sensor technologies might lead to a change in the healthcare system, from curing diseases to preventive healthcare, and provide input for personalized medicines. Nanotechnology enables to combine multiple sensors in a small device that could be either used in an invasive or non-invasive way.

Initial citizens' feedback:

A number of the citizens participating in the workshop was quite positive about the potential of this technology. They emphasized the benefits of early detection of diseases (e.g. in the case of cancer), and

prevention of diseases. They also emphasized the benefits of collecting all this data for personalized medicines. This could make the healthcare system much cheaper and more effective. Some of them emphasized that such a technology can offer support to people's worries, as it continuously gives feedback on health indicators, and can increase awareness of an individual's life style.

However, a large majority of the participants also saw downsides of this technology. Three themes could be distinguished in the downsides: 1) awareness of health indicators, 2) monitoring and interpreting data, and 3) privacy and security of data. They emphasized that constantly having measurements of health indicators could lead to a lot of stress and worries. Most of the citizens did not think this would increase their wellbeing. Furthermore, the interpretation of the data generated by the sensors and displayed on a smart device was discussed. If people have to read out the smart device themselves, it might lead to errors in interpretations, and can lead to a divide in society as not everyone is able to handle such a device. Also the reliability of the measurements was questioned. Will the device be 100% reliable, or is there a margin of error? They argued that for a lot of people a margin of error might be difficult to understand, and can cause stress. Related to this is the role of the medical professional. Many participants very much disliked the idea that sensor technology might bypass the professional in monitoring and diagnosing diseases. They preferred to have the medical professional operating as a moderator between the device and the citizen/patient. The professional should read and interpret the data, and give a warning when values show anomalies. This can be remote monitoring. Privacy and security of data was another issue that was discussed in relation to this technology. It was emphasized that people should own their own medical data, and should be given autonomy in decisions which data to collect, share, and store. Next to user friendliness of the smart device connected to nanosensors, privacy and security are important to take into account in the design. Data should, for example, not be linked to or be synchronized to other data (which is the case with mobile phones and smart watches).

In case of a monitoring device for patients, quite some citizens saw benefits as it decreases the burden of a disease and increases quality of life. However, they mentioned that they had concerns about getting too dependent on the device. What if the device stops working, or gives an error? There were some diabetes patients present at the workshop, who also saw the benefits of a monitoring device linked to an automatic insulin pump. One even had a semi-automatic insulin pump. He said it definitely increased his quality of life. However, he had to get used to it and it had to be personalized by indicating his own signal values. He stated that this device might not be able to be used by everyone.

2.2. EARLY-DIAGNOSTIC DEVICES

Based on nanotechnology, lab-on-a-chip-devices and other devices, such as the 'artificial nose', are being developed for the early detection and diagnosis of diseases. Scientists are working on devices that can detect anomalies in biomarkers in blood, urine, or breath in a very fast and sensitive way. Devices will probably first be implemented in hospitals and at the general practitioner's office, but might be also available for citizens in the future.

Initial citizens' feedback:

Most participants were positive about diagnostic devices such as the artificial nose, because of its non-invasiveness and externality. They liked the idea that the device would not be injected in their bodies, and would not constantly monitor their health. They were also positive about this device being operated

in hospitals or at the general practitioner's office. This would provide a safe and professional environment in case a disease would be diagnosed, and would safeguard from misinterpretations. Also, this would prevent a division in society into groups of citizens who are able to handle the device and who aren't.

Nevertheless, a large number of participants also had concerns regarding the early-diagnostic devices. A major issue was the detection of diseases that could not be cured (e.g. Alzheimer). Most of the participants were not sure whether they wanted to know whether they would have a higher risk for these diseases, as they did not think it would increase their wellbeing. However, a few of them mentioned that it could be helpful to know about higher risks as they could adapt their lifestyle, and postpone the symptoms of the disease. Also, the organization of using the diagnostic devices was questioned. Whom should it be applied to? Should it be a yearly check-up for everyone, or only for high-risk people? Would it have implications for their health insurance? Most participants emphasized that accessibility for everyone is important, but in relation to freedom of choice. Furthermore, the collection and storage of data was debated. Is it ethical if a medical professional has found biomarkers that indicate a high risk of a particular disease that cannot be cured yet, but does not share this information with the subject? Also, where will the data be stored and who will be the owner of the data? Similar to the monitoring device, most participants would opt for autonomy of the individual over the data.

Regarding the lab-on-a-chip device, participants were positive about the efficiency in time and costs. Also, they emphasized that people could become more emancipated with these devices, and less dependent on medical professionals.

However, quite some negative aspects were addressed as well, mostly regarding the reliability of the results and the home-environment in which the diagnosis takes place. Many of the citizens participating in the workshop would prefer a medical environment for the diagnosis of diseases, as the medical professional could take away fears and worries, and immediately propose a treatment plan. One citizen made the comparison with home-tests for HIV. In some countries these are prohibited, as governments fear that citizens might harm themselves when having a positive test result. Also, the creation of inequality in society was mentioned as a negative aspect, as some people might not be willing or able to use the lab-on-a-chip devices. It was emphasized that solidarity and autonomy should be leading in the design and implementation of such devices.

2.3. REGENERATIVE MEDICINES

It sometimes happens that people need a new organ, or other body parts, like beta-cells, a new hip, heart, pancreas, kidney. Scientists are working on the development of regenerative medicines that enable the use of (stem) cells to regenerate tissues and organs. Organs or skin patches made from your own cells could help to ensure the body accepts the new replacement better. In the case of diabetes type 1, for example, patients don't have beta cells that are needed for making insulin. With the use of regenerative techniques, scientists can make new beta cells from stem-cells.

Initial citizens' feedback:

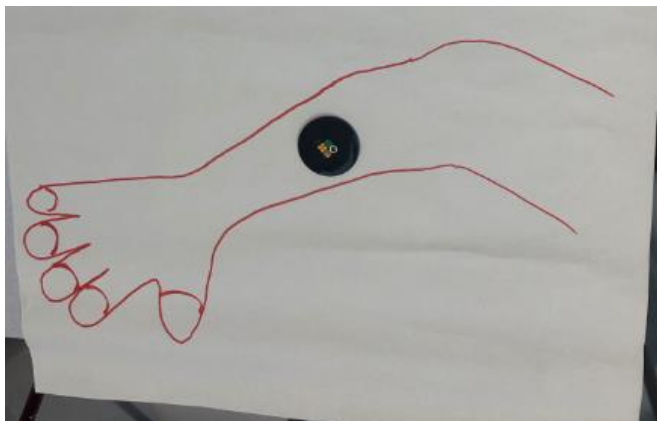
In general, participants were positive of curing diseases with regenerative treatments, by treating the origin of the disease and not the symptoms. However, quite a large group of citizens found it difficult to

have a clear opinion on this treatment as they did not know much about it, and thought it was hard to understand the working principles.

A number of concerns regarding regenerative medicines were addressed. One theme that was often mentioned was the accessibility of the treatment. Would this treatment be affordable for everyone, or only for the rich? And should it be applied to everyone who faces negative aspects of a disease, or only for people who can hardly live with it? A comparison with transplantations was made. Not everyone will get on the waiting list for transplantation, but patients need to meet a number of criteria for this. Participants could see a similar system with regenerative medicine. Also, it was mentioned multiple times that this treatment should be linked to the lifestyle of people. By offering a regenerative treatment, it should not mean that (potential) patients should not have a healthy lifestyle. If relevant, treatment should start with changing behaviour. Another potential polarization in society that was often addressed was between religious and non-religious people. Most participants thought religious principles should not be leading in the development of technology. In quite some debates the comparison was drawn to vaccinations (which is a major issue in The Netherlands). Participants were afraid that this technology would also lead to a polarized debate in society. Everyone agreed that citizens should have autonomy in decisions about their treatments, as long as it does not harm other people. Another concern mentioned with regenerative medicine were the potential side effects. What would happen with these cells? Would they change the structure of DNA? Would they work for ever? Could they be taken out of the body as well? Citizens had a lot of questions in this regard.

3. CITIZENS' PREFERENCES TO NANOTECHNOLOGY APPLICATIONS IN HEALTH

Participants at the deliberation and envisioning workshop formulated a number of wishes, principles and rules related to the future applications of nanotechnology in health. Based on individual wishes, every table produced two wishes and one table one wish, of how an ideal technology would look like (in total 15 wishes). Participants were asked to individually vote on the wishes based on relevance and importance. The group of 8 tables was divided in two groups, one group (25 citizens) could vote on 8 technologies designed by the other group and vice versa.

Wish 1	Sensorpatch	Number of votes
		30
Reference to the application area: monitoring device		
Renewable (environmentally-friendly patch) that monitors various reference values in body. The patch can be used or taken off whenever a person wants to, and it is non-invasive. The patch is connected to a smart-device.		
Quality of the technology: <ul style="list-style-type: none">• Non-invasive• Autonomy of user• Environmentally-friendly		
Target group: For everyone, but only by free choice		
		

Wish 2 Medical-record-on-a-chip

Number of votes:

28

Reference to the application area: monitoring device

Description:

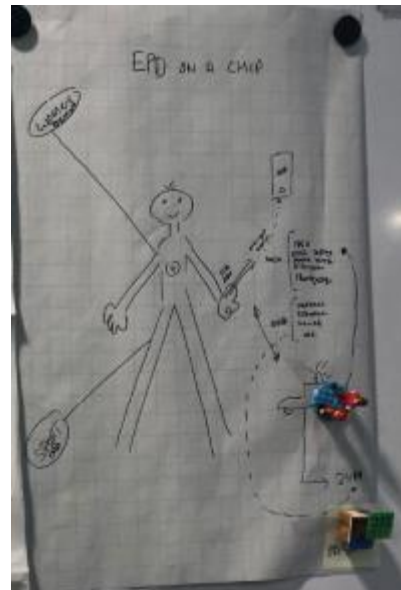
A biometrical chip that can measure blood values, but also contains information about an individual's medical history. The chip is implanted in the fingertip. Medical data can only be read after approval of an individual, and data is encrypted. In case of emergency, healthcare professionals have access to basic information about the person on the chip (name, identity, donor, and acceptance for reanimation), and an individual can decide for allowing access to other information (medical history, allergies, etc.). Everyone should have access to the chip, but only by free choice.

Quality of the technology:

- Autonomy in collection and sharing of data
- Security of data
- Relevant information in case of emergency
- Unawareness of health data

Target group:

- Everyone who wants to use the chip



Wish 3 Health monitoring through urine

Number of votes:

25

Reference to the application area: monitoring device

Description:

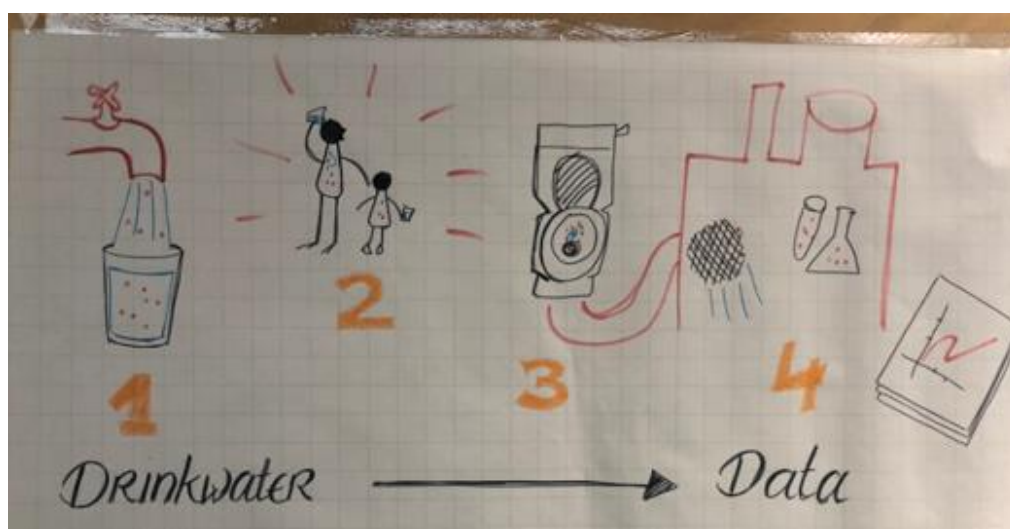
A device that can be placed on toilets and measures biomarkers in urine. Data is going to a regional database, that measures and recognizes patterns of health on a regional scale. Based on these data the municipal health authority can launch targeted health campaigns, and targeted actions (e.g., regional health check). Also (potential) epidemics can be detected.

Quality of the technology:

- Not individually based, but based on large amounts of data
- Regionalized healthcare
- Targeted campaigns
- Early detection of epidemics
- Pattern recognition
- Non-invasive

Target group:

- Can be placed in public toilets



Wish 4

Blood for blood

Number of votes:

19

Reference to the application area: regenerative medicine

Description:

A medical device that generates new blood based on own blood. Through a very sensitive sensor the exact characteristics of an individual's blood can be detected. Based on these characteristics new blood can be created in an external device outside the body.

Quality of the technology:

- Replacement of blood donations
- Identical blood
- Helps with shortage in particular types of blood

Target group:

- People who need blood (e.g. with trauma patients, accidents)



Wish 5

Autonomonitor

Number of votes:

18

Reference to the application area: early-detection device

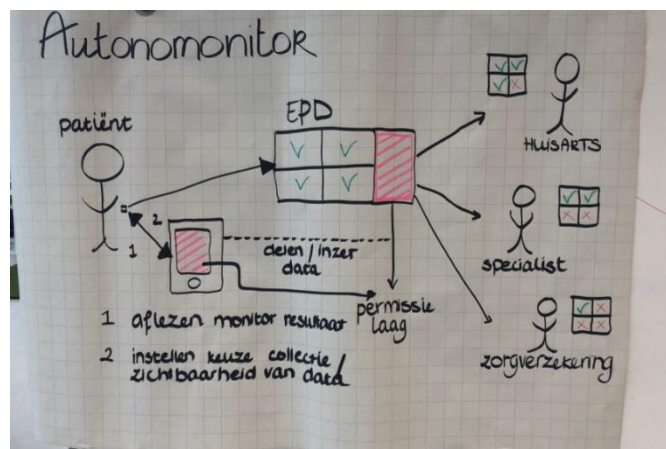
Nano-chip implanted in body, which is linked to a smart device. Individual can decide which data will be collected by chip, stored and shared, through a smart device. The smart device is linked to a national electronic medical file. The individual can decide which actors have access to which data (e.g. general practitioner has access to a lot of data, while insurance company to only limited amount of data).

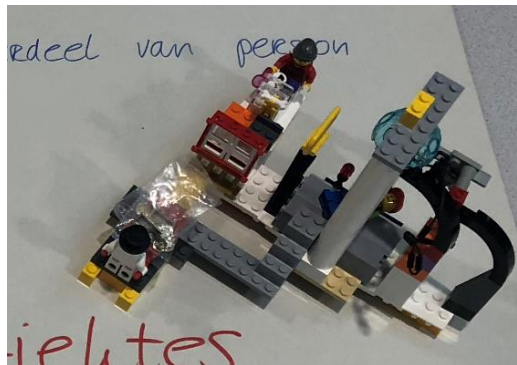
Quality of the technology:

- Solution of discussion around electronical medical file
- Autonomy and ownership of data by individual
- Medical professionals are included in the healthcare process

Target group:

Everyone, but only by free choice



Wish 6	Medical POD / scanner	Number of votes
		18
Reference to the application area: regenerative medicines / monitoring device		
Cells that are generated and manipulated by adding a nano-sensor that can monitor various reference values in the body. These ‘fake cells’ will not be rejected by the body, and become part of your body, once injected. Data are send to an external smart device, which is secured and only accessible by permission of the patient.		
Quality of the technology: <ul style="list-style-type: none">• Bodily substance• Not rejected• No nano-parts in body• Secure monitoring device• Medical professional is included in the monitoring process		
Target group: For everyone, but only by free choice		
		

Wish 7	Regenerative 2.0	Number of votes:
		14
Reference to the application area: regenerative medicines		
Description:		
Self-regulating cell-structure based on nanotechnology. The cell-structure monitors specific reference values and can detect a shortage of particular components (e.g., insulin, vitamins, or hormones) in the body and automatically refill these components, despite contextual factors (food, physical efforts, etc.). Data will be stored in a secured database.		
Quality of the technology:		
<ul style="list-style-type: none">• Cell-structure can be adapted and taken out of the body• Autonomous• Internal (unawareness of device/regulation mechanism)• Periodically check-up at GP's office• Won't be rejected by the body• Semi -biological (e.g. stem cells) and semi smart material		
Target group:		
<ul style="list-style-type: none">• People who have a shortage for particular components		

Wish 8

Mobile diagnostic device

Number of votes:

13

Reference to the application area: early-diagnostic devices

Description:

This product is a mobile diagnostic device that can measure multiple components and can detect anomalies. It is used by medical professionals at people's homes. It is non-invasive and external, and after the diagnosis the collected data will be stored in an anonymous database for analyzing and recognizing patterns.

Quality of the technology:

- Non-invasive
- Interpretation by medical professionals
- Applied in the home environment
- Decreases burden and stress of patient/citizen

Target group:

- For everyone, but not obligatory



Wish 9

Nano-slim

Number of votes:

12

Reference to the application area: monitoring device

Description:

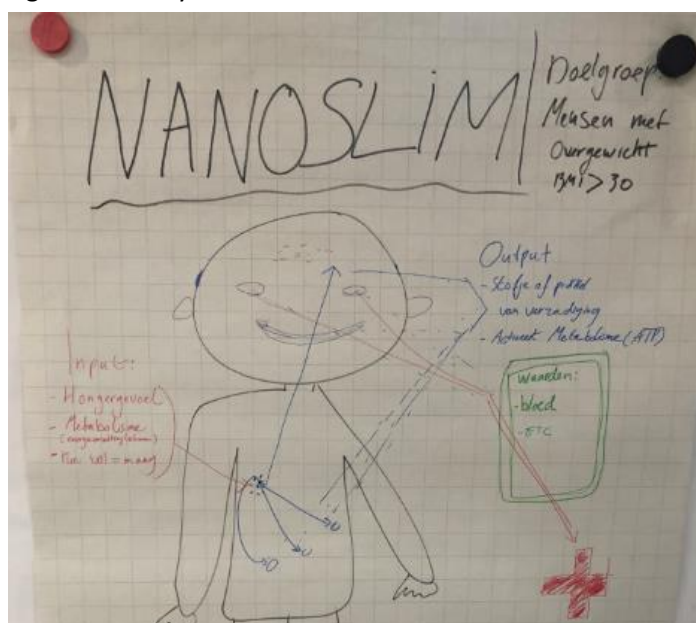
A sensor in a person's body that measures the feeling of hunger (either based on hormones or neurological indicators). When the feeling of hunger arises, the chip can release a substance that activates a feeling of satisfaction. Helps against obesity.

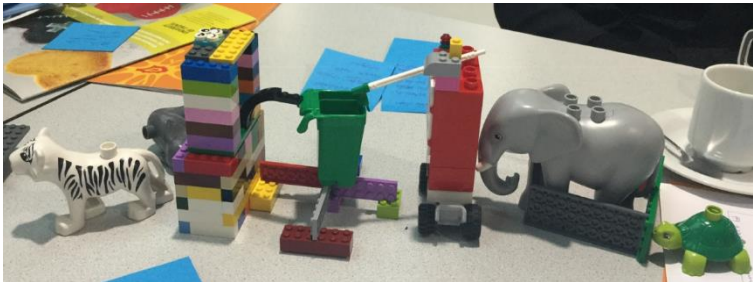
Quality of the technology:


- Measures indicators of hunger
- Measures metabolism
- Output can generate a signal (to create awareness)
- Output can generate a substance that creates metabolism

Target group:


- People who suffer from obesity or eating disorders
- Diseases that slow down metabolism

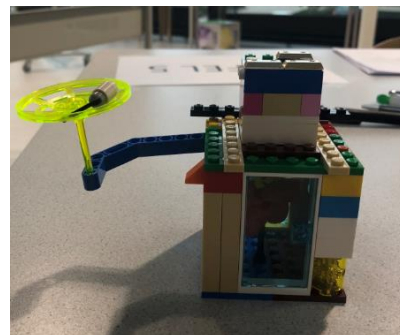



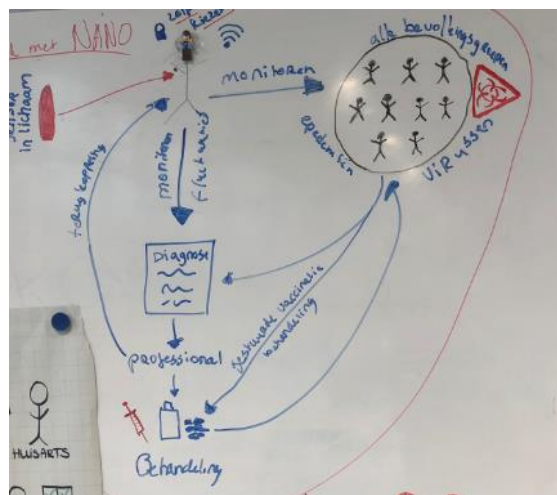
Wish 10	Nano-thirst meter	Number of votes:
		10
Reference to the application area: monitoring device		
<p>Description:</p> <p>This technology is a nanochip that is implanted in the body of people who have been or are addicted to alcohol or other substances. The nano-sensor constantly monitors reference values in the body and can detect a feeling of thirstiness (longing for alcohol), before the person can feel it him or herself. When this feeling arises, a substance will be released that solves the longing for alcohol. In extreme cases, the data of the chip can be linked to a device that is monitored by a medical professional or care-giver.</p> <p>Quality of the technology:</p> <ul style="list-style-type: none"> • Semi-automatic behavioural change • Instrument for helping with recovery of an addiction • Focus on fysiological processes in case of addiction <p>Target group:</p> <ul style="list-style-type: none"> • People who have problems (are addicted to) with substances 		
		

Wish 11	Remote doctor	Number of votes:
		9
Reference to the application area: monitoring device		
<p>Description:</p> <p>Device that monitors reference values, but sends the data to the general practitioner. In case of anomalies, the general practitioner can contact the patient.</p> <p>Quality of the technology:</p> <ul style="list-style-type: none"> • Multi-functional • Intermediate role of medical professional <p>Target group:</p> <ul style="list-style-type: none"> • Patients 		
		

Wish 12	Nano-detectives	Number of votes
		8
Reference to the application area: early-detection device		
Nano-pill with sensor that can detect anomalies in blood.		
Quality of the technology: <ul style="list-style-type: none">• Multi-functional• No use of needles• Sensitive		
Target group: People who need blood tests		

Wish 13	Baby-tummy-registration	Number of votes
		7
Reference to the application area: monitoring device		
Description: A nano-chip that is placed in the placenta during a pregnancy and monitors the development of the baby in the mother's tummy. In case of problems or anomalies, a signal is send to a smart device.		
Quality of the technology: <ul style="list-style-type: none">• Feeling of security during pregnancy• Positive for development of fetus		
Target group: <ul style="list-style-type: none">• Pregnant women		
		



Wish 14	Nano-medicine	Number of votes
		7
Reference to the application area: monitor		
<p>Description:</p> <p>A very thin nano-film that can be attached underneath the tongue. In case of a migraine attack, the film can release immediately a medicine.</p>		
<p>Quality of the technology:</p> <ul style="list-style-type: none"> A sensor is placed in the film that can signal the beginning of a migraine attack <p>Target group:</p> <ul style="list-style-type: none"> People with migraine 		
		
Wish 15	Nanosensors for population studies	Number of votes
		5
Reference to the application area: monitoring device		
<p>Nano-chip implanted in body to monitor for diseases. Data is linked to a database of professional, which is linked to a large national database. Individual does not need to worry for interpreting data, when something is wrong medical professional will give a signal. Large scale database can be used to detect epidemics and viruses.</p>		
<p>Quality of the technology:</p> <ul style="list-style-type: none"> Medical professional is included in monitoring process National database with a lot of information Detection of epidemics <p>Target group:</p> <p>For everyone, but only by free choice</p>		
		

These elaborated envisioning wishes from all the tables stem from a large number of specific **individual wishes** – these were most frequently connected to: 1) ownership of data, 2) human interaction, 3) non-invasiveness, 4) reliable interpretation of data, 5) secure storage of data, 6) autonomy in healthcare, 7) inclusion of medical professional in the process, 8) unburden the patient/citizen.

4. MESSAGES TO STAKEHOLDERS

Researchers

Be transparent about results and insights in nanotechnology, also the negative ones. This will lead to trust and higher acceptance of technologies among the general public. Right now, there is hardly access to research results and new developments; Look at the needs of consumers/citizens. Do not have the prime focus on the possibilities of the technology, but look at the needs in society. It seems that with regard to the monitoring and diagnostic devices, developers/researchers are looking at all possibilities of values that can be monitored, but they should consider whether this leads to an increase of people's wellbeing; When designing monitoring or diagnostic devices, make sure that people can indicate their own boundaries and have autonomy over their own data; When developing nanotechnologies, do not only focus on the technology, but also on the user experience of the device/product in which it is integrated. Make technologies accessible to a large audience, including the less tech-savvy people; When developing technologies that collect and/or store data, make sure these data are collected in a secure way. Take into account people's privacy; Make sure technologies are being developed in a sustainable and safe way.

Policy-makers / government

Hold dialogues with researchers, to see how you can facilitate them in an optimal way; Make sure that there will not be a gap between the development and implementation of technologies and regulations; Be transparent and consistent about rules and regulations regarding nanotechnologies in healthcare. Explain to people why you defined particular rules, and make sure they are legitimate; Regional governments, inform citizens about possibilities with health technologies; Serve the needs of citizens, not industry; Be open for another direction in the healthcare system, from curing to prevention; Make sure that with the implementation of monitoring and detection technologies a 'closed-loop' is organized, in which the medical professional is not bypassed; The whole care package should be accessible to everyone, but custom-made for different types of people; Ensure the freedom of choice with these kind of technologies, this includes decisions about in vitro or in vivo, different alternatives (e.g., stem cells or not), and collection of types of data; Safeguard the privacy of citizens; Prevent the development of 'super humans', safeguard the integrity of the human genome; Make sure that the implementation of healthcare technologies is not directed by industry, but by government and strive towards autonomy, solidarity, and accessibility of healthcare. Developments in healthcare should not be at cost of accessibility to healthcare.

Health insurance / industry

Invest in new technologies that ensure that healthcare remains affordable and accessible for everyone; Take into account the impact technologies might have on polarizing society (e.g. based on social economic status); Respect individual's privacy; Do not only follow algorithms derived from big data, but keep the individual in mind when implementing technologies; Restructure financing healthcare, take into account a shorter depreciation period. Technological innovations happen faster than ever, but the current financial system in healthcare slows down the implementation.

Medical professionals

Use technology in a way that it decreases your workload, and makes your work more efficient; Educate and inform patients about nanotechnology, its risks and possibilities; Give your opinion to researchers and policymakers about applications of nanotechnology, also when this opinion is negative; Do not only

focus on the results detracted from data, but also listen to the patient. Keep using your intuition in this regard, and use technology to test it.

Media

Discuss all perspectives on technologies, and be aware of your role in creating public support or opposition for technologies; Think about how to publish information in an understandable way, this should already start in schools with educating children.

Citizens/patients

Be aware of the information you collect and share, and the potential consequences this might have.

Patient organizations

Stay involved, cooperate with patients, and focus on practical applications of technologies. Keep control and watch over safety and security of patients.

Government, insurance companies, and medical professionals

Think about how to organize the financial system in healthcare, in relation with new technologies. Currently, medical professionals are being paid per cure/visit, but with remote monitoring or preventive technologies, a different financial structure should be implemented.

Researchers, medical professionals and government

Never forget that technology is not an end in itself, but that it is for the benefit of mankind. Keep having a dialogue on this theme.

5. SUMMARY

In general, citizens could see the potential of monitoring devices, early-diagnostic devices, and regenerative medicines. They saw benefits in the prevention of diseases, unburdening the patient and how different technologies could improve people's wellbeing. However, citizens also mentioned a number of concerns and wishes to take into account when further developing nanotechnology in health. These can be divided in four areas: nanotechnology in general, accessibility and autonomy, reliability and interpretation of data, and privacy and security of data.

Little attention was given to 'nanotechnology in general', but when citizens addressed it, they thought nanotechnologies should be developed in a safe and sustainable way. Especially with regard to invasive technologies, such as nanochips and regenerative medicines, citizens emphasized the importance of not harming a person's health. However, they saw much more possibilities of the potential applications of these technologies, than disadvantages in this regard.

Accessibility and autonomy was much more often addressed when discussing the different technologies. Citizens emphasized that healthcare should be affordable and accessible for everyone. Nanotechnology could be an enabler for decreasing the costs. However, citizens also addressed that medical technologies should not polarize society. They posed some concerns regarding diagnostic and monitoring devices that were designed to be used by citizens, which could lead to a digital divide in society between people who are able and willing to use these devices and people who are not. In case of regenerative medicines, citizens mentioned the potential divide between religious and non-religious

people. They could understand that some people would not agree with a treatment based on regenerative medicine or stem cell technologies. Most citizens thought religious values should not be leading in the development and implementation of health technologies. Nevertheless, they did emphasize that there should always be an alternative treatment for people who do not want to have regenerative treatments. For all health technologies, a large number of citizens stated that people should at all times have autonomy in the decision whether to make use of a technology or not.

Reliability and interpretation of data were often mentioned in relation to monitoring and diagnostic devices. Citizens emphasized that even though 'home-monitoring' and 'home-diagnostic tests' could increase emancipation of citizens and decrease the costs of the healthcare system, it could also cause stress for an individual and potentially lead to misinterpretations. Citizens questioned whether constantly being aware of health indicators would lead to an increase in wellbeing. They suggested to take this into account in the design, and only focus on signals when anomalies are detected. Additionally, citizens emphasized the importance of reliable data, and educate users about how to interpret this data, and how to handle a margin of error. A large number of citizens underlined that they would not want to exclude the medical professional in the diagnosis and treatment of diseases. They thought the medical professional should act as a moderator between the device and the citizen or patient. The professional should analyse and interpret the data (remotely), and warn the individual in case of anomalies.

Privacy and security in the collection, storage, and sharing of data were also often mentioned in relation to monitoring and diagnostic devices. Citizens thought it was very important that various parties involved in the process of data collection were transparent about what would happen with the data. Citizens also emphasized that in the design of a smart device, security and privacy should be one of the leading principle. Furthermore, citizens emphasized that an individual should be the owner of his or her own data, and should be given autonomy in decisions of data collection, monitoring, storage, and sharing. This should be custom-made, as everyone could have different wishes and needs in this regard.

These wishes and concerns can be seen as a Leitmotiv throughout the whole day. They were addressed when discussing the technologies, designing the wishes, and defining messages to stakeholders. It should be noted that citizens received in advance an information package in which various developments of nanotechnology were mentioned and future scenarios. In these descriptions of developments and scenarios, a large focus was on nanotechnology in relation to monitoring and diagnostic devices. This may have influenced the prominence of concerns and wishes relating to these technologies. Nevertheless, the workshop gave a very good insight in citizens' thoughts, wishes, and recommendations regarding the development and implementation of nanotechnology in health.

ANNEX 1: COMPOSITION OF PARTICIPANTS

	Actual Recruitment*	
	Number of Participants	Share
Gender		
Male	27	54%
Female	23	46%
Age		
18-24	7	14%
25-34	17	34%
35-49	5	10%
50-59	9	18%
60+	9	18%
Education		
Low	0	/
Middle	6	12%
High	44	88%
Size of the Residence area		
Up to 5 000 inhab.	4	8%
5 000 to 89 999 inhabitants	16	32%
Over 90 000 inhab.	30	60%
Region		
East (Twente)	28	56%
West (Randstad)	9	18%
Other	13	26%
Economic activity		
Student	7	14%
Retired person	7	14%
Employee, employer	36	72%

	Required Recruitment*	
	Number of Participants	Share
Gender		
Male	27	50%
Female	28	50%
Age		
18-24	11	20%
25-34	11	20%
35-49	11	20%
50-59	11	20%
60+	11	20%
Education		
Low	11	20%
Middle	22	40%
High	22	40%
Size of the Residence area		
Up to 5 000 inhab.	6	11%
5 000 to 89 999 inhabitants	11	20%
Over 90 000 inhab.	38	69%
Region		
East (Twente)	30	55%
West (Randstad)	12	21%
Other	13	24%
Economic activity		
Student	11	20%
Retired person	11	20%
Employee, employer	32	60%

* Beforehand a total of 55 people were recruited. Three gave notification that they could not attend. Two did not show up on the day itself. The total number of participants was therefore 50.

ANNEX 2: EVALUATION OF RESULTS

At the end of the envisioning workshop a questionnaire was handed out. The questionnaire is a part of a larger evaluation instrument aiming to evaluate the whole co-creation methodology of the GoNano project. The questions were based on the KPI's Knowledge and understanding; Trust and mutual understanding and Co-creation as formulated in the proposal. A more detailed report in which also the results of the three countries is compared is available separately (see Annex IV).

2.1. KNOWLEDGE AND UNDERSTANDING

In the Netherlands, in total 50 citizens participated in the citizen consultation. Participants indicated that they were little informed about nanotechnology prior to the workshop ($M = 2.44$; $SD = 0.95$), while the indicated knowledge on nanotechnology after the workshop was significantly higher ($M = 3.35$; $SD = 0.77$; $p = .00$). Of all participants, 70% thought they were more informed about nanotechnology after the workshop than prior to the workshop, 28% did not indicate an increase in knowledge, and one citizen (2%) had the feeling he/she was less informed after the workshop. Also, most participants agreed that the workshop contributed in improving their understanding of nanotechnology in general ($M = 3.93$; $SD = 0.67$) and of nanotechnology for health applications ($M = 3.90$; $SD = 0.65$). For both questions more than 75% of the participants agreed that their understanding improved after the workshop.

Participants indicated that they hardly participated in nanotechnology prior to the workshop ($M = 2.23$; $SD = 0.89$). They sometimes heard, read or watched information about nanotechnology ($M = 2.94$, $SD = 1$), but hardly searched for information about nanotechnology ($M = 2.35$; $SD = 1.2$), and almost never participated in meetings about nanotechnology ($M = 1.44$; $SD = 0.91$). After the workshop, participants indicated that they felt the need to obtain more information about nanotechnology ($M = 3.72$; $SD = 0.66$).

Participants reported a positive attitude towards nanotechnology ($M = 4.0$; $SD = 0.6$). In line with this, they saw more benefits than risks regarding the development of nanotechnology ($M = 3.8$; $SD = 0.77$).

2.2. TRUST AND MUTUAL UNDERSTANDING

Most actors were trusted to some extent in dealing with nanotechnology in a responsible way. Researchers were among the actors that were trusted the most, while industry/companies were trusted the least ($M=2.90$; below the midpoint of the scale) (See Table 2.3). Also the participants' expectations of how actors will deal with the outcomes of the citizen workshop in the co-creation process were the highest for researchers and the lowest for industry (see Table 2.3).

With regard to self-efficacy, the scores around the mid-point of the scale showed that citizens did not feel very secure nor insecure about their ability to act when something happens related to nanotechnology ($M = 3.2$; $SD = 0.69$).

Trust and expectations

Actor	Level of trust: mean (SD)	Expectations: mean (SD)
Researcher	4.39 (0.61)	3.69 (0.87)
Policymakers	3.65 (0.79)	3.53 (0.84)
Industry/companies	2.90 (0.88)	2.98 (1.00)
Civil society organizations	3.84 (0.90)	3.39 (0.95)
Consumer organizations	3.51 (1.00)	3.39 (0.91)

2.3. Co-CREATION

The participants were very positive about the organization of the citizen workshop, they gave a score between 4 and 5 on a five-point-Likert-scale ($M = 4.35$; $SD = 0.50$). They were even more enthusiastic about the quality of the group discussion, with a mean score of 4.8 (0.35), and 68% of the participants giving the full score to every single item in this construct. Participants were also positive about the quality of the output, but slightly less than on the other constructs ($M = 4.26$; $SD = 0.48$).

About one third of the participants wrote something down on one of the open questions (suggestions for the organization of the workshop, and final remarks). Most suggestions were about getting more information on nanotechnology and its applications before the workshops. Most remarks were about the gratitude of the organization of the workshop, and the question to stay involved in GoNano.



Evaluation results of the workshop with citizens

ANALYSIS OF CZECH REPUBLIC, SPAIN, AND THE NETHERLANDS

Work Package:	WP3 – Envisioning and Deliberating with Citizens
Deliverable number:	3.2 – Annex IV
Partner responsible:	University of Twente
Compiling author(s):	Sikke Jansma and Anne Dijkstra, University of Twente
Contributing author(s):	Lenka Hebáková, Technology Centre CAS Marek Pour, Technology Centre CAS Craig Richmond, RMIT
Quality assurance:	Lise Bitsch, Danish Board of Technology Foundation
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Dissemination level:	PU

1. INTRODUCTION TO THE EVALUATION RESULTS

At the end of the envisioning citizen workshop, a questionnaire was handed out to every participant. The questionnaire is part of a larger evaluation measurement, aiming to evaluate the whole co-creation methodology of GoNano by measuring various Key Performance Indicators (KPIs). Related to the citizen engagement activities, three KPIs were defined:

1. Knowledge and understanding: 90% of the citizens participating in the GoNano pilots will agree to better understanding nanotechnologies.
2. Trust and mutual understanding: 80% of the participants, including citizens, will agree to understanding and trusting each other.
3. Co-creation: 90% of the participants, citizens and stakeholders, will agree that the process of producing product suggestions was co-creative.

The questionnaire that was filled out at the citizen workshop served both as a baseline measurement (e.g., trust in various stakeholders and expectations in co-creation process), and as an evaluation-measurement (e.g., organization of workshop and increase of knowledge and understanding). It consisted of several constructs (existing of three or four items measuring one concept) and a few single-item questions and all were based on five-point-Likert scales. An English questionnaire served as the main document, and the questions were translated in the languages of the pilot country (Dutch, Czech, and Spanish). Every construct that was included in the questionnaire had a Cronbach's Alpha of 0.70 or higher, which is therefore thought to be a reliable measure of the underlying internal consistency of the concept (Field, 2005). Table 1 provides an overview of the concepts and where applicable the reliability measures. Further details will be discussed below.

Table 1: reliability of measures

Concepts or topics in the questionnaire	Number of items	Cronbach's alpha (N= number of respondents)
<i>Knowledge and understanding</i>		
Level of engagement before the workshop	3	0.76 (N=116)
Knowledge prior and after workshop	2 single items	
Information need after the workshop	3	0.70 (N=117)
Perceived risks and benefits	4	0.80 (N=118)
Attitude	4	0.70 (N=118)
Understanding general and specific application	2 single items	
<i>Trust and mutual understanding</i>		
Self-efficacy – dealing with possible risks	4	0.79 (N=117)
Trust in actors and stakeholders	5 single items	
Expectations of actors and stakeholders	5 single items	
<i>Co-creation</i>		
Quality of the group discussion	3	0.79 (N=119)
Quality of the output	3	0.70 (N=118)
Organisation	4	0.71 N=114)

1.1. KNOWLEDGE AND UNDERSTANDING

To measure citizen's knowledge of nanotechnology, two single-item questions were included, asking about knowledge about nanotechnology, both prior to the workshop and after the workshop. Furthermore, a construct of three questions was used to indicate the level of engagement of citizens prior to the workshop, and a construct of three questions was used to test the information need after the workshop. Three questions about the level of engagement were formulated as follows: "Before you participated in this workshop, have you ever read, heard or watched information about nanotechnology; have you ever searched for information; and, have you ever participated in meetings about nanotechnology. This engagement construct reported a Cronbach's Alpha of 0.79. Three questions formed the construct for information need: "After this workshop I will search for more information about nanotechnology; I will keep an eye on information about nanotechnology; and, I will search for the latest news about nanotechnology" (Cronbach's Alpha is 0.70).⁷

Furthermore, to get a clearer picture of citizen's understanding of nanotechnology, two single-item questions asked about the participants' increase in understanding of nanotechnology in general and about their increase in understanding of nanotechnology in the pilot theme. Additionally, two constructs with both four questions were included about perceived risks and benefits, and attitude on nanotechnology. Questions about perceived risks and benefits included: "I perceive risks and benefits about nanotechnology in general for myself / the average citizen / society / future generation" (Cronbach's Alpha is 0.80). The four questions about attitude towards nanotechnology are "I feel attracted to developments of nanotechnology; I believe that developments of nanotechnology are important; I feel involved with developments of nanotechnology; and, I am personally interested in developments of nanotechnology" (Cronbach's Alpha is 0.70).

1.2. TRUST AND MUTUAL UNDERSTANDING

To measure trust and understanding of various stakeholders participating in GoNano, we asked the citizens to indicate their trust on a five-point-Likert-scale regarding various actors or stakeholder groups, namely, researchers, policy makers, industry/companies, civil society organizations, and consumer organizations. We included a similar question about citizen's expectations of how the different actors or stakeholder groups will use the outcomes of the citizen workshop. Additionally, we included a construct with four questions about self-efficacy to measure how citizens trusted themselves of dealing with possible risks of nanotechnology. This construct included the questions: "I consider myself able to search for relevant information; I am able to anticipate possible risks; I am able to react adequate when something goes wrong; and I am able to help others if needed", and reported a Cronbach's Alpha for internal consistency of 0.79.

1.3. CO-CREATION

Three different constructs with each three questions were used to measure co-creation and to evaluate the citizen workshop: quality of group discussion, quality of the output, and organization. Quality of group discussion had a Cronbach's Alpha of 0.73. The questions were: "I felt sufficiently comfortable to voice my opinions during the process; All participants were respectful towards one another; The moderators did a good job in ensuring a constructive process during the discussions". Quality of output reported a Cronbach's Alpha of 0.70, and included: "I am satisfied with the overall quality of the output of the citizen workshop; Despite different opinions we were able to formulate main needs

⁷ Cronbach's Alpha is a measure of internal consistency or scale reliability used in tests / evaluations. (<https://stats.idre.ucla.edu/spss/faq/what-does-cronbachs-alpha-mean/>)

and benefits; and, I am convinced that the needs and benefits formulated today will serve as input for the upcoming stakeholder workshops”. Organization of the citizen workshop had a Cronbach’s Alpha of 0.71, and consisted of: “The purpose of the citizen workshop was well communicated beforehand; The information material I received beforehand was easy to understand; and, It is clear to me what will be done with the results of the discussions today”.

2. ANALYSIS

In this section, first, results per country will be described, followed with an overall conclusion.

2.1. CZECH REPUBLIC

Knowledge and understanding

A total of 48 citizens participated in the workshop and completed a questionnaire. Participants indicated that they were little informed about nanotechnology prior to the workshop ($M = 2.13$; $SD = 0.80$), but the indicated knowledge on nanotechnology after the workshop was significantly higher than before ($M = 3.38$; $SD = 0.92$; $p = .00$). Of all participants, 75% thought they were more informed about nanotechnology after the workshop than prior to the workshop, and 25% did not indicate an increase in knowledge. Also, most participants agreed that the workshop contributed to improving their understanding of nanotechnology in general ($M = 3.75$; $SD = 0.53$) and of nanotechnology for food applications in particular ($M = 3.92$; $SD = 0.54$). For both questions respectively 70% and 80% of the participants agreed that their understanding improved after the workshop.

Participants indicated that they hardly engaged in nanotechnology prior to the workshop ($M = 1.91$; $SD = 0.76$). They sometimes heard, read or watched information about nanotechnology ($M = 2.51$; $SD = 0.88$), but hardly searched for information about nanotechnology ($M = 1.94$; $SD = 1.07$), and almost never participated in meetings about nanotechnology ($M = 1.28$; $SD = 0.85$). After the workshop, there was a need to obtain more information about nanotechnology ($M = 3.58$; $SD = 0.52$).

Participants reported a moderately positive attitude on nanotechnology ($M = 3.6$; $SD = 0.51$). In line with this, they saw more benefits than risks with the development of nanotechnology ($M = 3.7$; $SD = 0.5$).

Trust and mutual understanding

Participants assessed actors differently when it comes to trust in whether these actors will deal with nanotechnology in a responsible way. Researchers were trusted the most, while policy makers were trusted the least (See Table 2.1). Also, expectations of how actors will deal with the outcomes of the citizen workshop in the co-creation process, were the highest for researchers, and the lowest for policy makers (see Table 2.1). Nevertheless, the expectations showed a smaller difference than the scores on trust.

With regard to self-efficacy, participants were moderately confident about their ability to act when something happens related to nanotechnology ($M = 3.53$; $SD = 0.54$).

Table 2.1: trust and expectations

Actor	Level of trust: mean (SD)	Expectations: mean (SD)
Researcher	3.94 (0.67)	3.90 (0.93)
Policymakers	2.47 (0.72)	2.69 (1.01)
Industry/companies	2.94 (0.98)	3.19 (1.01)
Civil society organizations	3.03 (0.85)	3.09 (0.80)
Consumer organizations	3.40 (0.84)	3.42 (0.85)

Co-creation

The participants were very positive about the organization of the citizen workshop ($M = 4.29$; $SD = 0.45$). They were also positive about the quality of the group discussion with a mean score of 4.49 (0.56), and 35% of the participants giving the full score to every item in this construct. Participants were also positive about the quality of the output, but slightly less than on the other constructs ($M = 4.10$; $SD = 0.48$).

About one fifth of the participants answered at least one of the open questions (suggestions for the organization of the workshop or final remarks). Most suggestions were about making sure that nanotechnologies and nanoparticles do not cause any harm and are safe enough for the human health as well as for the environment ("Please, pay more attention to the consequences of nanoparticles use when it comes to the environment. Applications will be simply generated by the market..."). Most remarks were about the gratitude of the organization of the workshop and getting information on nanotechnologies in general as well as more concretely in the area of food.

2.2. SPAIN

Knowledge and understanding

A total of 21 participants filled in the questionnaire. Participants indicated that they were little informed about nanotechnology prior to the workshop ($M = 2.14$; $SD = 0.96$), but the indicated knowledge on nanotechnology after the workshop was significantly higher than before ($M = 3.40$; $SD = 0.68$; $p = .00$). Of all participants, 80% thought they were more informed about nanotechnology after the workshop than prior to the workshop. Also, most participants agreed that the workshop contributed in improving their understanding of nanotechnology in general ($M = 4.24$; $SD = 0.54$) and of nanotechnology for energy applications in particular ($M = 4.24$; $SD = 0.63$). For both questions 80% of the participants agreed that their understanding improved after the workshop.

Participants indicated that they hardly engaged in nanotechnology prior to the workshop ($M = 1.88$; $SD = 0.77$). They rarely heard, read or watched information about nanotechnology ($M = 2.35$, $SD = 1.14$), hardly searched for information about nanotechnology ($M = 2.10$; $SD = 1.07$), and almost never participated in meetings about nanotechnology ($M = 1.14$; $SD = 0.66$). After the workshop, there was a need to obtain more information about nanotechnology ($M = 4.13$; $SD = 0.51$).

Participants reported a positive attitude on nanotechnology ($M = 4.03$; $SD = 0.44$). In line with this, they saw more benefits than risks with developing nanotechnology ($M = 3.89$; $SD = 0.59$).

Trust and mutual understanding

Participants considerably trusted researchers, consumer organizations and civil society organizations in that they will deal with nanotechnology in a responsible way. They also trusted policy makers but to a lesser extent. Industry/companies were trusted the least (See Table 2.2)., Expectations of how actors

will deal with the outcomes of the citizen workshop in the co-creation process were the highest for researchers, and the lowest for policy makers (see Table 2.2).

With regard to self-efficacy, citizens indicated that they were confident about their ability to act when something happens related to nanotechnology was above the mid-point scale of 3 ($M = 3.7$; $SD = 0.52$).

Table 2.3: trust and expectations

Actor	Level of trust: mean (SD)	Expectations: mean (SD)
Researcher	4.43 (0.68)	4.38 (0.74)
Policymakers	3.24 (1.14)	2.95 (1.02)
Industry/companies	2.95 (1.28)	3.19 (1.29)
Civil society organizations	3.76 (0.83)	3.50 (0.83)
Consumer organizations	4.05 (0.92)	3.71 (1.06)

Co-creation

The participants were very positive about the organization of the citizen workshop ($M = 4.32$; $SD = 0.38$). They were also positive about the quality of the group discussion, with a mean score of 4.79 (0.32), and 62% of the participants giving the full score to every item in this construct, and the quality of the output of the workshop ($M = 4.46$; $SD = 0.44$).

About one third of the participants answered at least one of the open questions (suggestions for the organization of the workshop or final remarks). Most of them gave their gratitude for participating in the workshop. One suggestion was made about increasing the dissemination activities of the workshop in advance, and another one about coming up with more specific examples of nanotechnology in energy during the workshop.

2.3. THE NETHERLANDS

Knowledge and understanding

In the Netherlands, in total 50 citizens participated in the citizen consultation. Participants indicated that they were little informed about nanotechnology prior to the workshop ($M = 2.44$; $SD = 0.95$), while the indicated knowledge on nanotechnology after the workshop was significantly higher ($M = 3.35$; $SD = 0.77$; $p = .00$). Of all participants, 70% thought they were more informed about nanotechnology after the workshop than prior to the workshop, 28% did not indicate an increase in knowledge, and one citizen (2%) had the feeling he/she was less informed after the workshop. Also, most participants agreed that the workshop contributed in improving their understanding of nanotechnology in general ($M = 3.93$; $SD = 0.67$) and of nanotechnology for health applications ($M = 3.90$; $SD = 0.65$). For both questions more than 75% of the participants agreed that their understanding improved after the workshop.

Participants indicated that they hardly participated in nanotechnology prior to the workshop ($M = 2.23$; $SD = 0.89$). They sometimes heard, read or watched information about nanotechnology ($M = 2.94$, $SD = 1$), but hardly searched for information about nanotechnology ($M = 2.35$; $SD = 1.2$), and almost never participated in meetings about nanotechnology ($M = 1.44$; $SD = 0.91$). After the workshop, participants indicated that they felt the need to obtain more information about nanotechnology ($M = 3.72$; $SD = 0.66$).

Participants reported a positive attitude towards nanotechnology ($M = 4.0$; $SD = 0.6$). In line with this, they saw more benefits than risks regarding the development of nanotechnology ($M = 3.8$; $SD = 0.77$).

Trust and mutual understanding

Most actors were trusted to some extent in dealing with nanotechnology in a responsible way. Researchers were among the actors that were trusted the most, while industry/companies were trusted the least ($M=2.90$; below the midpoint of the scale) (See Table 2.3). Also the participants' expectations of how actors will deal with the outcomes of the citizen workshop in the co-creation process were the highest for researchers and the lowest for industry (see Table 2.3).

With regard to self-efficacy, the scores around the mid-point of the scale showed that citizens did not feel very secure nor insecure about their ability to act when something happens related to nanotechnology ($M = 3.2$; $SD = 0.69$).

Table 2.3: trust and expectations

Actor	Level of trust: mean (SD)	Expectations: mean (SD)
Researcher	4.39 (0.61)	3.69 (0.87)
Policymakers	3.65 (0.79)	3.53 (0.84)
Industry/companies	2.90 (0.88)	2.98 (1.00)
Civil society organizations	3.84 (0.90)	3.39 (0.95)
Consumer organizations	3.51 (1.00)	3.39 (0.91)

Co-creation

The participants were very positive about the organization of the citizen workshop, they gave a score between 4 and 5 on a five-point-Likert-scale ($M = 4.35$; $SD = 0.50$). They were even more enthusiastic about the quality of the group discussion, with a mean score of 4.8 (0.35), and 68% of the participants giving the full score to every single item in this construct. Participants were also positive about the quality of the output, but slightly less than on the other constructs ($M = 4.26$; $SD = 0.48$).

About one third of the participants wrote something down on one of the open questions (suggestions for the organization of the workshop, and final remarks). Most suggestions were about getting more information on nanotechnology and its applications before the workshops. Most remarks were about the gratitude of the organization of the workshop, and the question to stay involved in GoNano.

2.4. COMPARISON BETWEEN COUNTRIES

Knowledge and understanding

In all pilot countries, Czech Republic, Spain and the Netherlands, a large majority of participants (70% to 80%) reported an increase in knowledge about nanotechnology after the workshop: from little informed to moderately informed. In the Netherlands the increase was less than in the other two countries as participants reported to have more knowledge prior to the workshop (see Table 2.4). Furthermore, a similar amount of participants (70% - 80%) agreed that the workshop contributed to improving their understanding of nanotechnology in general, and of applications of nanotechnology in the domain of the pilot country (health in the Netherlands, food in Czech Republic, energy in Spain). In Spain, the participants were a little more convinced of the effect of the workshop on their understanding of nanotechnology than in the other two countries (see Table 2.4).

In the three countries, participants indicated that they hardly engaged in nanotechnology prior to the workshop. Although, in the Netherlands participants engaged slightly more often in nanotechnology than in the other two countries. After the workshop, a majority of the participants indicated that they

felt the need to obtain more information about nanotechnology, with the Spanish participants having the highest information need (see Table 2.4).

To get a clearer picture of how participants perceived nanotechnology, we asked about their attitude on nanotechnology in general and their perceived risks and benefits. Participants had quite a positive attitude towards nanotechnology, but in Czech Republic the attitude was a little lower than in the other two countries. Also, participants saw more benefits than risks with the development of nanotechnology, with no significant differences between the three countries.

Trust and mutual understanding

In the Czech Republic, participants were less trusting towards actors than in the other two countries. Although, in all three countries ‘researchers’ were trusted the most, Dutch and Spanish participants were more positive about them than Czech participants. Policymakers were perceived as relatively trustworthy in the Netherlands, a little less trustworthy in Spain, and not very trustworthy in Czech Republic (see Table 2.4). In the latter country, policy makers were assessed the lowest on their trustworthiness, while in both the Netherlands and Spain the industry/companies received the lowest score. A reason for the lower level of trust in Czech Republic, could be that it is due to the topic of food. From previous studies, we know that citizens are more sceptical towards nanotechnology in the area of food, than regarding other domains (e.g., Capon, Gillespie, Rolfe, & Smith, 2015). Another explanation could be that Czech citizens are more sceptical towards the intentions of professional stakeholders, than the Spanish and Dutch citizens.

With regard to the expectations of how various actors would deal with the outcomes of the citizen workshop, the results show a different picture. Dutch participants had higher expectations of policymakers, than Spanish and Czech participants. Meanwhile in the Czech Republic and Spain the expectations of researchers were higher than in the Netherlands. Except for the policymakers, the Spanish participants had higher expectations of how actors would deal with the outcomes than in Czech Republic and the Netherlands (see Table 2.4).

Co-creation

In all three countries, the participants were very positive about the organization of the citizen workshop. There were no significant differences between the countries. Also, the participants regarded the quality of the group discussions and the quality of output participants as very positive.

Table 2.4: Descriptive results of the three pilot countries regarding KPIs

	The Netherlands	Czech Republic	Spain	Total
	N = 50	N = 48	N = 21	N = 119
<i>Knowledge and understanding</i>				
Knowledge prior to workshop	2.44 (0.95)	2.13 (0.80)	2.14 (0.96)	2.25 (0.90)
Knowledge after workshop	3.35 (0.77)	3.38 (0.92)	3.40 (0.68)	3.38 (0.82)
Improved understanding of nano in general	3.93 (0.67)	3.75 (0.53)	4.24 (0.54)	3.91 (0.61)

Improved understanding of nano in health/food/energy	3.90 (0.65)	3.92 (0.54)	4.24 (0.63)	3.97 (0.61)
Engagement prior to workshop	2.23 (0.89)	1.91 (0.76)	1.88 (0.77)	2.04 (0.99)
Information need after workshop	3.72 (0.66)	3.58 (0.52)	4.13 (0.51)	3.73 (0.61)
Attitude towards nanotechnology	4.00 (0.60)	3.60 (0.51)	4.03 (1.07)	3.83 (0.57)
Perceived risks/benefits	3.80 (0.77)	3.70 (0.50)	3.89 (0.59)	3.76 (0.64)
<i>Trust and expectations</i>				
Self-efficacy	3.20 (0.69)	3.53 (0.54)	3.70 (0.52)	3.41 (0.63)
Trust in...				
Researchers	4.39 (0.61)	3.94 (0.67)	4.43 (0.68)	4.21 (0.68)
Policymakers	3.65 (0.79)	2.47 (0.72)	3.24 (1.14)	3.09 (0.99)
Industry/companies	2.90 (0.88)	2.94 (0.98)	2.95 (1.28)	2.92 (0.99)
Civil society organizations	3.84 (0.90)	3.03 (0.85)	3.76 (0.83)	3.50 (0.93)
Consumer organizations	3.51 (1.00)	3.40 (0.84)	4.05 (0.92)	3.56 (0.95)
Expectations of...				
Researchers	3.69 (0.87)	3.90 (0.93)	4.38 (0.74)	3.90 (0.90)
Policymakers	3.53 (0.84)	2.69 (1.01)	2.95 (1.02)	3.08 (1.02)
Industry/companies	2.98 (1.0)	3.19 (1.01)	3.19 (1.29)	3.10 (1.09)
Civil society organizations	3.39 (0.95)	3.09 (0.80)	3.50 (0.83)	3.28 (0.88)
Consumer organizations	3.39 (0.91)	3.42 (0.85)	3.71 (1.06)	3.46 (0.91)
<i>Co-creation</i>				
Organization of citizen workshop	4.35 (0.50)	4.29 (0.48)	4.32 (0.38)	4.32 (0.46)
Quality of group discussion	4.80 (0.35)	4.49 (0.56)	4.79 (0.32)	4.67 (0.47)
Quality of output	4.26 (0.48)	4.10 (0.48)	4.46 (0.44)	4.21 (0.52)

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