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4.2

WORKING PAPER ON THE DESIGNS AND OUTCOMES OF WORKSHOP ROUND 1

GoNano is a Coordination and Support Action funded by the European Union under the NMBP Programme of Horizon 2020, Grant Agreement n° 768622.

Work Package:	WP4 – Co-creation with professional stakeholders
Deliverable number:	D4.2
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Planned delivery date:	M20
Actual delivery date:	M21
Dissemination level:	PU

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EXECUTIVE SUMMARY

This working paper presents the design and outcomes of the first round of stakeholder workshops organised in the Netherlands, the Czech Republic and Spain as part of the European project GoNano (Governing Nanotechnologies through Societal Engagement).[1] The GoNano project is built on the assumption that several types of knowledge are needed to define sustainability, acceptability, and desirability of nanotechnologies. The project builds on previous efforts in public engagement and new technologies to develop a pilot project in each of the nanotechnology research areas: health, food and energy. 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 health, food, and energy formed the first step of the co-creation process. The stakeholder workshops formed the second step. The workshops aimed to explore opportunities and barriers for co-creation in the three thematic areas.

Five workshops in three countries

The first stakeholder workshops were held in the three designated pilot countries in February and March 2019.[2] The University of Twente (UT) organised three workshops in the thematic area of nanotechnologies and health in the Netherlands: the first workshop on 12 February focused on diabetes, the second workshop on 5 March looked at sensors, and the third workshop on 7 March discussed health policy. The Technology Centre of the Czech Academy of Sciences (TC CAS) organised a fourth workshop on nanotechnologies and food in Prague on 28 February. A fifth workshop on nanotechnologies and energy was held in Barcelona by the European Office of the Royal Melbourne Institute of Technology (RMIT), also on 7 March.[3]

All workshops followed a similar structure, featuring four interrelated co-creation sessions: an exploration phase, where participants got to know each other and explored the needs and values expressed by citizens as well as their own needs and interests; an ideation session, where participants imagined and co-created responses to the needs and values expressed by the citizens by imagining revisions of ongoing research and innovation trajectories; a prototyping session, where participants generated a storyboard that visualized how the resulting research lines and product suggestions could be designed in relation to the needs and values expressed by the citizens and

[1] An assessment of the overall co-creation process of the GoNano project will come out in February 2020.

[2] The partners organising the workshops in the respective countries are: the University of Twente (UT) in The Netherlands, the Technology Centre of the Czech Academy of Sciences (TC CAS) in the Czech Republic, and the Royal Melbourne Institute of Technology (RMIT) in Spain. The lead partner on the coordination of the stakeholder workshops is De Proeffabriek (DPF), a consultancy for responsible innovation based in the Netherlands.

[3] Brief summaries and video reports on the workshops are available on the project website:
- For the workshops on health: http://gonano-project.eu/stakeholders-insights-for-research-products-and-policy-on-nanotechnology-and-health/
- For the workshop on food: http://gonano-project.eu/setkani-odborniku-nanotechnologie-a-potraviny/
- For the workshop on energy: http://gonano-project.eu/5181-2/

suggested concrete actions to be taken to realise this vision; and a concluding reflection, where participants presented their visions and reflected on the overall workshop outcomes.

Workshop findings

Collectively, the workshops have mobilized almost one hundred stakeholders around co-creation in nanotechnologies. The events provided productive spaces for engagement and mutual learning between a wide range of stakeholders: researchers, producers, policy makers, civil society and citizens.

Responses to the evaluation questionnaire and follow-up interviews show that participants appreciated the events. Those who responded to the questionnaire were very positive about the quality of the group discussion: more than 75% agreed or strongly agreed that the group discussions were of good quality, and around 65% thought the citizens' messages were relevant for the workshop. Particularly in the Netherlands and in Spain, the majority of respondents thought it made sense to consider the needs and values of citizens and societal stakeholders in an early stage (see Annex 1 for the full evaluation report).

The workshop discussions gave rise to interesting suggestions: in the diabetes workshop at UT, citizens' concerns about the ownership of medical data sparked a discussion about data management in the case of the artificial pancreas, highlighting considerations that might be of use to the product developer in further developing a data management plan. In the sensor workshop, interactions with envisaged future users of a biomedical sensor raised the researcher's awareness of the performance criteria that will determine adoption of the sensor. These examples suggest that 'exposure' to use considerations further down the line can attune research design to future use contexts. The overall workshop approach of enabling carefully moderated, highly focused, interest-driven discussions in a four-step process (exploration, ideation, prototyping, reflection) seems to have worked well in these cases.

Reflection on the findings

Looking at the learning objectives for the stakeholder workshops, the results suggest that – at least in some cases – the workshops succeeded in raising awareness with stakeholders that the early consideration of the needs and values of citizens and societal stakeholders can add value to innovation in nanotechnologies. However, it seems that participants valued the workshops not just because of a direct self-interest but also because they provided general opportunities for mutual learning and networking opportunities. Exposure to different perspectives was considered an enriching experience in itself. The workshops raised a general awareness with stakeholders of the need to incorporate social needs and values in the development of nanotechnologies.

But the workshop findings also point to barriers for co-creation. It proved difficult to connect the input from the citizens to the research agendas and concerns of the professional stakeholders. On a very critical reading, one could argue that the workshops achieved many things: they managed to raise awareness of stakeholders of the importance of integrating broader societal considerations in research, and even encouraged stakeholders to consider citizens' views more deeply. However, in most cases this did not lead to co-creation in the sense of productive collaborations leading to

tangible outcomes such as a new research avenue, proposal, product or prototype.[4] The findings suggest that there is a trade-off between inclusiveness and specificity: the decision to treat all stakeholder perspectives on an equal footing for reasons of inclusiveness may come at the cost of a clear action perspective. Conversely, the choice of one particular action perspective to enable specificity is – by definition – partial and exclusive.

These observations reconfirm the complexity of the GoNano co-creation process as a whole: it is far from self-evident how broader societal considerations can be applied meaningfully to research and innovation practice. It requires insight in the individual, day-to-day decisions being taken in nanotechnology research and innovation (and respect for the limited room for manoeuvre at that level); a deep understanding of public perceptions of, and attitudes towards, nanotechnologies; a process that allows participants to build a relationship and develop a shared language in which their contribution to the problems at hand can be meaningfully expressed; and above all, the capacity to 'translate' needs and concerns from the social realm to practical options in the technological realm in real time. This is a tall order indeed, but it is exactly what needs to happen to realise the policy prescriptions underlying the notion of Responsible Research and Innovation and the Science in Society-movement in general: *"to encourage actors in their own disciplines and fields to participate in developing Science in Society perspectives from the very beginning of the conception of their activities."*[5]

[4] Co-creation is defined in GoNano as follows: *„Co-creation activities enable productive collaborations between researchers and societal stakeholders over longer timeframes, focusing on specific nanotechnology research lines, leading to tangible outcomes such as a new research avenue, proposal, product or prototype."* For further information, see this earlier report on the co-creation methodology for GoNano: http://gonano-project.eu/deliverable-2-1/.

[5] European Commission. (2007). Work programme 2007, Capacities, Part 5, Science in Society. C(2007)563.

1. INTRODUCTION

This report presents the design and outcomes of the first round of stakeholder workshops organised in the Netherlands, the Czech Republic and Spain as part of the European project GoNano (Governing Nanotechnologies through Societal Engagement). The stakeholder workshops are a key part of the GoNano project: integrating the lessons learned in the first exploratory stages of the project and the citizen workshops, the workshops aimed to raise awareness with stakeholders that the early consideration of the needs and values of citizens and societal stakeholders can add value to innovation in nanotechnologies. After presenting the workshop organisation and outcomes, this report considers the extent to which the learning objectives and expected outcomes have been achieved, and what that implies for the organisation of the second round of workshops in October 2019 (the implications for the upcoming online survey with citizens are discussed elsewhere).

1.1 OVERALL OBJECTIVES OF GONANO: ENABLING CO-CREATION

The GoNano project is built on the assumption that several types of knowledge are needed to define sustainability, acceptability, and desirability of nanotechnologies. To test this hypothesis, GoNano explores opportunities and barriers for co-creation in different thematic areas (Health, Food and Energy), combining face-to-face citizen engagement, stakeholder workshops and online consultations (see Figure 1).

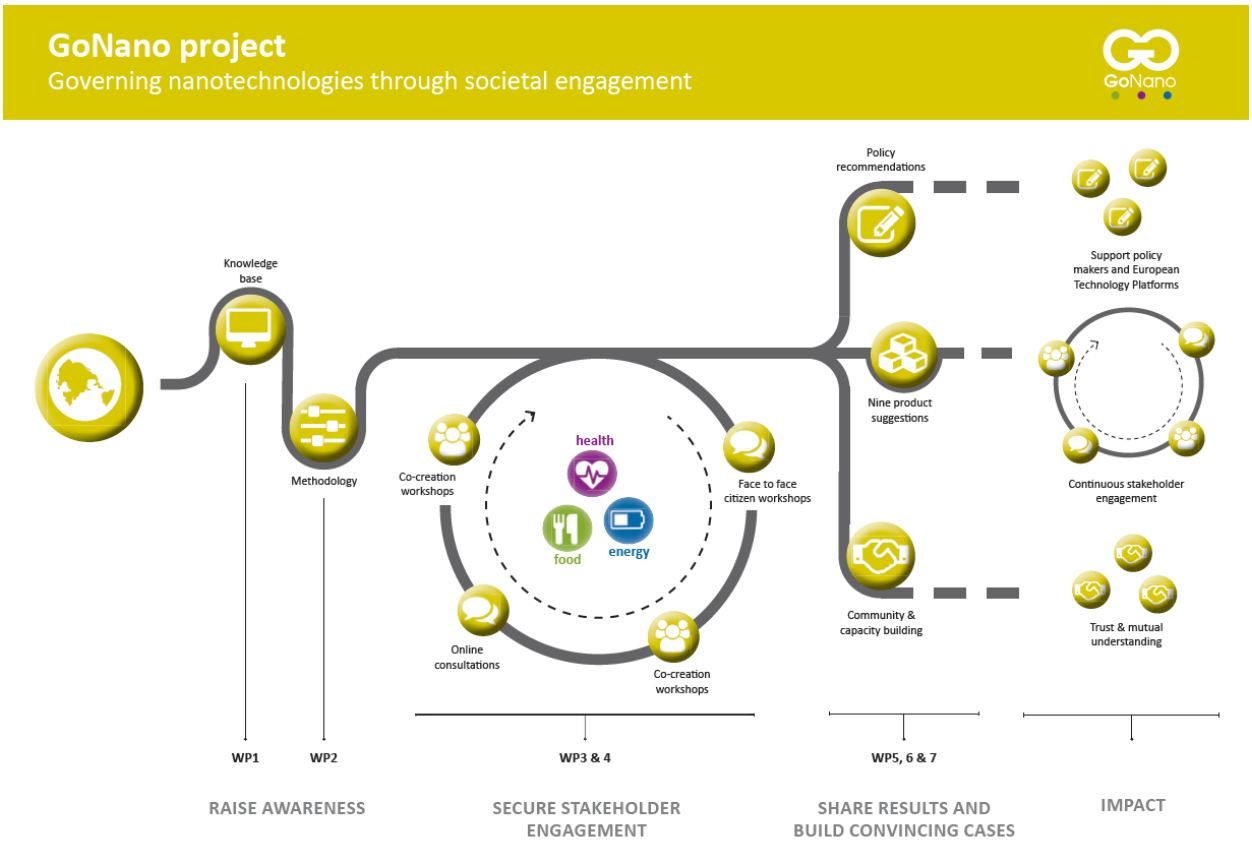


Figure 1 - Overall design of the GoNano project

Building on the knowledge base and the methodology developed in earlier stages of the project, GoNano has established an iterative process to integrate societal considerations in nanotechnologies: in a series of citizen workshops, citizens express their wishes and concerns with respect to each of the application areas. In a series of stakeholder workshops, stakeholders subsequently explore ways to take these wishes and concerns into account in nanotechnology research and innovation.

The three pilot partners organised a series of face-to-face citizen workshops in the Netherlands, the Czech Republic and Spain in October/November 2018 (see the briefing report[6] for further information on the outcomes of the citizen workshops). The aim of the first round of stakeholder workshops was to come up with concrete 'responsive' design suggestions that can be fed back in ongoing research and innovation activities, building on the outcomes of the citizen workshops. These design suggestions will feed into the next round of citizen consultations, which in turn is expected to feed into second round of stakeholder workshops that will evaluate the uptake of the responsive design suggestions of the previous round. Collectively, these consecutive tasks are meant to explore the value of co-creation to integrating societal values in research and innovation.

1.2 Co-creation workshops with professional stakeholders – the first round

The first stakeholder workshops were held in February and March 2019. The University of Twente (UT) organised three workshops in the thematic area of nanotechnologies and health in the Netherlands: the first workshop on 12 February focused on diabetes, the second workshop on 5 March looked at sensors, and the third workshop on 7 March discussed health policy. The Technology Centre of the Czech Academy of Sciences (TC CAS) organised a fourth workshop on nanotechnologies in food in Prague on 28 February. A fifth workshop on nanotechnologies and energy was held by the European Office of the Royal Melbourne Institute of Technology (RMIT), also on 7 March (Table 1).

Table 1 – Overview of the first stakeholder workshops

Location	Partner	Topic	Date	Participants
Enschede (NL)	UT/DPF	Health (Diabetes)	February 12, 2019	11
Prague (CZ)	TC CAS	Food	February 28, 2019	34
Enschede (NL)	UT/DPF	Health (Sensors)	March 5, 2019	8
Enschede (NL)	UT/DPF	Health (Policy)	March 7, 2019	9
Barcelona (ES)	RMIT	Energy	March 7, 2019	27

[6] http://gonano-project.eu/wp-content/uploads/2019/02/D3.2-Briefing-report-from-the-citizen-workshops.pdf

2. WORKSHOP DESIGN

While the objectives and expected outcomes of the workshops have been discussed in consortium meetings from the beginning of the project, concrete planning of the workshops started in August 2018. WP4 partners regularly discussed progress during online and physical meetings between September 2018 and February 2019: pilot partners UT, TC CAS, RMIT and WP leader De Proeffabriek (DPF) presented and discussed their ideas for the programme, with input on broader topics from other partners (for example, on gender and diversity by the European Institute of Women's Health (EIWH), and on integrating the insights from a literature review of earlier experience and best practices in co-creation by Oslo Metropolitan University (OsloMet).

2.1 LEARNING OBJECTIVES AND EXPECTED OUTCOMES

Building on the findings of the literature review (D1.1), interviews with relevant stakeholders (D1.3) and the proposed methodology (D2.1), WP4 partners defined the following expected outcomes beforehand, and agreed to use these expected outcomes to assess the extent to which the workshop objectives have been achieved (see section 4.3 below for the assessment):

1. *Concrete design suggestions which relate to the research and innovation at hand*
   Concrete design suggestions are 'actionable': i.e. it is clear who should undertake action and what steps should be taken. Once the stakeholders have identified design suggestions based on the societal needs and values expressed by citizens, the workshop should focus on identifying *actions*: who will do what, when and where? In the ideal case, these action plans could even serve as the starting point for the second workshop: "did we do what we said we would do?" (Realistically, some more work may be required between the two workshops).
2. *Responsiveness of the design suggestions to societal needs and values*
   Responsiveness implies that the design is somehow *modified in light of the societal needs and values* presented at the workshop. So, it first has to be clear to all participants exactly which 'design' is under discussion, to explore how the societal needs and values identified could influence the design decisions. This again requires that the workshop programme clearly defines the topics under discussion. Second, there needs to be a mechanism (work form) by which the societal needs and values can be productively brought to bear on the topics at hand. This work form should create a 'multidisciplinary level playing field' (building on the principle of the symmetry of ignorance), where all participants can creatively and collaboratively explore links between the 'technical' and 'social' dimensions of the design at hand.
3. *'Awareness' of participants: stakeholders see the relevance of citizen perspectives and multi-stakeholder engagement*
   Feedback in ongoing research and innovation activities will only occur if stakeholders are *aware and convinced of the relevance* of citizen perspectives for their work. Given that participation of stakeholders is voluntary (participants are under no obligation to incorporate the results of the workshop), uptake will depend first and foremost on the willingness of stakeholders to integrate these results. The workshop should therefore convincingly demonstrate that the outcomes of the citizen workshops *matter* for the ongoing research and innovation activities at hand, and that

they *add value* to the work of the stakeholders.[7] This relevance is not self-evident, but will require 'translation' of the outcomes of the citizen workshops (based on D3.2) to the specific research context under discussion by the workshop organisers.

4. *Willingness of stakeholders to continue*
   If the points above work out as planned, stakeholders may be more likely to want to continue the engagement process because they are aware of the relevance of multi-stakeholder perspectives, and know how to productively apply it in their own work. However, as with point 3 above, this will only happen if the workshops can demonstrate the added value of this engagement from within their own perspective. Therefore, the workshop has to focus on 'what's in it for them'.
5. *Questions for the online consultation*
   In the ideal case, stakeholders might even want to know more about societal views on their work, which could serve as input for the online consultation.

These expected outcomes translated into two specific learning objectives for the workshops:

1. To *raise awareness with stakeholders* that the *early consideration* of the needs and values of citizens and societal stakeholders *can add value* to innovation in nanotechnologies.
2. To *explore effective approaches* to productively embedding societal considerations in ongoing research and innovation (hence, the workshops are 'cases' within the broader GoNano ambition to create a methodology for responsive design of nanotechnologies).

2.2 WORKSHOP OVERALL STRUCTURE AND PROGRAMME

The programmes and participant lists were iteratively defined to align them as much as possible to the interests of the participating stakeholders. To ensure consistency across the workshops, DPF proposed an overall programme structure for the stakeholder workshops, building on the original Description of Action, reports on the literature and the methodology, earlier discussions, agreed expected outcomes and draft programmes from pilot partners. The proposed programme structured the workshop in five sessions: a general introduction, followed by four interrelated co-creation sessions:

- Session A: **Exploration**, where participants got to know each other and their work and explore the needs and values expressed by the citizens as well as their own needs and interests.
- Session B: **Ideation**, where participants imagined and co-created responses to the needs and values expressed by the citizens by imagining revisions/adaptations of ongoing research and innovation trajectories, building on the varied expertise around the table.

[7] Schuurbiers has argued elsewhere that first-order reflective learning, „the improvement of the technology and the improved achievement of one's own interests in the network," is a prerequisite for the possibility of second-order learning, „reflection 'on' the research system, including the value-based socio-ethical premises that drive research, the methodological norms of the research culture, and the epistemological and ontological assumptions upon which science is founded": the willingness of researchers to engage in critical reflection on the broader socio-ethical context of research has been found to be dependent on their perception that the collaboration also improved the achievement of their own (research) interests. See: Schuurbiers, D. (2011). What happens in the lab – Applying midstream modulation to enhance critical reflection in the laboratory. *Science & Engineering Ethics* 17(4): 769-788.

- Session C: **Prototyping**, where participants generated a storyboard that visualized how the resulting research lines and product suggestions could be designed or modified in relation to the needs and values expressed by the citizens and suggested concrete actions to be taken by the stakeholders present to realise this vision.
- Session D: **Reflection**, where participants presented and reframed their storyboards, reflected on the ways in which the citizens' needs shaped the storyboards, identified actions to be taken in preparation for the next workshop and reflected on the overall workshop objectives.

(For further details on the proposed programme structure, please see the relevant section in Annex 2).

Pilot partners integrated this overall structure in their specific programmes, while modifying the programme to fit the specific workshop topics and cultural specificities (as detailed in the thematic sections).

2.3 Supporting material: background information, engagesuite, report template and evaluation questionnaire

Background material: 'translating' outcomes of the citizens' workshops

Partners UT and DPF prepared background information for each of the workshops in consultation with the pilot partners. The background material transformed the information gained in the first phase of the project (including the insights and deliverables from the literature study, methodological considerations, the background production developed for the citizen workshops and feedback from citizens) to fit the context of the stakeholder workshops. For further details on the process and the final materials, please see the GoNano website.[8]

Figure 2 – Information material for the workshop on nanotechnology and diabetes organised by UT (front page)

The purpose of the background material was to inform stakeholders about the co-creation process of GoNano, nanotechnologies and the outcomes of the citizen workshops. By distributing the background material before the workshop, stakeholders with various backgrounds could acquire a base-level of knowledge on nanotechnology, co-creation, and the social needs and values of citizens.

Furthermore, the background material emphasized the importance and urgency of stakeholder engagement and the potential value of including societal needs and values in the development of nanotechnologies

[8] http://gonano-project.eu/information-material-stakeholder-workshops/.

Figure 3 – Timetable for the workshops, showing the four main pillars of co-creation: exploration, ideation, prototyping and reflection.

Digital support tool for the stakeholder workshops

The project partners employed an IT tool called 'EngageSuite' was used as a support tool to facilitate the workshop discussions and reporting. The tool is meant to facilitate interactive meetings via video and chat functionalities and collection and sharing of meeting notes.

Evaluation questionnaire

In order to follow the achievements on mutual learning and trust, partner UT prepared an evaluation questionnaire, which was handed out to the workshop participants at the end of the stakeholder workshops. The questionnaire is part of a larger evaluation process, aiming to evaluate the overall co-creation methodology of GoNano. The results of the evaluation are available in Annex 1.

National report template

Pilot partners TC CAS, UT and RMIT drafted national reports of the workshop and its outcomes based on a report template proposed by DPF (shown in Annex 2). The national reports in the next section aim to present rich descriptions of the events themselves, the characteristics of the participants, the plenary and subgroup discussions, (implicit) group dynamics and tangible outputs (notably the initial responses from stakeholders to the messages from citizens and the storyboards) as well as reflections on the workshop objectives (testing the main hypothesis) and on the question of inclusivity. The national reports were written by the pilot partners, with editorial support and reflection from all partners. They serve as the basis for the reflection on the workshop findings in section 4.

3. Workshop National Reports: Organisation and Outcomes

3.1 Report on the first stakeholder workshops in Enschede (NL)

3.1.1 The workshop overall

Three stakeholder workshops were organized in the Netherlands on three different areas within the context of health: 'diabetes' (12 February, 2019), 'sensor technologies' (5 March, 2019), and 'health and policy' (7 March, 2019). All workshops took place in the DesignLab at the University of Twente (UT) in Enschede. Each workshop had a different emphasis on nanotechnology, depending on the specific area and the composition of stakeholders.

To ensure that the workshops address their needs and interests, the organizers developed the theme of the workshop in consultation with key stakeholders. Stakeholders' needs were explored in a series of individual interviews and used as input for the programme, upon which other relevant stakeholders were identified who were subsequently invited to the workshop. In total, 40 personalized invitations were sent, aiming at 10 participants per workshop. There was a high number of positive responses, as 33 stakeholders initially agreed to participate. Overall, 28 stakeholders participated, with 8 to 11 participants per workshop. These included 11 researchers, 6 representatives from businesses, 4 people from a civil society organisation (CSO), 4 stakeholders connected to policy making, and 3 citizens who attended the citizen wortkshops of GoNano in November 2018. 11 participants were female (40%), and 17 were male (60%).

Since the workshops were organized on three separate days, lessons that were learned from the previous workshop(s) were applied in the organization of the following workshop(s). Therefore, the programme differed per workshop. The duration of every workshop was the same, from 11.00 – 15.00h. This time plan was chosen, as a number of stakeholders needed one to two hours of travel time.

a) Diabetes

The first stakeholder workshop dealt with diabetes. During the preparation of the workshop, the organizers met with a senior researcher who focuses on the development of nanosensors for better and earlier diagnosis of diabetes, and the head of innovation of a CSO that represents the interests of diabetes patients. Based on these meetings, promising technologies for detecting, curing and treating diabetes were explored, and relevant stakeholders linked to the development and implementation of these technologies were identified.

The promising technologies that were discussed, include the artificial pancreas (a device that continuously measures glucose levels and automatically injects insulin when needed), an early diagnostic device (which detects type 2 diabetes[9] ten years before the symptoms occur), and regenerative medicine (regenerating the insulin-producing islets of Langerhans of the pancreas from human cells). These technologies for diabetes are in accordance with promising nanotechnologies

[9] A progressive disease in which the body becomes resistant to insulin or the pancreas makes less insulin.

that were mentioned in the interviews with experts connected to nanotechnology (see report WP1.3, Pimponi et al. 2018). The first two types of technologies are in the product development phase, and can be brought to market in a couple of years. Regenerative medicines are in an early research phase.

Stakeholders connected to the three technologies were invited to the workshop. The aim was to invite stakeholders with different backgrounds (research, policy, business, and CSO), to explore whether bringing them together could lead to novel insights for research and product development. Researchers who are involved in regenerative medicines were not be able to come to the workshop, but business representatives and researchers who are connected to the artificial pancreas and the early diagnostic device did come to the workshop.

Furthermore, a representative of the National Institute for Public Health and the Environment (RIVM) was present, as well as a representative of the Dutch foundation for diabetes patients (Diabetes Fonds) and a diabetes patient. In total, eleven stakeholders participated: three researchers, three representatives from business, three people from a CSO, one policymaker, and one citizen. The focus of the diabetes workshop was on the two technologies, and primarily on suggestions for product design and product implementation. The representatives of the two different companies gave interesting input for the discussion, which was well-connected to the output of the citizen workshop.

b) Sensors

The second workshop explored the development of sensors. For this workshop, the organisers collaborated with a post-doc researcher who participates in a larger UT Sensing-programme and saw potential for their own research in the aims of the GoNano-project**.** This Sensing-programme has been set- up a year ago by Mesa+, the nanotechnology research institute at UT, and is aiming at "integrating modern design concepts with advanced ICT, nanotechnology, social, and humanities sciences realizing Smart Nanobased Sensor solutions in industrial, environmental and medical applications" (University of Twente, 2019). The researcher's work focuses on improving the diagnosis of cancer tumours through the detection and measurement of specific proteins.

Together with the researcher, several stakeholders were identified and invited. These were selected based on the hypothesis that early involvement of stakeholders linked to the R&I-stages of an innovation, can add value to research and innovation. By ensuring that research trajectories are better aligned with users and developers' needs, the organizers and the participating researcher identified key stakeholders, who were subsequently invited to the workshop.

During the workshop eight stakeholders participated: five researchers (from different disciplines), one representative of a CSO and two people from the R&I department of a company. The focus of this workshop was mainly to collect suggestions for adjustments in the research direction of the post-doc researcher and the Sensing-programme. In consultation with the researcher it was decided not to invite citizens from the citizen workshop to this workshop, because the research project was the point of focus and not the output of the consultation, and citizens are not the end-user of the technology. Furthermore, it was expected that when inviting citizens, the discussion would necessarily be less in-depth and less about the technological aspects of nanotechnology.

c) Health and policy

The third stakeholder workshop explored the policy context of nanotechnology and health. The organisers invited stakeholders connected to nanotechnology and health in general who are in a position to influence policy making. These included the director of a research institute, a chair of a research programme, a programme leader of a funding organization, a senior policy maker at the ministry of health, and a national risk coordinator of nanotechnology.

In this workshop nine stakeholders participated: three researchers, four stakeholders connected to policymaking, one representative from business, and two citizens who were present at the citizen workshop. The focus of this workshop was to explore structural embedding of societal engagement in the development and implementation of nanotechnology in health. This focus was chosen because it linked directly to the (potential) interests of the different stakeholders who would be present at the workshop and connected the different types of organizations they represented. As this workshop was not specifically linked to an application area but rather to health policy in general, it proved more difficult to come up with a clear subject in this workshop.

3.1.2 Co-creation steps

The same co-creation phases (exploration, ideation, prototyping, and reflection) were applied in each of the workshops, but the precise way of addressing these phases differed per workshop. Therefore, the processes and outcomes of the three workshops will be described separately.

3.1.2.1 Diabetes

a) Exploration

The exploration phase of the diabetes workshop consisted of an explanation of GoNano, including its objectives and methodology, an introduction round where participants had to introduce their neighbour (name, organization and motives for participation), three short pitches and a presentation about the results of the citizen workshop. The pitches were given by two entrepreneurs and one researcher, and were about different nanotechnologies for diabetes. One entrepreneur pitched an early diagnostic device for diabetes type 2, which is still in its early phase of development, the other entrepreneur presented the artificial pancreas which is close to the implementation phase, and the researcher pitched about sensor technologies that can improve monitoring and detection of diabetes. For this session, 60 minutes were scheduled, but the actual time needed was 90 minutes, as the introduction round took more time than expected, the pitches triggered a discussion, and the presentation and questions about the results of the citizen workshop took more time than planned.

When reflecting on this phase, some insights were gained. While the objectives of GoNano were presented, stakeholders did not seem to know exactly what was expected from them. A reason for this might have been that the hypothesis of trying to come to new insights by bringing together different perspectives and the specific reasons for why these stakeholders were invited, was not clearly explained. Also, when asked about the stakeholders' motivations to participate in the GoNano workshop, they had difficulties in answering this question as they did not have clear expectations of the outcomes of the workshop. This influenced the discussion during the day. Furthermore, the content of the pitches influenced the discussion. While the participants could easily relate to the

pitches of the entrepreneurs, they had more difficulties with the pitch of the researcher as this included more technical details and jargon. The pitches of the entrepreneurs triggered a discussion among the participants, which led the focus already in this first phase on product applications of nanotechnology in the context of diabetes. Furthermore, the presentation about the results of the citizen workshop was too long. For the stakeholders, the whole context of the results was less interesting, but they were especially interested in the conclusions of the consultation. Also, few stakeholders saw (at this stage) surprising results for their own organization.

In this exploration session the state-of-the-art of nanotechnologies for diabetes was clearly presented. Stakeholders were well introduced to each other, and a nice atmosphere was created.

b) Ideation

After the lunchbreak, participants were asked to split into two groups, to choose one of the 'dilemmas' that were formulated as conclusions of the citizen workshop (see Figure 4), and to discuss how this dilemma (potentially) affected their organization. It appeared that participants had difficulties with organizing themselves, and therefore the moderator divided the group around the two product suggestions, artificial pancreas and the early diagnostic device for type 2 diabetes, that were pitched in the morning. An advantage of this division was that the ideation phase was specific. A disadvantage was that it was steered towards product applications, without including research and/or policy.

Figure 4. Conclusions from the Dutch citizen workshop

Group 1 – Early diagnostic device

One group, consisting of a policy maker, a researcher, a CSO representative and an entrepreneur, discussed the early diagnostic device. They chose to discuss the dilemma from the citizen workshop about 'focus on prevention of diseases versus limited use of monitoring/diagnostic devices' (see

Figure 4). This message was chosen by the entrepreneur as they had not thought of the citizens' wish to have a limited use of monitoring/diagnostic devices.

While the participants were convinced about the added value of the device, an interesting discussion took place about the implementation. The discussion included questions about the availability of the device (high-risk individuals vs. everyone), the accessibility of the device (at the GP's office, communal centres, or another public place), the context for offering the diagnostic test (through a national public campaign or by request of a citizen), and the sender/agent who offers the test and or launches the campaign (health professional, government, insurance company). These were interesting questions as the entrepreneur who is developing the device did not think of them before. They had mainly considered the technical development of the diagnostic device. By combining the different stakeholders in one group, different perspectives on early diagnosis of diabetes and the complexity of implementing a preventive health care device became apparent. This is a very clear example that is in line with the hypothesis of the GoNano-project, that 'exposure' to broader societal views can add value to product development.

Group 2 – Artificial pancreas

The second group was composed of two researchers, a representative of a CSO, two entrepreneurs, and a diabetes patient who was present at the citizen workshop. They discussed the artificial pancreas that constantly detects levels of glucose and automatically injects insulin when needed. They chose to discuss the dilemma of 'ownership of data vs. inclusion of health professional in monitoring and diagnosis', which was one of the conclusions of the citizen workshop (Figure 4).

During the discussion, the group focused on what to do with the data and how to include this in the design of the device. The main topic that was discussed was about the accessibility of data. Different types of data were distinguished (personal, trends), and different types of stakeholders were detected (user, caregiver/family member, health professional, insurance company, device operator). Questions about these types of data were discussed, such as which data should be accessible to whom? Should the data only be available by the user or also by the health professional, caregiver/family member and/or another actor? How should this availability be organized, through the interface of the device or in a different way?

While the stakeholders did not see the immediate value of the citizen workshop during the exploration phase, they did acknowledge the value after the ideation phase. Especially the entrepreneurs who were working on the product applications gained new insights from this phase.

c) Prototyping

After the ideation phase both groups were asked to express their ideas in the form of a storyboard. While the moderator showed an example of the storyboard and shortly explained the working principles, both groups had difficulties with working with the storyboards. They did not see a clear need for using them, and had difficulties with visualizing their ideas. The storyboards were mainly composed of text and some abstract sketches, without indicating a clear storyline (see Figures 5 and 6). In addition to the storyboards, both groups were asked to present their ideas. Based on the discussion, the storyboards, and the presentation two 'improved' product suggestions could be detected as tangible outputs of the workshop.

Output 1 – Early diagnostic device for type 2 diabetes

The group focused on the implementation of the early diagnostic device, which is a lab-on-a-chip device that can detect type 2 diabetes based on a small droplet of blood taken from the finger. Based on the ideation phase, the group came to the following output:

The device will be available for *all/high* people at the *general practitioner's office / communal centre / other public places, namely*_____. People are motivated to make use of the device through *a national campaign / GP / other health professionals / peers.* The organization who initiates the campaign and pays for using the device is the *GGD (local government) / national government / insurance company / citizens.*

In this group, participants were enthusiastic to collaborate and to define questions to explore implementing the device. An interesting aspect of this discussion was that every stakeholder could add their own perspective. For example, the policymaker explained how the organization of a national campaign works and whether that is relevant for this context, and the CSO explained how awareness among citizens for diabetes was created and focused on the difference between type 1 and 2 diabetes. For the business representative, the output was especially relevant as they had gained insights into the societal context in which his product would land. Also, during the prototyping phase a network was created between the business developer and the CSO for an exploration of potential funding sources.

Figure 5. Storyboard for the implementation of an early diagnostic device for type 2 diabetes

Output 2 – Data management of artificial pancreas

The group focused on suggestions for collecting and sharing of data obtained by the artificial pancreas, which is used for continuously monitoring glucose levels and injecting insulin levels when needed. Through this monitoring, a lot of data about the patients' health is collected. Different suggestions were made on how to handle this data:

- Loop between *patient* and *health professional* → daily use by patients, signal when *anomalies* happen / quarterly use by health professional, analysis of *trends*
- Loop between *patient* and *care giver* / parent → in the case of less 'skilled' people using the device and interpreting *personal data* (e.g., elderly people, children)
- Loop between devices and *company* → *big data* (anonymous), for detecting *trends* to develop personalized medicines.

In this group, there was a number of enthusiastic participants, but also a few participants who contributed less to the discussion. Especially one of the researchers, who had a hard time giving input on the specific product suggestions, since the discussion did not involve specific research input.

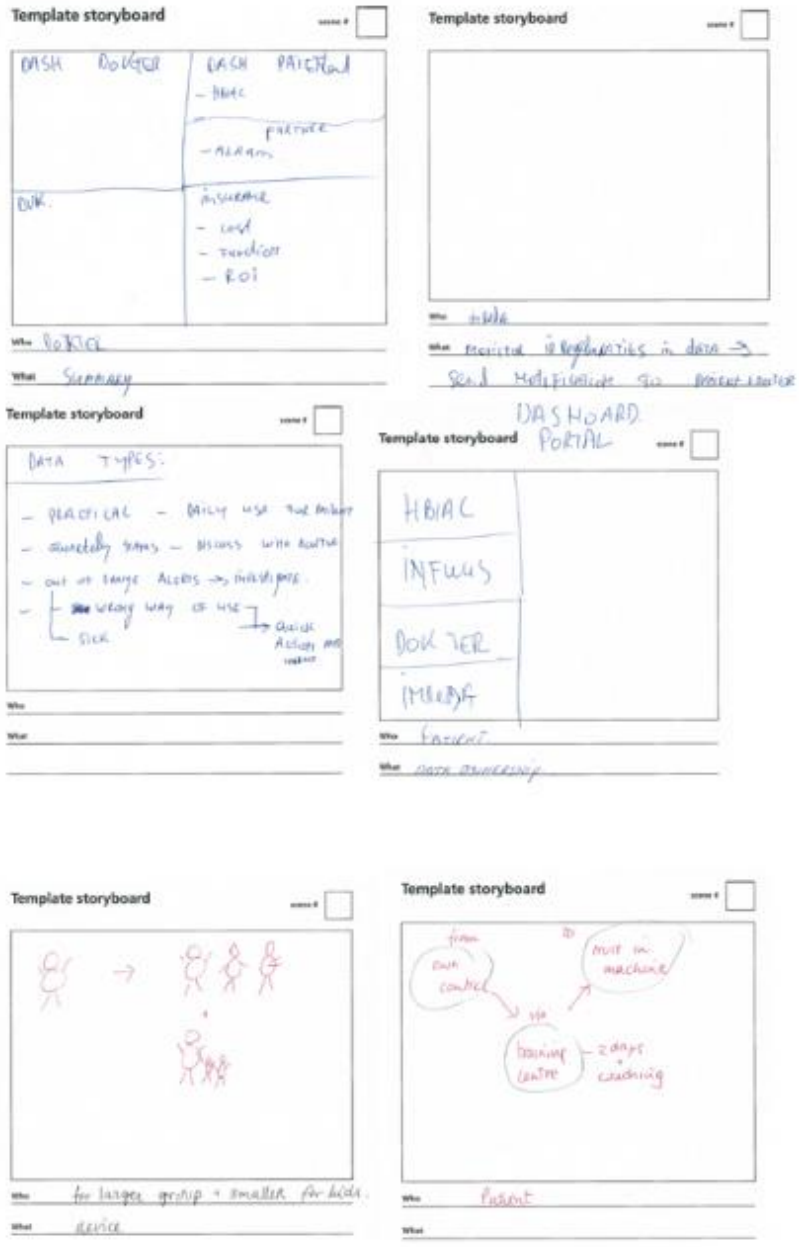


Figure 6. Storyboard on data management of artificial pancreas

d) Reflection

Since the introduction and the exploration session ran significantly over time, there was no time left for the reflection. This was a missed opportunity, as the workshop now ended with product suggestions without having a clear plan of action. Also, there was hardly any time to discuss the relevance of the workshop with the different stakeholders. Nevertheless, at the informal drink afterwards and in the video testimonials, a number of participants came to the organizers and shared their enthusiasm about the workshop. This was also reflected in the results from the questionnaires. The representatives of the two companies, for example, explicitly stated how the workshop helped them to further develop certain aspects of the application. One of the representatives said they felt: "supported in the somewhat vague ideas [for implementation that they] had, which had become much clearer". At the end of the workshop the different partners also agreed to continue the discussion online. While experience suggests that it may prove difficult to keep stakeholders involved, the organisers aim to keep them involved by bringing new and relevant information into the discussion (e.g., asking for input or sharing results of the online consultation).

As both individual feedback from participants of the workshops and responses to the evaluation questionnaire suggest, the participants were enthusiastic about the workshop. Most of them thought it was interesting to meet other stakeholders working in the area of diabetes and learned about new developments in the area of diabetes. The diabetes patient, for example, stated in the testimonial video that they thought these kinds of activities were very interesting to them as they had obtained knowledge about the latest technological developments. For the entrepreneurs the input of the workshop could be directly used for further developing their product. They received specific input from the citizen workshop, and thought it was very relevant to discuss their product with different stakeholders and to collect ideas from different perspectives for further development. They also showed their interest in the results of the online consultation, as they wondered how (prospective) users of the technology would judge the output of the stakeholder workshop. One company even agreed to disseminate the online consultation to their patients. The positive responses afterwards, and the relevance of the output of the workshop for the entrepreneurs, shows that it can indeed be valuable to include different perspectives in the development of (product) applications based on nanotechnology.

3.1.2.2 Sensors

Based on the needs of the stakeholders and lessons learned with the evaluation of the diabetes workshop, the time plan and programme of the sensor workshop was adjusted. By having different meetings with the post-doctoral researcher with whom the organisers collaborated, the aim of the workshop was specified: collecting input from different stakeholders along the value chain (i.e.: potential users, researchers from other relevant disciplines and product developers) about the future direction of the research, the development from fundamental to application-based research, and more general input for the organization of the Sensing-programme. In the set-up of the workshop there was less focus on the output of the citizen workshop, only one pitch (instead of three), stakeholders had to make a plan of action instead of a storyboard during the prototyping phase, and a substantial amount of time was planned for the reflection.

a) Exploration

The exploration phase of the sensor workshop started with an explanation of GoNano and a short introduction of the stakeholders. When explaining the GoNano-project, the focus was on the aim of the methodology, the reason why the different stakeholders where invited and what was expected of them during the workshop. The mismatch between research and implementation (also known as the 'valley of death' in the literature) was explained, including the various phases of product development (from research to implementation) (see Figure 7). By way of introduction, a graph was shown in which all stakeholders were placed in one of the phases of product development (see Figure 8). Stakeholders were asked whether they agreed with the graph, and what they hoped to get out of the workshop. The graph triggered an interesting discussion between stakeholders about the phases of product development, and the participants recognized the relevance of integrating social values and needs in early research and innovation. In this workshop, some participants (researchers from other disciplines, and potential users) had clear expectations of the aim of the workshop, these were mostly about giving input for further development of the post-doc's research. Others' expectations (business developers, researcher connected to Sensing-programme) of what to get out of the workshop were less clear.

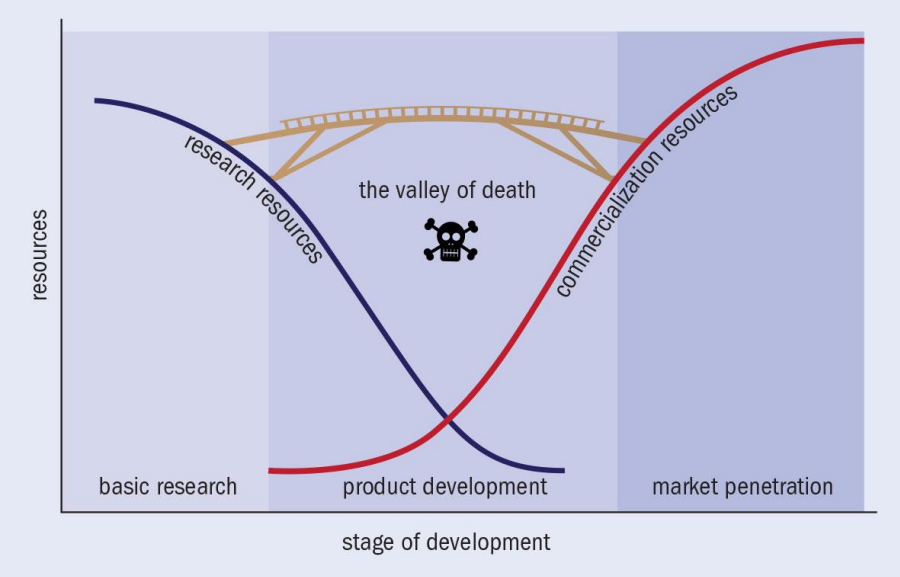


Figure 7. Visualization of the 'valley of death'

After the introduction, the post-doc researcher gave a pitch about their research project on improving the diagnosis of cancer cells through monitoring specific proteins. During the pitch various participants posed some fundamental questions, which led to an in-depth discussion right away. The pitch of the research was quite technical, but relevant and well-connected to the stakeholders present at the workshop. Next to the pitch, a short explanation of the Sensing-programme was given. Instead, some researchers that were linked to the programme were asked to add their perspectives to the explanation.

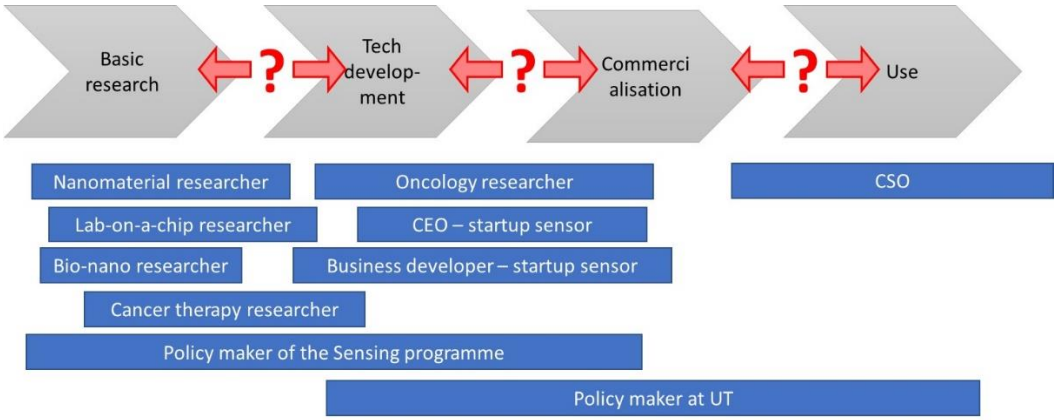


Figure 8. Phases of R&I and participants linked to them

b) Ideation

After the exploration phase, the participants were asked to write down possible connections between the post-doc's research and their own research or innovation, their recommendations for the post-doc researcher, their suggestions for the Sensing-programme, and their interest in the Sensing-programme. After 10 minutes, participants had to bring forward their suggestions which were then written on two white boards in a mind-map, one about the research of the post-doc researcher and one about the Sensing-programme (See Figure 9 and Figure 10).

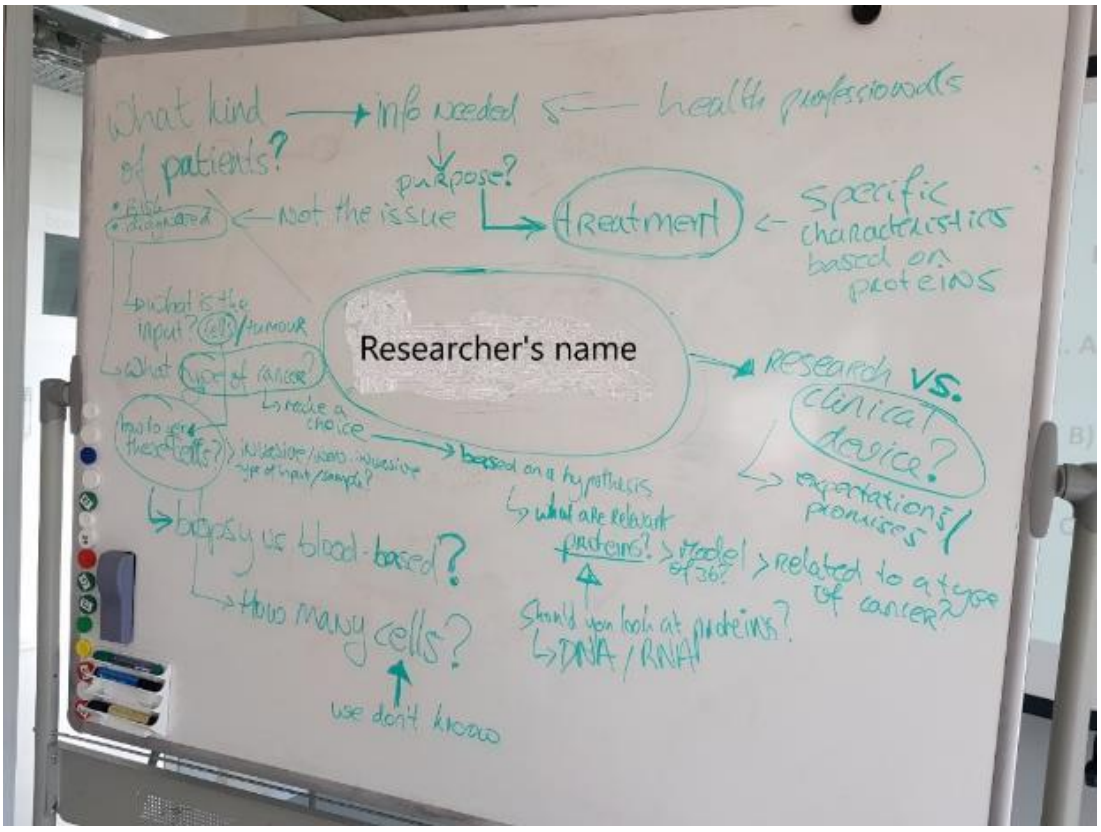


Figure 9. Mind-map of the post-doc's research

This activity worked very well. Many of the participants were nano-researchers, but from a different discipline or focusing on a different application area to the postdoc who presented the pitch. Therefore, they brought in different types of knowledge and expertise. Also, the two people from business had a background in nano-research and gave relevant input by applying their business perspective on the research. Furthermore, two participants with a social science background gave input from their perspectives. Participants provided lots of input for the post-doc researcher who still had many decisions to make regarding the overarching research theme of the future research (e.g., which type of cancer to focus on in their research, why monitoring specific proteins, how to extract the proteins from the body, how to label the proteins, why this research and for whom is it relevant). For the Sensing-programme some suggestions were also made, but they were less specific. This was mainly because there was not a clear representative of this programme present during the workshop

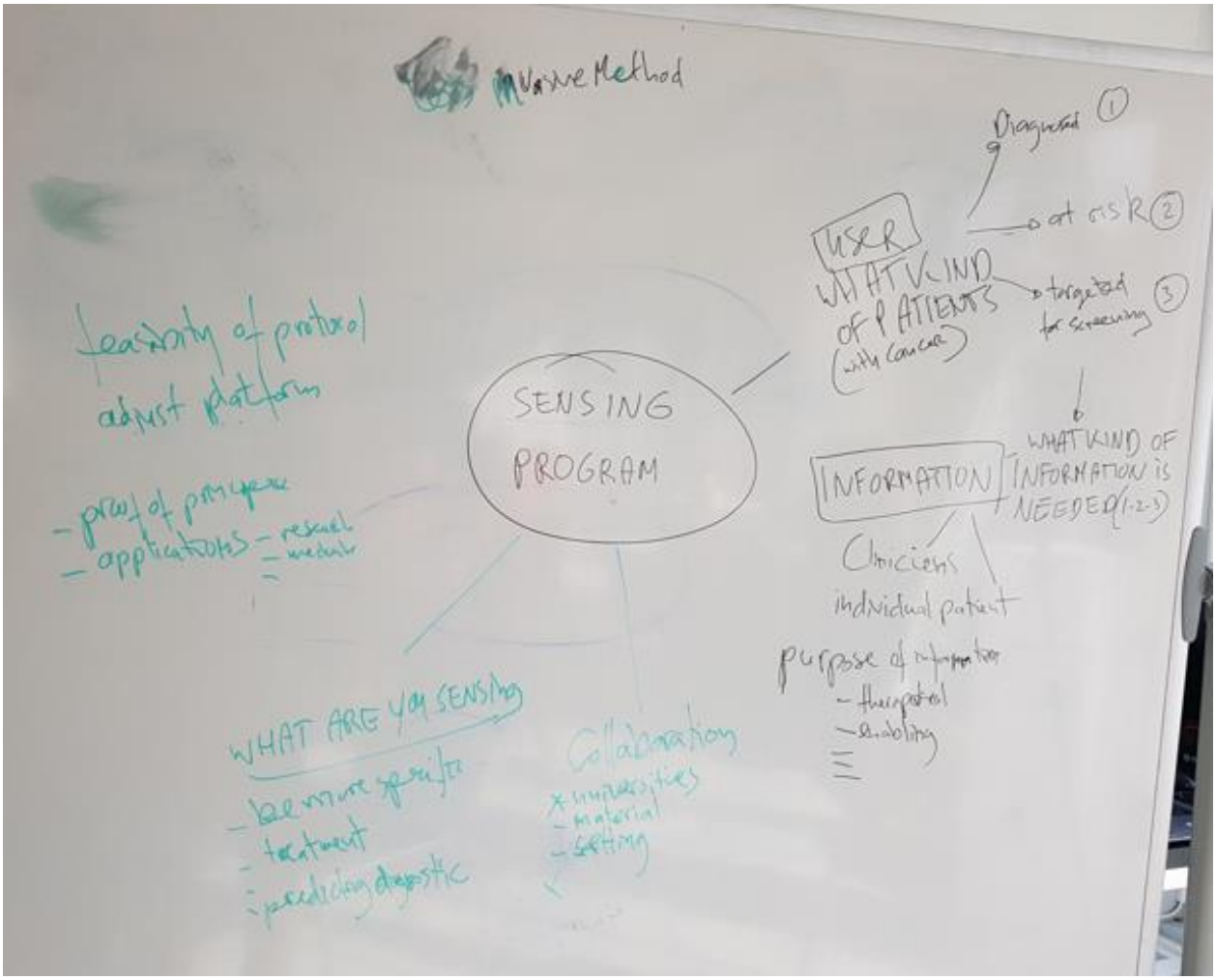


Figure 10. Mind-map of the Sensing-programme

c) Prototyping

After the lunch break, participants started prototyping. The initial plan was to have one group working on suggestions for the Sensing-programme, and another group working on suggestions for the research of the postdoc. However, as there was no representative of the Sensing-programme

present at the workshop due to illness, the second subgroup decided to further discuss the link of the Sensing-programme to innovation practice. Instead of the storyboards that were used in the diabetes workshop, both groups were asked to come up with a plan of action. Based on the specific actions that were formulated as output of this session in both groups and the sense of ownership some participants felt, a plan of action seemed to be more effective than working on a storyboard.

Group 1 – Improvement of diagnoses of cancer through monitoring proteins

This group consisted of researchers with different backgrounds, including the post-doc. The other researchers had backgrounds in nanomaterials, medical oncology, and medical cell biophysics. The discussion continued where the ideation session had ended. Various specific suggestions for improvement in the research project were addressed, including:

- Identify for which types of cancer a need exists for better diagnosis – by talking to professionals and other researchers;
- Specify and detect a treatment plan for these specific types of cancer by talking to oncologists and pharmacists, to clarify the need for a better diagnosis of tumour cells;
- Improvement of the device by labelling cell-specific proteins – to have a working device, first various proteins should be labelled, this should be done through desk research, interviews with other researcher in this field and empirical research;
- Developing the device from research to application – talk with potential users (oncologists) about their needs and business developers, and make a time-plan for development and budget financial resources;
- Make a plan for getting tumour cells to study and using laboratory equipment.

The discussion provided constructive input for possible adjustments of the research trajectory. While experts were able to provide direct input, it is interesting to see how citizens will judge the output of this discussion, as it might be quite abstract for them. This output will be used as input for the online consultation with citizens. Additionally, participants emphasized during the workshop that it would be interesting to see how potential users of this technology, in this case oncologists would evaluate the suggestions. This particular stakeholder group can be included during the second stakeholder workshop.

Group 2 – Better link between research and business within the Sensing-programme

This group consisted of one policy maker, two representatives of business, and one social science researcher. The discussion focused on how to establish communication between the core expertise within the institute about materials, sensor systems and technology, and end-users. The Sensing-programme could link with researchers at UT, but also externally with business partners. In the latter case, timely information should be shared, before patents are drafted and research has been published.

The output of this discussion was that there should be an institutionalized network with internal and external relationships. It should not just be based on individual researchers' interests. An example is to provide an opportunity for business partners (innovative start-ups) to bring in questions for more

application-oriented test research within the Sensing-programme, without having these partners financing a PhD-project or post-doc project. Similar to the output of group 1, this outcome might also be quite abstract for citizens, and it is therefore interesting to see how citizens will judge it in the online consultation. The focus in this discussion was on different stakeholders relevant for different product development phases. End-users, rather than citizens, are important actors in this regard.

d) Reflection (from the organisers)

In both groups a sense of ownership could be detected. In the first group, the post-doc researcher clearly felt the ownership of taking actions based on the input of the prototyping session. Nevertheless, the other participants in this group also offered their knowledge and expertise and possibilities for future collaboration. Some actions were identified based on the output of the prototyping session, but a specific time-plan linked to these actions was lacking. It became clear that a specified action plan, and plan for adjustment of a research line cannot be made in one workshop, as it takes more time to reflect on the input, and to know what kind of information, resources, and finances are needed.

In the second group, the business representative gave particularly useful input for future action. They planned to come up with an interesting case and/or problem description from their company's perspective that can be discussed within the sensors theme of the second GoNano stakeholder workshop. Especially in this group, the composition of stakeholders types shaped the discussion. As there was no representative of the Sensing-programme, the focus was mostly on how the programme could be relevant for innovative businesses and less on how it could be useful for the research institute.

In this workshop there was plenty of time to reflect on the relevance of the workshop and the hypothesis of GoNano. All participants were enthusiastic about the set-up of the workshop, and saw the relevance of societal engagement and including different stakeholder perspectives in early research and innovation. They were positive about the workshop, because it directly related to their own interests and expertise and had a specific aim, although they did think the discussion on the research of the post-doc was more specific than the discussion on the Sensing-programme. By putting effort and time in the preparation of the workshop, the organizers knew what to discuss and who to invite for the workshop, in order to make it relevant and specific. For the post-doc researcher, the output of the workshop was very valuable. In the testimonial video, which was recorded after the workshop, they concluded: "I can say, today I built the next three years of my research life". Only for the business developers the workshop would have had greater value if a specific case from their business context was discussed. Nevertheless, they saw the added value of the GoNano-project and the co-creation methodology.

During the workshop, both in the prototyping and reflection phase, various participants emphasized that it is important to include the (potential) end-user in the co-creation process. In the prototyping phase, the participants emphasized that the new suggestions that are formulated in the workshop should be discussed with health professionals to see whether they are practically relevant and match their needs. During the reflection phase, participants were asked how they thought the online consultation could contribute to the further development of the research suggestions. They again discussed that it would be interesting to discuss the suggestions with potential users of the device, rather than with citizens in general as they doubt whether citizens could give relevant input, taking

into account that the research and suggestion were on a theoretical and technical level. There seems to be a trade-off between having specific and technical discussions and being inclusive. Many health technologies are not consumer technologies, but are used by either health professionals or by patients. As all citizens are in some sense (potential) patients, they can be easily included in the latter context. However, their contribution becomes harder to operationalize as the workshops discussions become more detailed. Nevertheless, it is interesting to ask for citizens' input on the suggestions during the online consultation, and to see whether their input is in line with the expectations of the professionals, or whether citizens come up with different, and more relevant, insights than expected by the stakeholders.

3.1.2.3 Health and policy

The time-plan of this workshop was similar to that of the sensing workshop. Differences between the previous workshop and this workshop were that only the conclusions of the outcomes of the citizens' workshop were presented (see Figure 4) and that there were no pitches being given by the stakeholders.

a) Exploration

The exploration phase of this workshop started with an explanation of GoNano and a short introduction of the stakeholders. When explaining the GoNano-project, the focus was on the aim of the methodology, whereby a reference was made to the creation of 'Trading Zones',[10] where stakeholders develop a 'pidgin', a shared language to exchange the value of one's own contribution to a shared problem in a way that makes sense from the perspective of others. By means of an introduction, participants were asked to explain why they were present at the GoNano workshop. The motivations of participants' engagement in the GoNano workshop varied from interests in the co-creation methodology, the subject of embedding societal needs in early research and innovation of nanotechnology, to being interested in the GoNano project in general. The participants who were often connected to policy making were better able to express their motivations of participating in the workshop than the participants in the other two workshops.

After the introduction, the results of the citizen workshop and the outcomes of the two stakeholder workshops were briefly presented. Only the conclusions were presented to the participants in the form of dilemmas. Some questions arose about the background of these dilemmas, which were answered by the moderators. Furthermore, the results of the workshop on diabetes and sensors were explained. Especially the outcomes of the sensor workshop triggered a short discussion on how societal values could be better integrated into fundamental research.

b) Ideation

The ideation phase was similar to that of the sensor workshop. Participants were asked to write down on a post-it their suggestions for a meaningful realization / set-up of societal engagement in

[10] For further information on the notion of a Trading Zone, see: Galison, P. (2010) 'Trading with the Enemy'. In M. E. Gorman (ed.) Trading Zones and Interactional Expertise: Creating New Kinds of Collaboration. Cambridge, Mass.: MIT Press. See also: Gorman, M.E, & Schuurbiers, D. (2013). Convergence and Crossovers in Interdisciplinary Engagement with Science and Technology. In: Doorn, N., Van de Poel, I., Schuurbiers, D., and Gorman, M. E. (eds.). Opening Up the Laboratory: Approaches for Early Engagement with New Technology. Dordrecht: Springer.

research and implementation of nanotechnology in the area of health. They had to write down the context of this set-up, the methodology, the initiating party, and the target audience, and were invited to place their post-it on a whiteboard (see Figure 11).

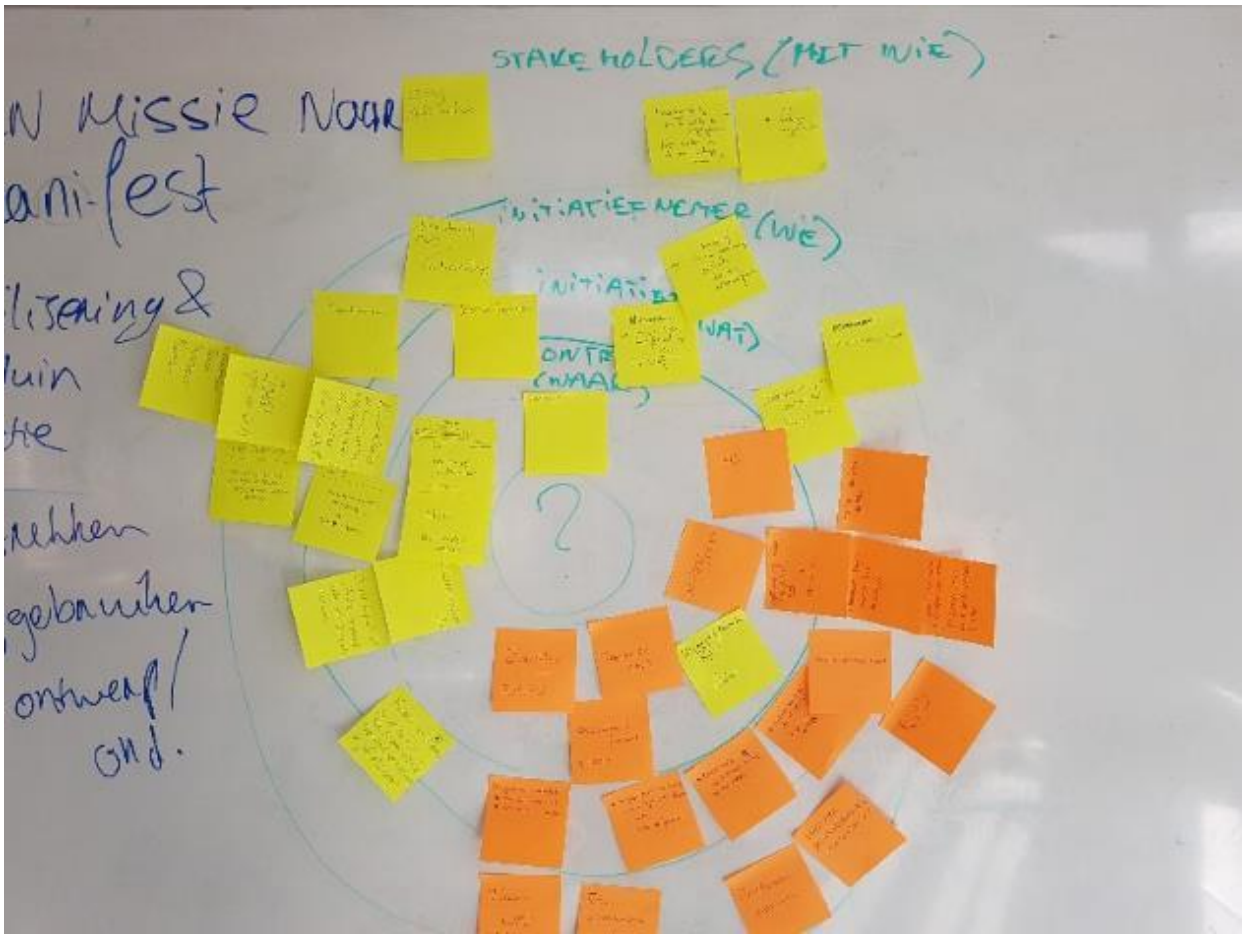


Figure 11. Post-its of the ideation session

After placing the post-its on the whiteboard, participants were asked to come up with suggestions for initiatives for structural societal engagement in research and innovation of nanotechnology in heath. Based on these suggestions a mind-map was created (see Figure 9). Participants were able to give suggestions, in more general terms, of how societal engagement could be better embedded in research and innovation (e.g., funding, product-design, mission-oriented research, education and information, involvement of patients). They could also mention relevant actors to these suggestions (e.g., nano-medicine platform, 'health users', chain of actors, science policy makers at relevant ministries). However, they had difficulties with defining specific suggestions from their own organization's point of view. They thought the question was too broad and too abstract for this. Nevertheless, during the prototyping phase, some participants were able to come up with specific actions and input from their organization's point of view on this subject.

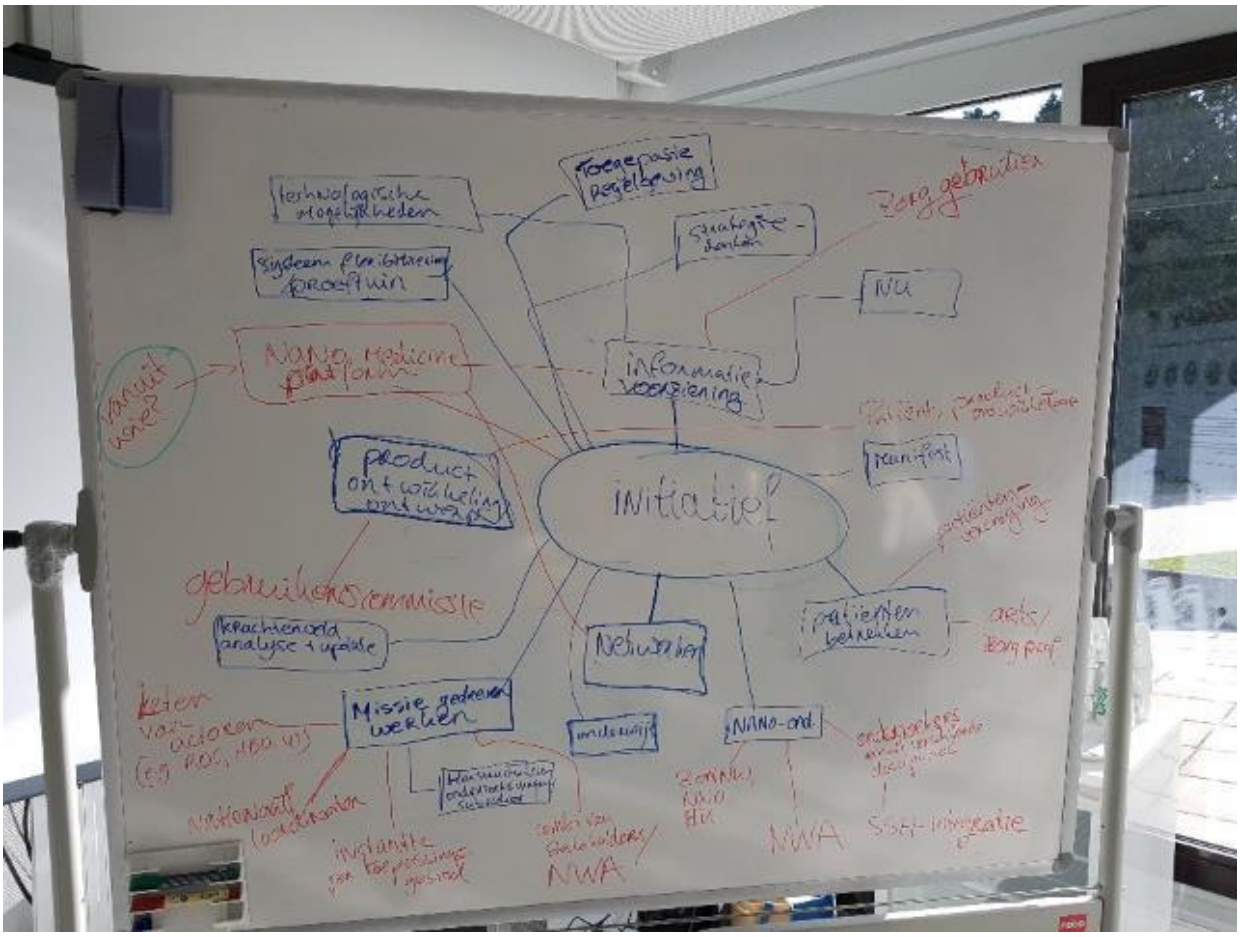


Figure 12. Mind-map of initiatives for societal engagement in R&I of nanotechnology

c) Prototyping

The participants were asked to select two initiatives from the mind-map and to organize them around these two initiatives. Whereas in the previous two workshops this process was steered by the moderators, in this workshop it was left open. One group of participants organized themselves around the theme 'mission-oriented research and innovation', and the other group was organized around the theme 'flexibilization of applications of nano-innovations in the area of health'.

Group 1 – Mission-oriented research and innovation

This group consisted of a researcher on nanotechnology, two policy makers, and a citizen. The discussion focused mainly on how to organize mission-oriented research and innovation, whether it should be institutionalized or not, who should be included in defining the mission, and who should be responsible for the process and implementation of the mission. While the participants had a lively discussion, they did not come to a specific action plan nor answer the questions about how to institutionalize mission-oriented research. The discussion focused mainly on identifying the relevant steps and questions to achieve mission-oriented research. It is difficult to point out why there was not a clear problem-owner. One reason might have been that the discussion was too open and too abstract. In the diabetes workshop and the sensors workshop, there was a clear subject and aim

during the prototyping phase. As the subject was chosen by the participants, this was less specific, and the aim was less clear.

Group 2 – Field lab for health technologies

This group consisted of a social science researcher, one representative from business, one policy maker, and one citizen. The discussion focused on how to connect (nano)technologies for health in an earlier stage to its users. Due to strict regulations, it takes a lot of time to bring technologies to the market that might be useful for diagnosis, treatment or curing of diseases. Also, many users and citizens are not aware of all technologies that are being developed.

As a solution this group proposed to create a field lab where scientists can test their technologies with (potential) users. To make this idea feasible the lab should first include non-invasive and less-invasive technologies (e.g., sensor-technologies or lab-on-a-chip). The field lab should be situated at a public place, for example a hospital, to make sure that everyone has access to the technologies. In addition to collecting input from users (patients, potential patients, health professionals), the field lab also functions as a way of disseminating scientific developments in the area of health, and creating awareness.

d) Reflection

Especially in the second group, a sense of ownership could be detected. During the discussion every participant added something to the suggestion of the field lab from their perspective. Also, after having worked out the idea of the field lab, an action plan was made on which all participants agreed. The following actions were formulated:

- Talking to the regional hospital to explore whether they are open to the idea of a field-lab (researcher);
- Talking to business developers, innovative start-ups in health, to explore whether they see opportunities for joining the field lab (business representative);
- Talking to funding organizations to see whether there is support for such a field lab (policy maker);
- Using the suggestion for a field lab in the online citizen consultation to explore whether there is societal support for this idea (organizers of GoNano).

The idea of the field lab was presented and during the presentation, participants of the other group were also enthusiastic about the idea and agreed to take action. Another policy maker, for example, agreed to talk with a representative of the ministry of health about the idea to see whether there is governmental support for it.

In the other group there was less ownership. Participants in this group mapped and defined issues to be solved in order to create an infrastructure for mission-oriented research and innovation, but did not come up with a specific action plan.

In this workshop there was plenty of time to reflect on the relevance of the workshop and the hypothesis of GoNano. As the deliberation of one of the groups ended with a specific action plan and

a concrete idea, all participants were enthusiastic about the set-up of the workshop, and saw the relevance of societal engagement and including different stakeholder perspectives. In the idea of the field lab consideration of the citizens was included. Even though the idea was not explicitly linked to the outcomes of the citizens' consultation, it does relate to them. For example, citizens mentioned during the consultation that there was a need for more information and education about health technologies, but that they wanted to be included in the design and development as well. Both of these issues are addressed with setting up a field lab.

5) Overall assessment of the workshop

Based on the reflection on the three workshops, it can be concluded that bringing stakeholders with different backgrounds together leads to interesting discussions and novel insights for product development, research projects, and policy making. There is not a single way of setting-up a co-creation workshop and different methodologies can work. By organizing the three workshops separately, the process and outcomes could be compared and some interesting findings could be defined. First, the findings of the reflection on the outcomes will be discussed, and these will be followed by the procedural and organisational findings.

Workshop outcomes

In the first workshop, the outcomes focused on suggestions for further development and implementation of existing products. According to the entrepreneurs who are developing the products, the workshop was a 'reality-check' of whether they were going in the right direction, and it helped them to explore the societal context into which their product will be implemented. According to the developer of the artificial pancreas, for which a data-management plan was formulated, the outcomes of the workshop "improved the foundation of their product as there were some new aspects discussed they hadn't thought of before". The developer of the early diagnostic device, for which an implementation plan was discussed, evaluated the outcomes as something that supported their initially somewhat vague ideas, which had since become much clearer. They thought the discussion with participants of different backgrounds was "very stimulating and motivating". Other participants thought it was an interesting workshop as well, but they saw less direct relevance for their own organization. The reason for this is that the prime focus of the workshop was on the two product applications, and not on other aspects (e.g., the research of the technologies used in the product applications). This shows that there is a trade-off between inclusiveness of interests versus specific discussions. The latter leads to more relevant output, but for a smaller group of stakeholders.

In the second workshop, the outcomes are connected to suggestions for adjustments in a research line and a broader research programme. We collaborated with a post-doc researcher, who is at the start of their research trajectory focusing on the diagnosis of cancer based on specific proteins. By discussing their proposal with different stakeholders along the value chain, the researcher got new insights in how to further develop their research. These include: identification of the demand for their research (for which types of cancer there's a need for better diagnosis) by talking to health professionals and oncology researchers, improvement of their 'fundamental research' device by labelling the relevant proteins in collaboration with other researchers who study those specific proteins, make a development plan for the device in that it can be used by health professionals by

collaborating with users and business developers. Next to these insights, some agreements for collaboration were made with the participants present at the workshop. For the post-doc researcher, the workshop was beyond their expectations as they got a "more concrete understanding in what steps to take and what steps not to take during the rest of their research", which helped them "to build the next three years of my research life". In this setting the other stakeholders (except for the business developers) knew in advance that the main focus would be on the research project of the researcher and the research programme, and therefore the workshop matched with their expectations. The benefits of this workshop over the diabetes workshop were that in this workshop there was a clear sense of ownership as we collaborated closely with the post-doc researcher in the set-up of the programme, and that there was enough time scheduled for the reflection part.

In the third workshop, outcomes were connected to initiatives for embedding societal engagement in policy making and research of nanotechnology in health. One idea that was developed was a field lab in a public place (e.g., hospitals) for testing new health technologies with (potential) users and for disseminating new technologies to the general public. Stakeholders were asked to define concrete actions, for realizing such a field lab, and were linked to these actions. The creation of an action plan made the workshop specific and gave a feeling of ownership to the participants. Although, it is difficult to say at this moment whether the actions will be executed, it did stimulate the discussion of the workshop. Nevertheless, the set-up and aims of this workshop were quite broad and abstract (suggestions for societal engagement in health and policy). The outcome of the field lab might be specific, but it is not closely related to current objectives or working areas of the stakeholders that were present at the workshop. It is most probable that the participants will not realize the field lab themselves by investing their resources (time and money). However, it would be interesting to further develop the idea and to collaborate for the second stakeholder workshop with an actor that has a direct interest in the idea.

Procedural / organisational considerations

Although relevant outcomes were formulated in all three workshops for (some) stakeholders, some lessons can be learned regarding the organisation of the workshops.

1. It proved essential to **explore the potential interests** that different stakeholders have in the workshop before it takes place. The various meetings with key stakeholders in the preparatory phase were of utmost importance. Especially in the workshop on sensors, in which the organizers closely collaborated with a post-doc, a clear sense of ownership could be noticed. Also, for the researcher it was extremely relevant to bring the different stakeholder perspectives together. In the workshop on diabetes the output was most relevant for the two start-ups that participated. It is unlikely the workshop would have led to this specific outcome without having the meetings in advance.

2. A **bottom-up approach** during the workshop, in which all stakeholders get the opportunity to actively participate, will enhance the group efforts. In the diabetes workshop a lot of time was spent on the exploration phase, which was mostly presenting information to the participants. Also during the ideation phase, the moderators took a leading role in organizing the groups. For some actors, mostly the business developers, the co-creation process was very relevant, but for others the relevance was less clear. Had there been more time and room for the stakeholders to give their input, share knowledge, and bring in their needs, the relevance could have been improved. In the other workshops this was organized in a better way. Although, in the sensor workshop the focus was

specifically on the research of the post-doc, all stakeholders could bring in their expertise. The health and policy workshop was even more open, and was consequently less specific.

3. To come to specific output (e.g. product suggestions, adjustments to research, or policy initiatives) a **particular focus in the co-creation workshop can be helpful** for both inviting stakeholders and coming to a fruitful deliberation. By selecting specific themes for the workshops on diabetes and sensors and specific research and product applications, this focus was clearly made. In the health and policy group an attempt was made to focus on an initiative for societal engagement. During the ideation phase this appeared to be abstract, but when a more specific theme was chosen during the prototyping phase, stakeholders were able to come up with suggestions. Also in the evaluation a number of participants emphasized the importance of having a discussion on a specific subject.

4. In order to come to specific product and/or research suggestions in which a community of stakeholders is built and where stakeholders have a sense of ownership, one or two workshops are not enough. A continuous dialogue – **a longer interactive process** – between various stakeholders is needed, including a clear plan of action, and a couple of enthusiastic stakeholders who are deeply involved in the project and motivate other stakeholders to take up the actions. The closest to this sense of ownership and community building was made with the post-doc researcher who will use the output of GoNano to adjust her research and who will keep in touch with a number of stakeholders. For the diabetes workshop continuing the discussion online appeared to be difficult, and for the health and policy workshop the involvement of stakeholders is not clear yet.

5. It appeared difficult to keep the focus in every workshop solely on nanotechnology. The discussions often took **the wider context** of developing new technologies in relation to societal needs into account. Nanotechnology is an enabling technology and the composition of the stakeholders existed of both experts and non-experts in nanotechnology, which meant that the discussions often were about applications of nanotechnology in products, implementation of products using nanotechnology, and policy of research on nanotechnology. Only in the sensors workshop, which focused on research, was the discussion mainly dedicated to nanotechnology. However, in this workshop the stakeholders' backgrounds varied less and mostly experts on nanotechnology (researchers and product developers) were present.

6. The stakeholders in all workshops saw the relevance of including societal needs and values in early phases of research and innovation. However, stakeholders **differed in their opinion about the role of citizens** in this regard. Some stakeholders emphasized the importance of involving citizens, but thought consultation still was a too passive level of participation. Other stakeholders thought that it is more important to focus on users instead of citizens. In the context of these three workshops these users can be diabetes patients, health professionals, management representatives of hospitals, researchers, or others. The online consultation might provide insights in how citizens take up the output of the stakeholder session and provide input for further development.

In conclusion, some important lessons have been learned during this first round of workshops. Stakeholders were enthusiastic about the aim and organization of GoNano and the workshops. Most of them explicitly stated they were looking forward to hear from the results of the online consultation, and to participate in the second round of workshops in October 2019.

3.2 Report on the first stakeholder workshop in Prague (CZ)

3.2.1 The organization of the workshop

The stakeholder workshop was held in the Technology Centre of the Czech Academy of Sciences on 28 February 2019. During January and February 2019, invitations were sent to more than 80 possible participants connected to various fields, including nanotechnologies research and production, food research and production, chemistry experts, packaging companies, state representatives, representatives of civic organizations, citizens or media. Initial invites explained the aims of the workshop and also provided potential participants with the results of the citizens´ consultation held previously. A reminder was sent with a detailed programme, including information on the three keynote speakers. There were 39 participants who registered through an online form and chose one of three topic discussion groups for the afternoon sessions of the day. On the day, there were 32 participants; however, participation in individual sessions fluctuated during the workshop. The final session had 19 participants – 6 in smart food packaging, 7 in novel foods and 6 in nanofilters. After discussing this issue with participants in the group, we chose to have one group for each topic area instead of the original plan to split into two sub-groups.

The workshop was attended by various stakeholders, including 9 representatives of universities (technical and chemical), 8 representatives of private companies, 7 representatives of research institutes, and several others including representatives from the Ministries of Agriculture and Environment, representatives of non-governmental organizations (NGOs), the media and citizens. 59% of the experts were male, 41% female. The most popular topics were nanofilters with 15 registrants, followed by 13 registrants for smart food packaging and 11 for novel foods.

The expertise was mostly academic, hence the – based on our impression – more convergent style of thinking[11] about the problems and questions that dominated in all the group discussions compared to the previous citizens´ workshop. About a third of the people left the workshop early (from 32 down to 19). We think this may have been due to several reasons:

1) **The programme:** Even though the aims of the workshops were repeatedly stated in the online communication and during the day – in the initial presentation or by each of the moderators at the topic groups – it could be the case that many participants were attracted more to the information provided by the keynote speakers than to the co-creation workshop agenda itself. The attraction to get to know more of the news from the Czech nanoindustry could have prevailed and may have made active participation for the whole programme less desirable.
2) **The methodology:** For many, the goals of the day were too abstract, even after being explained several times during the day and presented with the outcomes of the citizens´ workshop. It seemed that, whereas the citizens were quite bold putting forward ideas, the stakeholders would bring more criticism to the table. For the researchers from the various backgrounds it was hard to describe the purpose of the concrete product suggestions and visions due to their own narrow expertise and research interests.
3) **The role of facilitation, stakeholders' composition, and the possible cultural specificities:** It seemed that in the Czech stakeholder workshop many of the participants

[11] Riding, R., & Cheema, I. (1991). Cognitive styles—an overview and integration. Educational psychology, 11(3-4), 193-215.

came without any active ambitions. The primary interest for many therefore could have been to get new information. To conclude – there was a notion of certain passivity perceived by the facilitators, as they aimed to address this notion by their active facilitation of the discussions. To understand why this passivity would still prevail and if this was due to a role of facilitators, composition of participants, or even cultural differences is at this point unclear and requires further investigation.

Despite the effort of the properly trained moderators, the debate was often steered by the most active participants in all of the three groups. It is worth mentioning that contrary to our expectations the ideas of e.g. entrepreneurs to try to further develop their own aims did not prevail. This was the case only in one of the groups and only for a short time. In the other two groups, many entrepreneurs, including the three keynote speakers, left the workshop early. Therefore, the dominating ideas did not come from a particular group – rather, they often came from multiple groups, e.g. the researchers and "future regulators" such as the Ministry of Agriculture and Ministry of the Environment, citizens or the representatives of the NGOs. In the first part, the discussion in the smart food packaging group was strongly steered by a director of a packaging company for quite some time, after the intervention of the moderator, the discussion was then mostly dominated by researchers. Apart from some parts in smart food packaging group, the general mood throughout discussions was positive and productive.

2) Session A: Exploration

The first part of the programme dealt with the needs and values of the citizens. Even though the goal for each group was to choose the two most important values to elaborate further, this seemed to be rather complicated as the stakeholders often had the notion that many of the citizens´ requirements needed clarifications, or (as in the case of smart food packaging) some experts assumed that some of the values were only partially relevant, due to a perceived partial inaccuracy. Therefore, the most common scenario was that several "corrected" and more specified needs and values were used, rather than one or two crucial values, needs or messages (the needs and values are detailed in Deliverable 3.2).[12]

a. Novel foods

In the group discussing novel foods, the citizens´ outcomes were taken in a considered manner – the experts in the group seemed to be empathic with the participants´ perception of the (un)safety of nanotechnologies (Figure 13). There was agreement on the call for **standardization and a control system** – a call for a strong state authority and for a strong European food safety authority. Participants also pointed out that novel food is not solely defined by its content, but also by the way it is processed. How will customers accept nanoparticles in food? Stakeholders agreed there is already an enormous distrust of additives – particularly in France and Germany, as it was pointed out in later discussions. Experts also agreed that the most desirable and consensual use would be for

[12] See Hebáková L., Pour M. & Bitsch L. (2019). A report from citizen workshops in the Czech Republic, Spain and Netherlands. (http://gonano-project.eu/wp-content/uploads/2019/02/D3.2-Briefing-report-from-the-citizen-workshops.pdf).

people with specific health problems to come up with essential nutrients in a food that would be fortified, rather than completely new (also to dissolve the doubts for the more cautious customers).

Figure 13: Novel foods group discussion

However, from the point of view of the future development, stakeholders agreed that future generations might be more interested in the effectiveness and time saving aspects, rather than safety. Therefore, the presumption was that the target audience for the functional food would be mostly young people who are not as worried about the safety of the food as other groups could presumably be, and in the case of their concerns for safety, they are able to more easily find out about the potential risks of such products – even though it is unclear if being better informed would lead to less safety concerns.[13] Experts also considered the so-called "empty food", with adding flavours according to the needs of people – they presumed that this could be applied and produced within 5 to 10 years.

b. Nanofilters

In the nanofilters group, a citizen previously present at the citizens´ consultation initiated the discussion (Figure 14). This citizen actively depicted the fears and requirements from the citizens´ consultation in the form of connecting several societal needs and values – combining the lack of information available to citizens with the need for safety, reliability and standardization.

[13] Bucchi, M., & Neresini, F. (2002). Biotech remains unloved by the more informed. Nature, 416(6878), 261.

Starting with the safety concerns, the topic of penetration of substances through nanofilters was discussed (using the example of wine). Experts agreed that the density of nanofilters is adjustable according to the filtration needs (pore-size from 5 to 500nm) and this density has clear implications for the product (an example of the change of wine colour was mentioned). Therefore, such attributes could play a key role in the amount of colour that the wine retains.

Figure 14: Nanofilters group discussion

The group subsequently discussed how the dissolving of nanoparticles works, the shape of the nanofibers and the contemporary level of testing the impact of nanoparticles as what they seemed to perceive as the real safety aspects. From the filtering point of view, this meant there is a need to come up with concrete mechanisms to prevent nanofibers becoming fragile and potentially shedding nanoparticles that are able to penetrate into the products. In various applications of nanotechnologies, the effects would be different. In the area of nanofiltration – when it comes to clean water and air – stakeholders agreed that Czech research and business has great potential in the field based on specific filtration mechanisms and patents. In general, the applications would be more realistically used in the filtration of waste water, rather than in the filtration of potable water. The filtration applications could also be used in the form of an **artificial filtration system**, but also in the form of **specifically made/modified bacteria** used to clean water (bionanofilters). The discussion shortly touched upon the topic of the definition of nanomaterials (compare also with the Smart food packaging group) and to the lack of regulations, laws and control mechanisms.

Also, the handling of the overall "dead" material indeed seemed to be an issue. However, some stakeholders thought that elimination on the nanoscale can in fact be potentially not that difficult since they represent only a fraction of the whole weight of the general waste produced in the filtration processes. One of the other experts added to a question stated by the citizen, that to fully

confirm if some nanofiber is safe or not takes many years of testing. Therefore, it can be to a certain extent concluded that there was certain **scepticism towards guaranteeing the safety of nanoproducts**. This notion can be illustrated through the topic (and fear) of nanoparticles and the various definitions of nanomaterials – experts agreed that it is important to differentiate between nanoparticles and nanofibers as they have different properties and risks. Some stakeholders at the same time agreed that the issues mentioned can indeed be fixed by putting up regulation and control mechanisms.

c. Smart food packages

The exploration session started as planned (Figure 15). However, it soon seemed that some participants questioned the credibility of the citizens´ outcomes. According to the smart food packaging group there seemed to be some attitudes not entirely connected to the nanomaterials, but rather to many topics (chemistry, biology, industrial packaging processes, etc.).[14] Moreover, the initial impression of some of the experts who expressed their views most vividly was that the wider public has not fully understood the principles of nanotechnologies, and that the view of nanoparticles should reflect the way of thinking about our natural environment. That is, the thinking pattern behind nanoparticles as being something immediately unsafe seemed difficult to understand for some experts, as these questions and thinking patterns towards nanoparticles resembled GMOs and the GMO debate for some of the stakeholders. This issue was still "in the air" for the later debates as well – that the public perception seems to have been quite stable over time with its misunderstanding and negative perception of the matter. As it is illustrated below, a few of the experts dismissed the fears of the citizens despite these appearing to be based on reasonable concerns.

One of the most critical voices described the citizens' outcomes as a "...mixture of attitudes without any real knowledge", and that "…citizens don't have any awareness". For such voices, a desired change in education and as many possible different ways of building public awareness seemed crucial – to further explain nanotechnologies as a method and the realistic risks posed by using nanotechnologies. This notion of necessary **education** and long term building of **public awareness** was supported by many experts in the group.

The critical perception can also be attributed to the fact that at the initial point of the discussion, there was no representative of the citizens, NGOs or the media, while on the other side the debate was dominated by a few applied researchers and a director of a packaging company. Some citizens´ needs and values were generally accepted; however, the relation to nanotechnologies seemed unclear. That was also the case with possible customization of the food packaging according to the customers´ needs, which seemed to some as a legitimate requirement, but again the connection with nanotechnologies seemed unclear.

[14] This notion seems to be in line with previous findings. See the results of NanoDiode (2008): http://www.nanodiode.eu/publication/

Figure 15: Smart food packages group discussion

3) Session B: Ideation

After the first part of the programme, a third of the participants left. Consequently, the three groups were not divided further, with two groups of 6 participants each discussing smart food packaging and novel foods and a group of 7 participants discussing nanofilters. Concerning the ideas for the innovation trajectories and specific product suggestions, it seemed evident from which values and needs these ideas stemmed. These were mostly connected with the expertise of the discussing stakeholders, and because their backgrounds varied, it was intriguing to find two specific values or needs.

a. Novel foods

In the group discussing novel foods, there were two ideas in total, and both of them were connected to nanoparticles. Even though the discussion was sometimes going in other directions, the experts were able to come up with two ideas for the innovation trajectories:

1) **Detection of nanoparticles in food and research of the consequences of nanoparticles in food on human health**

   Experts seemed to acknowledge the citizens´ increased need for safety of nanotechnologies, especially their fears about nanoparticles, as they agreed on the necessary examination of the impact of nanoparticles on human health, from both the medical and chemical points of view. The need to focus on more than one approach was clearly proposed: by the physical properties of

nanoparticles and their interaction with other substances; and by the need for multidisciplinary analytical methods of detection and quantification of nanoparticles. That is also why many types of actors should be engaged (technologists, analysts, developers of methods), while the application part of the production should involve experts on detection and environmental impacts, and also customers.

2) **The use of nanoparticles for the customization of food**

Experts proposed two research ideas: (a) Research on nanoparticle use in food for people with allergies – the possibility of customized food for people with celiac disease was mainly discussed. However, there was no clear agreement on how the problem could be solved specifically by nanoparticles. (b) Research of food products containing mixtures of all needed substances, including vitamins and other nutrients, was also mentioned.

b. Nanofilters

The prevailing idea of the discussion was the broadening of the filtration of liquids and exploitation of filtration in the food industry. Experts also added that the initial laboratory production would entail low productivity, therefore a high price could be expected. These concerns were raised by experts from one company that dominated the discussion from the beginning, as they presented their own water filter as a possible and relatively unique technology, which has a high overall price because the production of nanoyarn is demanding and expensive. The possible proliferation of nanofilters into everyday use could mean that the costs would become lower (Figure 16).

Participants further developed the idea and stated that the way to make the production of such filters less expensive would be through further development of the machines producing the nanoyarn; however, even these improvements would not be able to make the product 10x less expensive.

The discussion subsequently steered into a critical **discussion of the current state of development in nanotechnologies**: a small number of professionals that can engage in such activity was mentioned as researchers at universities are being overwhelmed by their pedagogical duties and obligations. Some experts also believed that competition makes the progress slower, because the researchers are not able to come up with a single solution. The big companies in the industry are the main customers for nanofilters, but seem to be unreliable partners (despite their need to filter big volumes at a relatively fast pace) – so mainly small producers are being engaged in new product developments (such as local wine producers).

The experts also discussed the demand for the filters: some believed that the second biggest demand after the filtration of wine products themselves would be the filtration of wine waste that could be reprocessed and sold. Experts agreed that nanofilter use in food would mainly be connected to a more sophisticated production process than simple filtration (e.g. of milk). Other than that experts agreed that the market for nanofilters would mainly be in countries where there is a big demand for potable water. Several other issues raised included the use of nanofibers in nanotextiles, as this application seemed problematic to some as nanofibers may not be sufficiently resistant.

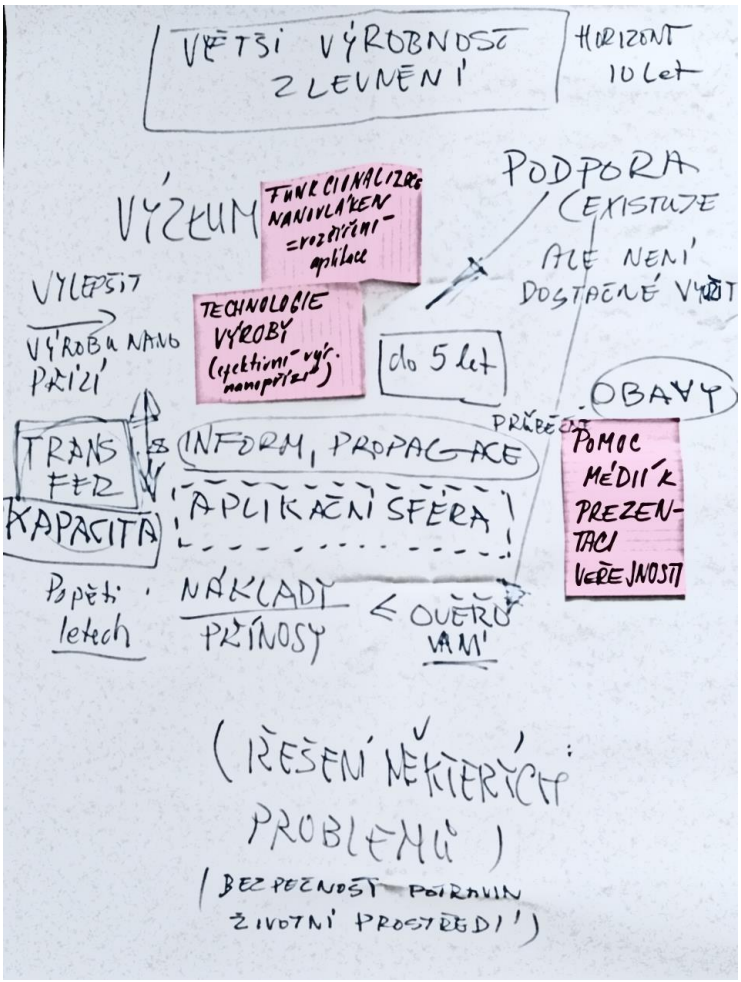


Figure 16: Diagram of the 10 year research vision for nanofilters

This diagram represents a research vision 10 years from now: From above, the main message is to lower the costs to produce materials for nanofilters and to boost the effectiveness of the production. The left side of the diagram: experts claim that it is necessary to improve the production of the nanoyarn and at the same time to be able to effectively transfer the technology; to build additional capacities as well (after 5 years). The right side of the diagram: There should be enough support provided. At the same time, it is necessary to respond to public concerns through media: Informing and promoting should be intertwined with the application sphere. At the same time, problems connected to the safety of food and environment should be solved as well.

c. Smart food packaging

The smart food packages discussion was for quite a long time steering through the general discussion of the methodology and meaning of envisioning the future research aims for the practical use of researchers and entrepreneurs. However, in some time there seemed to be an agreement on the two citizens´ outcomes that were freely elaborated on – these were ideas to (a) protect food, (b) prolong the shelf life of food.

Experts agreed that a consensual future innovation trajectory would be a **package protecting the contents from both outside and inside**. Specifically, it could be a plastic material with enhanced properties – e.g. with barrier qualities of glass: It would be resistant against the pests in warehouses, and at the same time this packaging would be made of material that would be light and easy to wash (Figure 17).

The inside part would be impregnated, a layer made of nanofibers would be developed for the specific food. This impregnation could lead to a healthier and more sustainable food. The layer could contain a microbial agent, it could protect and prevent the contact between the food and the packages.

As far as the material goes – apart from the mostly consensual innovations of plastic materials – natural polymers that would be biodegradable were mentioned. These would be useful e.g. for fast storage, as they would react with water. Metal packages were also mentioned as a way to lower the price of a desired package. Metal could also have better barrier and antimicrobial properties. A strong consensus seemed to be to work with the already used materials such as – from the citizens´ view often criticized materials – **plastics** (and metal) as the main material. Experts also touched upon the citizens´ heavily emphasized biodegradability, as they were quite sceptical about such requirement, as degradability would – in the case of plastics – lead to the degradation into microplastics and even beyond, which does not seem to be desirable either.

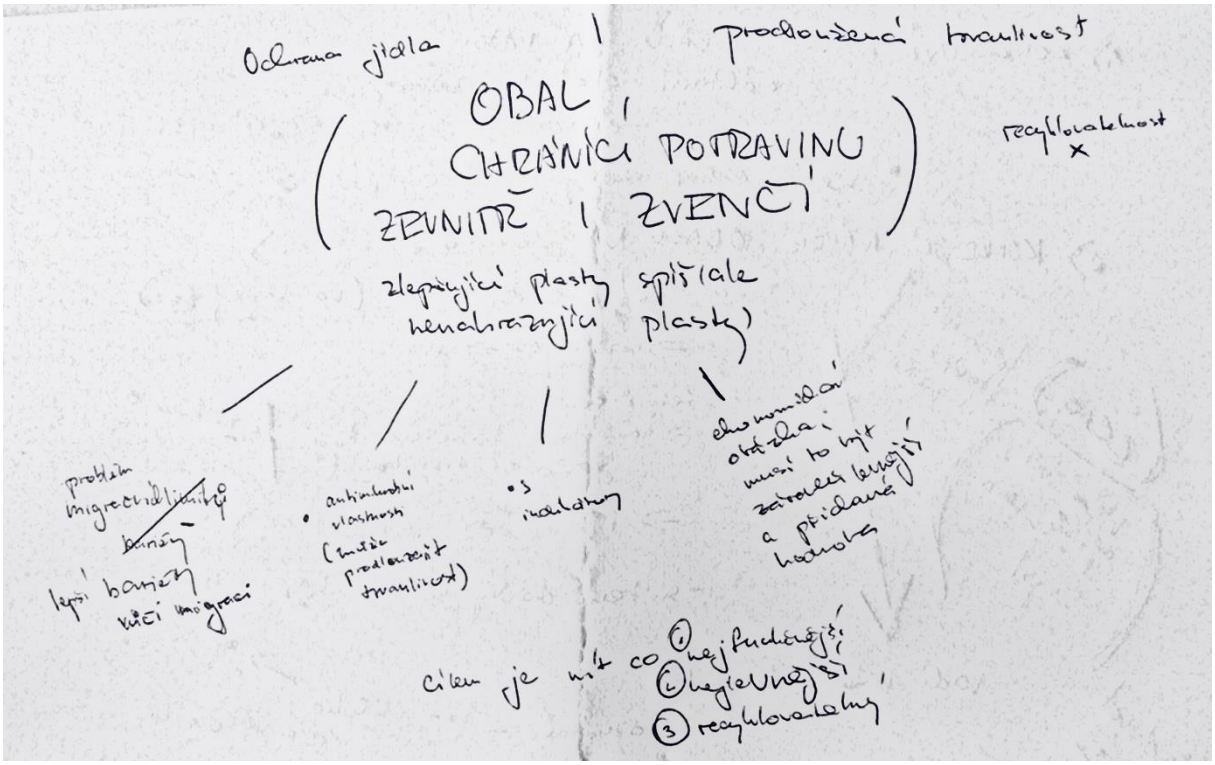


Figure 17: A research aim/product suggestion for a smart food package.

The diagram represents a smart food package that builds on two of the citizens' main needs and values: (1) food safety and (2) prolonged shelf-life. The proposed smart food package protects the food from both environmental and internal factors, such as possible bacteria contamination. The package would most probably be made from enhanced plastic to provide better barrier properties and antimicrobial properties that could lead to increasing shelf-life; and would contain indicators of the shelf-life. Stakeholders agreed that the whole packaging system would be a result of an economical question – it has to be a low cost packaging system and have its own unique added value to the comparable packaging systems. The goal would be to develop the most functional, inexpensive, recyclable packaging system possible.

For the experts, the economical question was also relevant – they argued that every new package has to be cheaper than the former one and also contain some added value (mostly connected to its function); a potential package should also be recyclable. That is why several other ideas were also discussed, including recycling related topics and the possible use of a "Pfand" system[15] labelling

[15] "Pfand" system stands for a recycling system for plastic and glass bottles.

of smart food packaged products and setting up strict migration limits of the agents into foods from food packaging.

4) Session C: Prototyping

Even though a clear distinction between Visioning and Prototyping session was announced, the Prototyping session appeared to be more of a direct continuation of the research visioning process. It appeared that the specific product suggestions were quite an obstacle for many, since expertise differed and it seemed to be quite hard to get across the idea of why a concrete product suggestion would be useful for the whole policy making process. Some of the participants in the novel foods group expressed the idea that it would be useful to go the other way round – to firstly formulate a specific product suggestion, and then elaborate the research aims leading to these specific products. Also, it seemed that all groups had difficulties depicting the ideas on storyboards and to actively present the ideas later on. Nevertheless, the process in almost all groups led to specific product suggestions as required:

a. Novel foods

The group concentrated mostly on the resolution of the research questions and aspects of the products that have something to do with research. That could be either given by the composition of the group and also by the research background of the participants. In general, representatives of business were relatively less active than researchers or citizens. This can be due to several reasons: citizens could feel connected to their needs and values and therefore presented them and reacted in a more active way. It could however also be due to the topics discussed – in the matter of safety or a certification system, it is understandable that the representatives of the state or NGOs would be more informed.

The main ideas circulated mostly around nanoparticles, as can be seen in both product suggestions – a novel food using nanoparticles for the sake of balance and efficacy, and with analytical methods responding directly to the citizens´ needs and values.

1) A food that contains a balanced mix of nutrients

A target group would be all the customers, since the product would be personalized to the needs and specifics of the customer: *Research* should concentrate on making the particles smaller and make their homogenization in the nanoscale possible; secondly on the encapsulation of the nutrients and their delivery to the desired spots. *Legislation* should concentrate on the composition of the particles of the products.

2) Analytical methods for the detection of nanoparticles

Methods would be used according to the size of the particles – electron microscopes, structural analyses, spectroscopy, etc. There should be a kit for detection and analysis of the nanoparticles developed. However, this method should be accredited at the international level first. From the legislation point of view: there would be a need to create a definition for nanoparticles in food, which would be placed under control. Stakeholders thought that it would be useful to reliably identify safe

numbers of artificial nanoparticles contained in food. Experts also discussed possible dystopic scenarios concerning sensors that would be used to detect nanoparticles, as this could supposedly lead to the contamination of the body – this requirement should be legislatively based.

b. Nanofilters

The nanofilters group dealt with many topics – in part it was a specific debate on the current state-of-the-art in the Czech Republic as the participants were discussing the production of nanoyarn compared to the rest of the world. They concluded that there is an excellence in the local production these days, as there is no other place where they have nanoyarn on such a small scale. Experts then came up with ideas on rather specific applications.

The most promising specific ideas that were mentioned were filtration of enzymes, specific sorptions, and the depletion of specific acids, pesticides and heavy metals during oil production. One of the most specific ideas were the Enzymatic flow reactors that, according to the experts, had one of the biggest potentials for future use as they represent a unique and advanced technology concept of filtering.

Later on, the discussion steered into the topic of informing the wider public and the media. Experts agreed that it is difficult to get concrete and understandable educational material from research. It is important to work more precisely with the public – to not underestimate the importance of informing and making an understandable experience with the wider public.

c. Smart food packaging

Throughout the discussion it seemed quite difficult to get the ideas that mostly came from the researchers´ side into concrete product suggestions, since there was a consensus that such activity is not particularly efficient due to the various expertise of the participants. However, the idea of the packaging product protecting the food from both the inside and outside eventually lead to two specific suggestions:

1) An antimicrobial meat packaging solution
The package would bring barriers against both outside effects and the undesired microorganisms that could be contained inside the package, e.g. in the form of antimicrobial coating. The package would also include a sensor – indicating the defectiveness of meat products. The packaging could be considered active as it would prevent proliferation of bacteria. In addition, according to some stakeholders, it would be desirable that the packaging would contribute to overall food waste reduction.

2) A fruits and vegetables packaging solution
In parallel to the initial idea, is a packaging system for vegetables. It would provide food to the customer with a prolonged shelf-life, and controlled atmosphere, temperature and ripening of the food. The packaging solution would also be microbiologically coated to protect the food from listeria. An ideal package could be used for each piece of fruit or vegetable. This was largely discussed since such an idea could also potentially be in contradiction to the other important requirement – for the food waste to be as low as possible.

In addition, several other points were discussed, including the notion that research without application doesn´t make much sense, and that the fears of the public should be allayed by the **media**. An often-discussed topic was the barrier properties of packaging systems.

5) Session D: Reflection

All of the citizens´ requirements were thoroughly discussed. Some ideas were soon dismissed by some expert groups, while the same ideas were elaborated further by other groups. Some general needs and values were deemed consensual, but in most cases these were at least partially corrected or disagreed with. It is also possible to conclude that the experts mostly didn´t choose just one or two specific citizens´ requirements, instead they tried to further specify and explain the given needs and values. Consequently, the research aims and product suggestions reflected the needs and values of the citizens (Table 2).

Table 2: Illustration of the citizens´ needs and values presented during the Ideation phase in the application area of nanofilters

Social values	Technology	Social needs	Suggestions
Safety, sustainability	All applications	Control and certification system, safety	Legislation should be centred around the needs of the citizen.
Human health, recyclability	All applications	Self and biological degradability	Nanoproducts should guarantee that they would be self and biologically degradable.
Safety, reliability, openness, transparency	All applications	Guaranteed safety of nanotechnologies when it comes to nanoparticles and their possible accumulation in the food chain	New products have to serve customers and they have to be non-threatening to health.
Sustainability, circular economy	All applications	Taking into account the context in the development of the technologies	
Sustainability	All, nanofilters	A solution to the global climate change	State should support nanofilters, and also in the third world.
Sustainability, affordability, wellbeing	Nanofilters	Clean and affordable water (both in households and in the third world as well)	Researchers, invent new methods to clean water and guarantee its abundance. Media inform transparently about both pros and cons.

Amongst the most consensual ones were needs and values that were common for all of the application groups, as it also seemed that the experts were more eager to discuss the system aspects with impacts on the society as a whole, especially in the novel foods group. Among these were: (a) the standardization of nanoproducts and control mechanisms; (b) a strong need for media being involved in the process of informing and promoting applications, which was mentioned as well and generally agreed on; and (c) the safety concerns, which were also agreed on and discussed. However, the connection of these issues specifically to nanoparticles was questioned in the smart food packaging group, as there was a need to explain that nanoparticles are more a matter of understanding about a specific size scale rather than substances that are instantly harming human health and the environment. For other experts, to guarantee food safety when it comes

to nanoparticles release from food was indeed an issue and a method of nanoparticle monitoring was elaborated (see Session C: Prototyping).

A strong debate was initiated when it came to informing and labelling of the potential products containing nanotechnologies/nanoparticles. Some experts thought that this labelling could lead to negative feedback for many customers – a point raised was that in Germany or France there is a huge trend of putting negative labels on products, e.g. that a product is "GMO free". A potential parallel to the NANO label was seen as well and therefore some experts presumed that when a specific label would be required, it would lead automatically to negative responses and "NANO free" products. The "fear" of not repeating the previous GMO discussion was an ever-present topic for many of the experts.

The discussion also led to points raised about the possibilities of reducing waste on one hand and providing high quality food with longer shelf-life on the other hand. Some experts agreed that this appears to be a dilemma that all customers have to solve by themselves – what is more important to me? Would people prefer to artificially increase shelf-life of food instead of buying natural products to tackle the food waste problem?

One of the more specific discussions connected to the needs of the citizens was the response on reducing plastics and substituting them with a rather different material – for many of the experts, this seemed unrealistic as plastics cover many specific materials which are not easily substitutable, and also since the requirement for longevity and freshness of products is somewhat connected to using plastics as well. Some experts claim that rather than getting rid of all the plastic materials it is reasonable to innovate these items to provide them with new specific properties, etc.

Although there were many criticisms and necessary corrections of the citizens´ needs and values, one can agree in general that the experts evaluated the citizens´ views and considered some of them rather important (that can be also illustrated via the similarities in the products suggestions, mainly in the novel foods section, see Table 3). Many participants also expressed their will to reflect many of the citizens´ recommendations throughout their future work. Other stakeholders who were more critical of the citizens´ outcomes, repeatedly explained the need to inform the public in more understandable and sophisticated ways through **media** and the **educational system**. More of a concern is the increased responsiveness as well, since the experts came from various backgrounds or spheres and since it seemed that just a few of the researchers dealt with nanotechnologies in such a close way, that these inputs would (or could) directly affect their work. It is also worth mentioning that the invited citizens were highly active and articulated many questions and proposals to the experts, especially in the novel foods group, where the citizen was capable of initiating and steering the discussion which lead to research aims and product suggestions directly building on their outputs. In contrast, a citizen was not present in the smart food packaging group during the Ideation part
of the workshop – therefore it may be that the citizens´ requirements could have been more easily dismissed.

Even though there was some criticism towards the citizens´ requirements or the methodology in one of the groups, the participants mostly agreed that the discussions were beneficial for many experts. However, this should be understood in the context of the expert information exchange and the more detailed insight in what the public opinion seems to be.

Table 3: A comparison of the specific products from the citizens and from the experts
Note: The first column describes the application area. The colour describes the similarity of topics in between both the citizens and the experts.

Application area	Citizens´ product suggestion	Experts´ product suggestion
Novel foods	**Strategic food** A rectangular-shaped artificial food of different taste, properties etc. that could be used where efficient food is needed (Emergency, Army, Astronauts etc.).	**A food that contains balanced mix of nutrients** A target group would be all the customers, since the product would be personalized to the needs and specifics of the customer
Novel foods	**Nanococktail** A product with an aim to provide customer with all needed nutrients.	
Other	**The control mechanisms for safe nanotechnologies in Food** Real time informing of the given stakeholders via mobile apps.	**Analytical methods for the detection of nanoparticles** Methods would be used according to the size of the particles – electron microscopes, structural analyses, spectroscopy. There should be a KIT for detection and analysis of the nanoparticles developed.
Nanofilters	**Desalinator 3000** A desalinating mechanism reacting to the lack of potable water in the third world.	Nanofilters - proliferation of usage A research aim meant to support the maximal potential of the nanofilters, incl. filtering waste products (wine byproducts, etc.)
Nanofilters	**Quality water** A multifunctional and energetically efficient system for filtering potable water at any place needed.	
Nanofilters	**Clean water for everyone** A filtering system both for resolving the lack of potable water in the third world and for increasing the quality of the potable water in Europe.	
Smart food packaging	**Nano-bal** A super packaging system that will substitute plastics. At the same time, it provides the customer with information about shelf-life, bacterial contamination, etc.	**An antimicrobial meat packaging solution** A smart food packaging solution that would be used both to eliminate the external factors and to increase the quality of the food packed, e.g. using an antimicrobial layer as a prevention against bacterial contamination.
Smart food packaging	**Nanospray** A smart food packaging system in a form of a spray that can be used with a current packaging system or as a substitute for “traditional” packaging systems.	**A packaging solution for fruits and vegetables** A smart food packaging solution that could be used for each piece of fruit or vegetable, with the aim to prolong its shelf-life and to increase the freshness and quality of the products.
Smart food packaging	**Drink without fear** A package system that prolongs the shelf-life of the contained food/drink and is also made from degradable and efficient materials.	

When it comes to the articulation of the specific problems and dilemmas connected to the difference between the citizen requirements and their feasibility, these seemed to be taken into account by many experts – as it can also be further illustrated by the experts´ need to use the media and education system for the potential role of informing and promoting about nanotechnologies. A crucial benefit can therefore be perceived – to a certain extent – in the **information exchange** between all the present actors. It is at the same time important to mention that the lack of a sense of ownership was omnipresent throughout the expert consultation when it came to the specific product suggestions.

> *"...it is important for the experts to exchange their views both within their field and outside their field of expertise."*
>
> [Statements by workshop participants]

As far as the methodology and processing went – not all of the planned methods were used during the workshops. This was also the case with storyboards that were given to some groups, but didn't seem necessary for the discussion and the depiction of the ideas and product suggestions. As far as the discussions went, it seemed that was more important to discuss the current possibilities – to develop a reality check. However, the absence of the fulfilled storyboards can also be perceived as a lack of enthusiasm towards the product suggestions. It is also worth noting that the product suggestions of citizens and experts shared some interesting similarities, both in the ideas and the ways they were being presented.

Even though the experts did not raise many direct questions that could be used in the T3.3 online consultations,[16] there were perceived benefits – mostly in the exchange of information between citizens and experts. The experts also certainly saw some specific benefits in exchanging information between themselves.

6) Overall assessment of the workshop

What are the lessons learned for future consultations? Based on the fact that after the presentation of the panellists soon circa 1/3 of the participants left the workshop, it would seem that the main motivation for a part of the participants was to mainly inform themselves about the state-of-the-art in the development of Nanotechnologies in Food, as they were less attracted to the programme itself. Given also the fact that there was certain criticism to the usefulness of product suggestions proposed by various experts without any special connections. It indeed seems that it would be useful to (1) communicate more with a rather smaller number of experts beforehand the session, to (2) use ideas of some that are already in development, use what we could call a first-order learning and provide these experts with a feedback from others: However, this could happen only through selection of the key partners and ideas to be developed as it would to a certain extent derail from the bottom-up built methodology.

One of the other lessons learned is that, in those expert groups without citizens present to explain the ideas in person, it was less difficult to dismiss some of the citizens´ needs and values. Therefore,

[16] T.3.3 Online consultation is a part of the Co-creation process taking place between Stakeholder workshop 1 and Stakeholder workshop 2.

it indeed seems that for the co-creation process, a constant vis-à-vis exchange of all the stakeholders is necessary and for the next phases of the discussions. And although an effort had been made to meet this requirement, e.g. a lacking representative of the citizens could have resulted in a more critical discussion of the needs and values presented. This notion needs to be taken into account and effected in a more rigorous way for the future phases of the project.

Even though there were some obstacles, the workshop seemed to be beneficial for many of the stakeholders (see the evaluation results in section 4.2 below) and those who remained at the workshop, were – although sometimes critical – active and present in all the discussions during the day. Overall, the meeting had a value of its own, both for the citizens who were trying to present their needs and values to be incorporated into the future visions and suggestions, and for researchers and business executives who were able to further discuss the differences between application and basic research. Another often mentioned benefit for many stakeholders was the possibility to exchange information and views about what nanotechnologies mean for the public – to be able to step out of their expertise and to come up with realistic ways to find a right balance between the expectations of uninformed potential customers and ways of using nanotechnologies for the benefit (whenever possible) of all the stakeholders.

3.3 Report on the first stakeholder workshop in Barcelona (ES)

3.3.1 The workshop overall

The "*GoNano Innovation and Co-Creation Workshop: Nanotechnology for Energy*" took place at the offices of RMIT Europe in Barcelona, Spain, on 7 March 2019.[17] The participants were a group of 27 stakeholders, including 21 researchers from science and engineering backgrounds, 2 researchers in design, 2 CSO representatives, a teacher, and a researcher in social sciences. Of the 21 researchers, 2 were junior researchers from small start-up companies and 19 were from local research centres and universities – including 8 senior staff, 3 postdoctoral researchers, and 8 postgraduate research students. The 2 CSO representatives and one of the researchers had moderated at the citizen workshop[18] held before this one, which provided some continuity between the workshops. One citizen participant had agreed to attend the stakeholder workshop but could not make it after the change of date.[17] The overall group was well-balanced with respect to gender and comprised 14 females and 13 males, which was a desired balance but was not achieved through any biasing of the recruitment strategy. A good balance of stakeholder diversity was also desired but was unfortunately not achieved, despite actively inviting a diverse mix of stakeholders. In total, 16 CSOs, such as energy cooperatives, foundations, and living labs; 25 companies, including (inter)national enterprises, SMEs, and business networks; 20 research institutes and universities; 10 European projects, networks, and consortia; and 14 organisations that support technology transfer such as start-up hubs and investment funds; were contacted via email in the months before the workshop, but many of these invites received negative or no responses.

On the day of the workshop, the participants gathered in plenary, where they were introduced to the overall objectives of the GoNano project and the specific aims of the workshop. This information had already been sent to the registrants before the meeting in the form of an information guide.[19] They were shown the results and the short summary video of the citizen workshop, which had been held a few months before the stakeholder meeting, and were invited to come up with new directions for research lines and activities in nanotechnology that put the citizens' needs and values at the centre. To achieve this, the workshop was organised in four main sessions: an initial *Exploration* session, where participants could analyse the key needs and values of the citizens surrounding the themes of energy and nanotechnology; and a series of 3 creative design sessions on *Ideation, Prototyping,* and *Reflection*.

3.3.2 Session A: Exploration

The first task set for the stakeholders was to analyse the needs and values of the citizens with respect to their perceived importance for the development of nanotechnologies in energy. A list of citizens' needs and values, which had been previously extracted from the results of the citizen workshop,[20] was presented to the stakeholders as a series of short statements which they then had to prioritise

[17] Original date planned for the workshop was 21 February 2019. The date of the workshop was changed later on due to protest activities arranged in the city for that day.

[18] http://gonano-project.eu/valuable-contributions-during-citizen-workshop-on-energy-at-rmit-barcelona/

[19] Further information on the background material of the workshops is available in D4.1: http://gonano-project.eu/wp-content/uploads/2019/03/D.4.1.pdf.

[20] See the briefing report on the citizen workshops (D.3.2): http://gonano-project.eu/wp-content/uploads/2019/02/D3.2-Briefing-report-from-the-citizen-workshops.pdf.

using the categories of *'essential'*, *'ideal/desirable'* or *'non-essential'*. They worked on this assignment in groups of between 4 to 8 individuals, which were predetermined according to the participants' backgrounds (with respect to gender, institution, research experience, and research interests). Their analysis of the citizens' needs and values was generally very positive, with the majority of citizens' needs and values being judged as either *'essential'* or *'ideal/desirable'*, as opposed to *'non-essential'* (Figure 18).

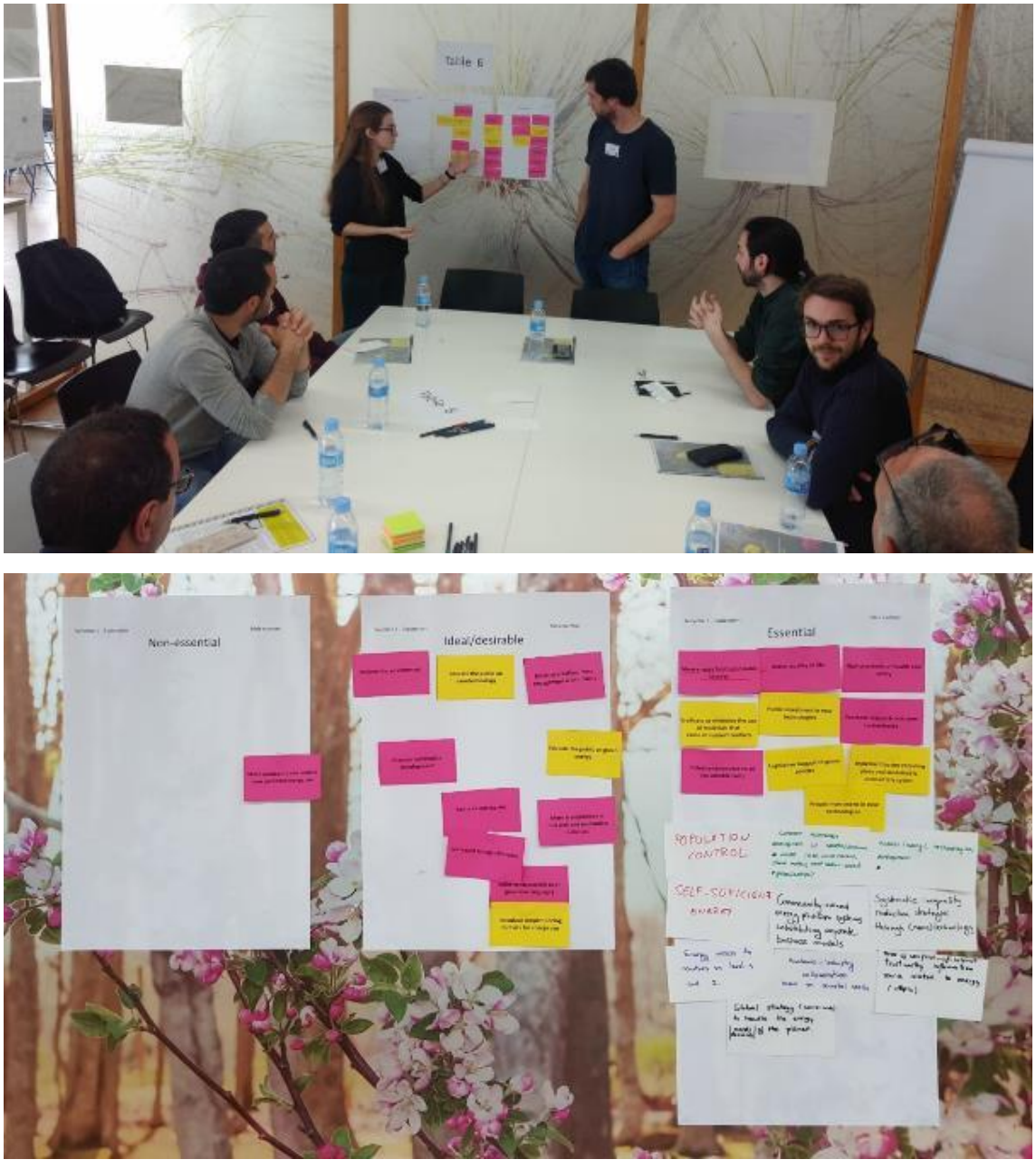


Figure 18. Images of participants and a completed template for the *Exploration* session.

This shows the participants' appreciation of the input from citizens and to some extent their accordance with the importance of these needs and values; however, the group members were not in constant agreement throughout the discussion. For example, one participant observed that there was some "*productive tension"* between the viewpoints of those from the natural/applied sciences and those from social sciences. To account for such differences of personal/professional opinion, the

participants were also instructed to carry out the same activity individually. This allowed us to record individual opinions as well as look for stakeholder-group-specific trends. The individual responses appeared to be similar to those of the groups, with most of the citizens' needs and values being classified as '*essential*' or '*ideal/desirable*': the average results of the 25 individual responses were 10 '*essential*', 9 '*ideal/desirable*', and 2 *'non-essential'*. A similarly empirical analysis of the responses of the whole group provided a slightly different perspective (see Table 4). Despite each individual only categorising on average 2 needs/values as *'non-essential'*, the accumulation of these responses in specific topics positioned them lower in the ranked list.

Table 4. Ranked list of the citizens' needs and values, as analysed by the stakeholders

Scoring was based on results from 25 respondents, assigning scores based on Essential = +1 point, Ideal/desirable = 0 points, Non-essential = -1 point

Score	Citizens' Need/Value
24	Respect the environment
24	Practice sustainable development
24	Legislative support of green policies
22	Implement better recycling plans and sustainable product life cycles
21	More energy from renewable sources
20	Increased energy efficiency
14	Promote sustainable development
13	Public investment in new technologies
12	Better quality of life
11	Promote research into new technologies
11	High standards of health and safety
10	Private investment in new technologies
9	Educate the public on green energy
8	Reduced energy use
5	Inclusive/accessible to all (reasonable cost)
4	Eradicate or minimise the use of materials that cause or support conflicts
3	More co-creation, more engagement with citizens
3	More transparency in research and innovation activities
-1	Inclusive/accessible to all (practical language)
-5	Educate the public on nanotechnology
-6	More autonomy and control over personal energy use
-9	Introduce simpler pricing formats for energy use

The almost unanimous support of social needs and values like *Respect the environment*, *Practice sustainable development*, *Legislative support of green policies*, etc. was not surprising, especially in a group almost entirely comprised of researchers. However, what was a striking observation was the low ranking of the need to *Educate the public on nanotechnology.* The general opinion of the researchers we spoke to throughout the day gave the impression that science communication and educating the public was important to them and their employers (mainly universities and research centres), but this result shows that they do not feel that such activities will contribute to the development of new nanotechnologies.

Another interesting observation was that the 2 CSO representatives categorised more of the citizens' needs and values as non-essential than the industry representative (two and six versus zero 'non-essential' answers, respectively). This was surprising at first, considering the type of needs and values in question: *High standards of health and safety; More autonomy and control over personal energy use; Inclusive/accessible to all (practical language/reasonable cost); Better quality of life;* and *Introduce simpler pricing formats for energy use.* However, it was later thought that this was simply a reflection of the particular mindset of the industry representative. Had more of these stakeholder groups attended, we could have probed this further to see if there was indeed a general trend within these stakeholder categories, but this was not possible given the composition of this group. Having more of these stakeholder groups and a greater stakeholder diversity overall may also have led to different outcomes in the global results and in the group discussions – a view equally shared by some of the workshop participants.

> *"Discussion and exchange of different points of view is always an enriching experience."*
>
> *"I would have liked to listen to companies and policymakers."*
>
> [Statements by workshop participants]

Improving stakeholder diversity and the inclusion of industry and policy makers is therefore a priority for the organisation of the second stakeholder workshop. During the session, the stakeholders were also invited to come up with their own *"essential needs and values"* and add them to the templates. Many of their own needs and values overlapped considerably with those of the citizens, which is understandable as they too are citizens, but a few could be seen to be more specific to their professions:

> *"[We need] more contact between university/research centres and industry"*
>
> *"[We need] open access to research and progress to promote science in the community (knowledge transfer)"*
>
> *"[We need to] enhance society's interest [in science]"*
>
> [Some essential needs of workshop participants]

3.3.3 Session B: Ideation

This session was designed to explore ideas for research activities based on a central societal need or value. Firstly, the stakeholders were asked to choose one of the citizens' needs or values that they thought must be considered when creating ideas and suggestions for applications of nanotechnology in the energy sector. Two groups chose *"More energy from renewable sources"*, whilst the other groups chose *"Better quality of life"*, *"Educate the public on green energy"*, and *"Promote sustainable development"*. The groups were then tasked with coming up with activities, research lines, and product suggestions based on their own expertise but also compatible with the central need or value.

The stakeholders didn't seem to have any problems with understanding or empathizing with the citizens' needs and values in the previous session, an observation that was confirmed in the responses in the evaluation questionnaire; however, a few stakeholders found it difficult to relate them directly to their own work. The other challenge they faced was trying to identify activities that all group members felt they could contribute to.

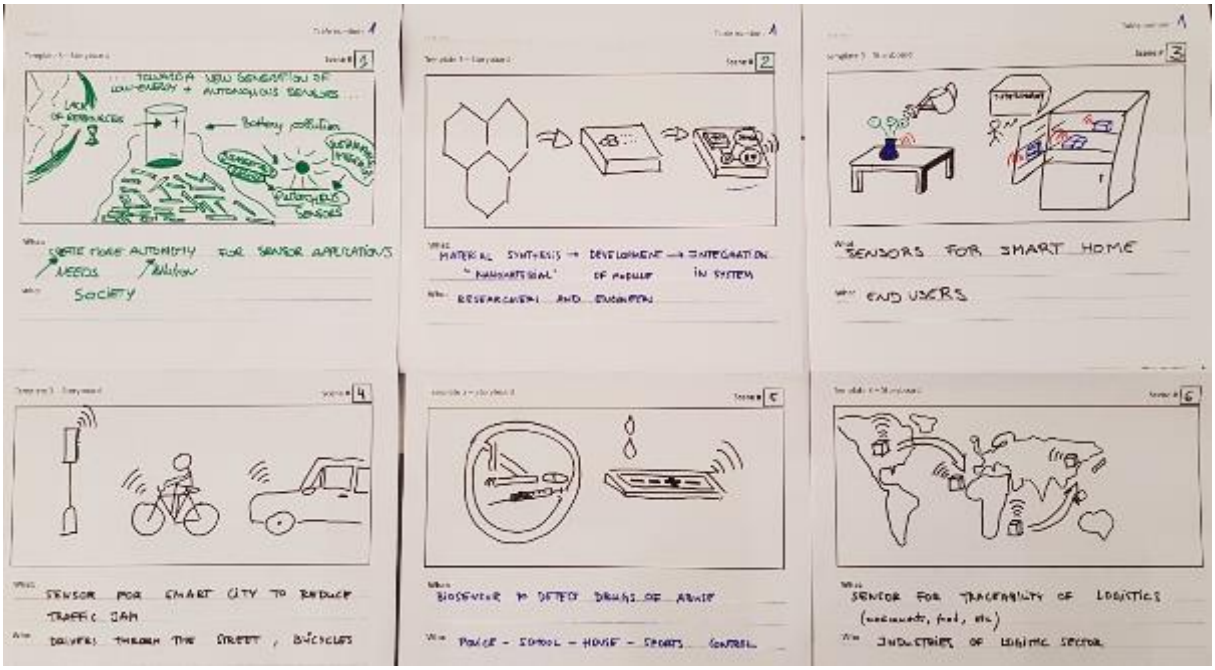
Figure 19. Images of participants and completed templates for the *Ideation* session.

The largely diplomatic approach of the groups towards making decisions led to the more generic ideas being favoured over some of the more specialised, but potentially more feasible and relevant, ideas under discussion. The example templates shown in the images in Figure 19 demonstrate this, where *educating the public through workshops and promotional activities* was selected over the *development of recycling strategies* or *improving the quality of renewable technology*. During the session, the participants were able to move around freely so that they could look at the other groups' ideas and possibly incorporate some of these into their group's template, and also provide feedback to the other groups. After a brief set of presentations where the groups explained to the others what their central citizens' need or value was and what activity their group was planning, the participants were informed that they could switch groups before the beginning of the next session, if there was an idea that resonated with them more or an idea where they felt they could contribute more. None of the participants took advantage of this and everyone decided to remain in their original groups. It was not clear what each individual's motive was for staying in their group; however, one participant stated that they wanted to stick with their group's idea even though it did not fit their own experience or interests, suggesting that they were already too invested in it to want to leave it behind.

3.3.4 Session C: Prototyping

The prototyping phase was where the groups took their initial ideas for activities, research lines, and product suggestions, and elaborated them through the medium of storyboards. All of the groups completed the activity by producing high quality, descriptive storyboards that can be easily followed and understood (Figure 20 series). However, some of the ideas were possibly a little too broad to serve as a basis for a real work plan. Work will be needed to focus the ideas more towards a specific item or task within them if they are to be acted upon by the stakeholders and other collaborators. Additionally, a few of the items lacked a direct link to nanoscience and nanotechnology. Despite being mostly scientists and engineers working within the nanoscience and nanotechnology field, while creating and describing their ideas for future activities, many focussed on the societal problem and offered general solutions, but shied away from the chance to offer their own research and expertise as a solution or to deal with some of the more specific technical challenges. It is possible that too much weight was placed on the societal needs at the start of the day, or their desire to be inclusive of all group members directed them along these lines. Or it could be that the timeframe was just too short for them to make the link between the societal values and their own projects or areas of expertise. With more time and complementary stakeholders (e.g. companies, policy makers), this may be achieved at the second round of stakeholder meetings.

Figure 20 series. The 5 storyboards produced during the *Prototyping* session.

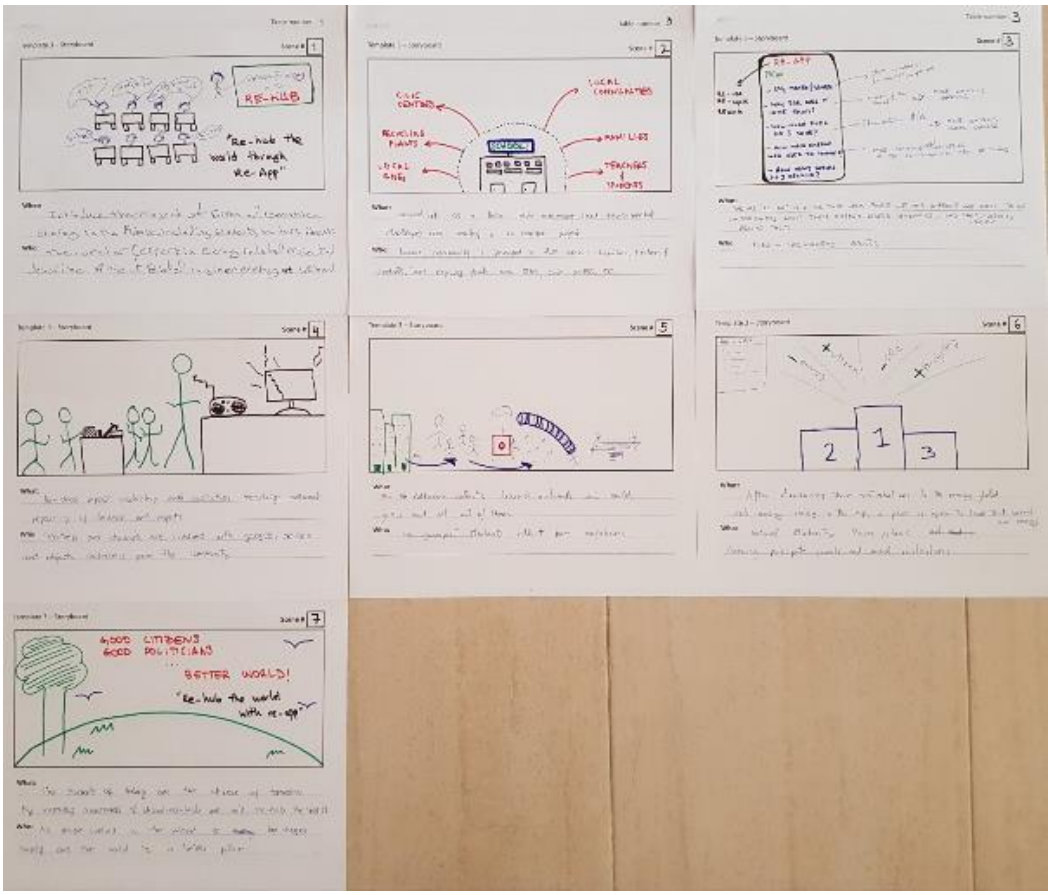


Storyboard 1. Central citizen need or value: More energy from renewable sources.

The storyboard above describes a number of applications for autonomous sensor technologies, such as in smart homes, smart cities, drug tests, and supply chains. The sensors would be developed by researchers and engineers and then integrated into the various application areas. The materials used in the sensors, including nanomaterials (although no specific materials were mentioned), would all need to be sustainable or recycled to prevent putting further stress on global resources.

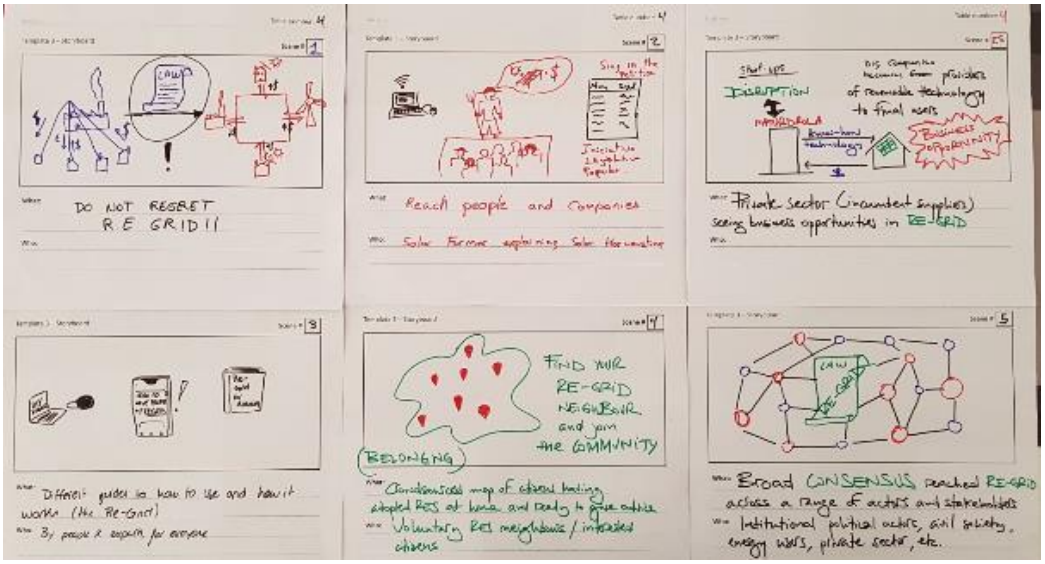
Storyboard 2. Central citizen need or value: Promote sustainable development.

The storyboard above describes a "Piezo Festival" for showcasing piezoelectric materials and devices to raise people's awareness of renewable energy technologies. Funding, advertising, organisation and impact of the festival are considered.



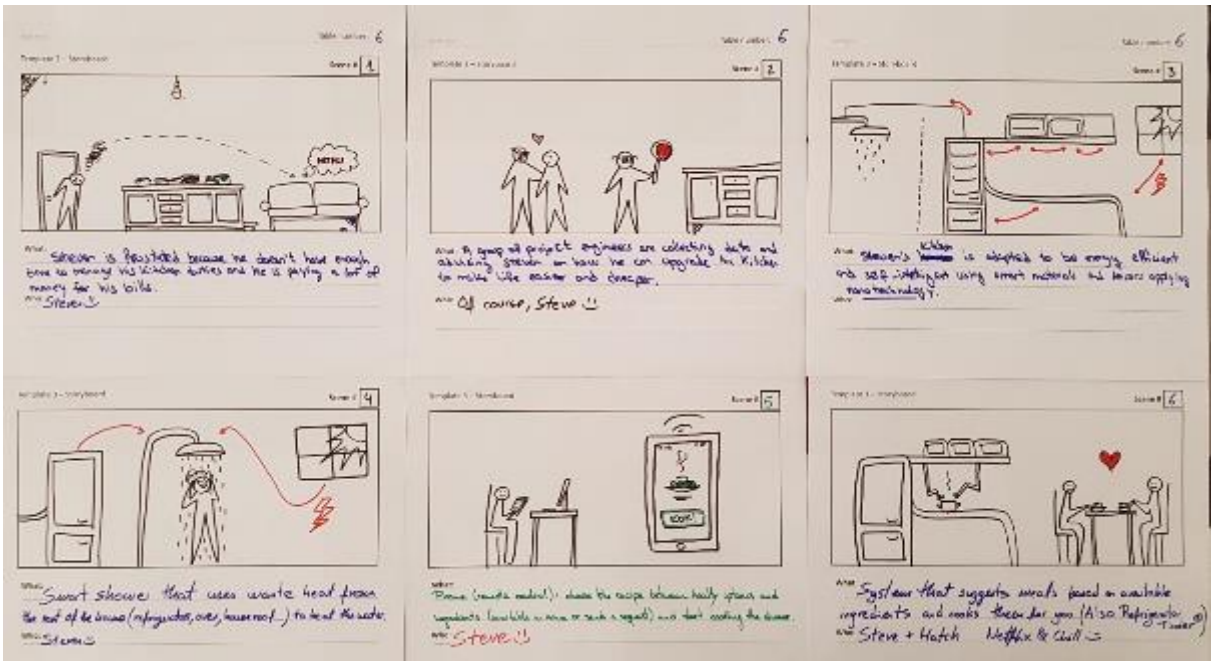
Storyboard 3. Central citizen need or value: Educate the public on green energy.

The storyboard above outlines a strategy to promote schools as the central hub for educating the entire public body (e.g. students, teachers, families, local businesses and CSOs) about green energy and addressing local environmental challenges.



Storyboard 4. Central citizen need or value: More energy from renewable sources.

The storyboard above examines how both top-down legislation and bottom-up community actions can be used to help the transition of the power grid from fossil fuels to renewable energy.



Storyboard 5. Central citizen need or value: Better quality of life.

The storyboard above vividly describes the daily routine of an over-worked individual who has little money and no time or willingness to cook their dinner when they arrive home from work. A group of engineers provide the solution in the form of smart materials and intelligent devices that can save energy and reduce the workload around the home.

3.3.5 Session D: Reflection

The final session of the day was an opportunity for each group to present their storyboards in plenary and to give and receive feedback on them (Figure 21).

Figure 21. Participants presenting their storyboards in the *Reflection* session.

All of the storyboards were presented with enthusiasm and the audience was respectful when delivering their comments. A common criticism during the presentations was that the concepts were not novel; for example, storyboard 2 proposed a piezo festival with an energy-generating dance floor, which is already a commercial product.[21] Storyboard 4 is also very similar to a renewable energy cooperative operating in Spain,[22] and the sensors and smart appliances of storyboards 1 and 5 also build on existing concepts. Some of the responses to the evaluation questionnaire reflected these observations, as in the following statements from individual workshop participants:

> *"I feel that the ideas generated are not novel; we all know what should be done. Most were relevant but difficult to implement."*
>
> *"I didn't see anything new."*
>
> *"[I was] not impressed by the relevance and the novelty of our group's proposal. It was too general…"*
>
> *"Some [suggestions] are far from being feasible but it's a matter of investment. Some are very novel, others not that much."*
>
> [statements from workshop participants]

The groups and the audience were in agreement that all of the proposals addressed the central citizen need or value that they were addressing. However, there were mixed responses when they were asked if their ideas could be linked to developments in nanotechnology. How 'nano-specific' we want

[21] https://energy-floors.com/the-dancer/
[22] http://www.unionrenovables.coop/

the final product suggestions to be is something that must be considered and resolved, before the next stakeholder meeting.

3.3.6 Overall assessment of the workshop

In conclusion, the workshop was successful in outlining the benefits of using a co-creation approach for research in nanotechnologies; the stakeholders were receptive to the concept and many of them said they would consider applying it in the future. The value of engaging with the public was evident to the researchers and is something that most of them were already aware of and practicing at their research institutions, albeit more through dissemination activities than co-creation. What they may therefore have taken away from this meeting was the benefit that these activities can have on shaping their own research:

> *"[I can use the suggestions to] steer my future research towards possible applications which have come up during the workshop."*
>
> *"If the citizens are the end consumers, it makes sense to consider them in the creative process."*
>
> *"I got some interesting ideas that can become real."*
>
> [statements from workshop participants]

This was in fact one of the key things that this workshop did not manage to achieve – a demonstration that researchers can adapt their own activities to the societal values and needs they are exposed to; thus demonstrating true responsiveness in R&I. However, the indication that they are willing to change and engage across all stakeholder groups is a positive sign. They were fully receptive and respectful of the citizens' inputs and were vocally disappointed by the lack of industry and policy makers at the meeting:

> *"I think that all [stakeholders] are necessary [in the co-creation process] but maybe more essential are policy makers because they decide where the money is spent."*
>
> *"Companies! [are essential for the co-creation process]. In the end, they are the ones building the products and their knowledge of the market is an important asset in these discussions."*
>
> *"If workshops like this were more integrated in companies' workflows, the impact would be bigger."*
>
> [statements from workshop participants]

The methodology worked well to stimulate the creation and sharing of ideas and engagement amongst the participants (being mainly researchers). The question now is whether it will still work when less-engaged stakeholder groups are involved, or if a change of strategy and/or focus will be needed at the next stakeholder meeting.

4. REFLECTION ON THE WORKSHOP FINDINGS

The workshop reports reflect the effort that all WP4 partners, particularly the pilot partners, have put into the co-creation workshops. Thanks to careful programming, diligent preparation and intense discussions among project partners throughout the project, the workshops have provided interesting insights. Collectively, the workshops have mobilized almost one hundred stakeholders around co-creation in nanotechnologies. The events provided productive spaces for engagement and mutual learning between a wide range of stakeholders: researchers, producers, policy makers, civil society and citizens.

Responses to the evaluation questionnaire and follow-up interviews show that participants appreciated the events. Those who responded to the questionnaire were very positive about the quality of the group discussion: more than 75% agreed or strongly agreed that the group discussions were of good quality, and around 65% thought the citizens' messages were relevant for the workshop. Particularly in the Netherlands and Spain, the majority of respondents thought it makes sense to consider the needs and values of citizens and societal stakeholders in an early stage (see Annex 1 for the full evaluation report).

All workshops had a fairly good gender ratio, considering how male-dominated the area generally is. Because of the nature of workshops, it was not possible to keep track of exactly what role if any gender played between the participants. Nevertheless, the issue of diversity comes up throughout discussions in the sense that workshop participants are encouraged to think in terms of societal issues and how to solve them and to include citizens' ideas and concerns. This is crucial and shows that diversity (of gender, but also of ethnicity, education, etc.) is essential to get the co-creation process going right from the start and to get an end-product that will be beneficial and does what it sets out to do.

The workshop discussions produced interesting suggestions: in the diabetes workshop organised by UT in the Netherlands, citizens' concerns about the ownership of medical data sparked a discussion about data management in the case of the artificial pancreas, highlighting considerations that might be of use to the product developer in further developing a data management plan. In the sensor workshop, interactions with envisaged future users of a biomedical sensor raised the researcher's awareness of the performance criteria that will determine adoption of the sensor. These examples suggest that 'exposure' to use considerations further down the line can attune research design to future use contexts. The overall workshop approach of enabling carefully moderated, highly focused, interest-driven discussions in a four-step process (exploration, ideation, prototyping, reflection) seems to have worked well in these cases. While in retrospect the outcome seems almost self-evident, both the researcher and the knowledge users were pleasantly surprised as they are not accustomed to these types of structured discussions and the concrete results that they can produce.

Moreover, it seems that participants valued the workshops not just out of direct self-interest but also because they provided general opportunities for mutual learning and networking opportunities. Exposure to different perspectives was considered an enriching experience in itself. A respondent from the energy workshop in Spain noted that: "brainstorming with people from different backgrounds are great to think outside the box".

The workshops also raised a general awareness with stakeholders of the need to incorporate social needs and values in the development of nanotechnologies – and the complexity of realising this in practice.

4.1 Assessing the workshop findings against the expected outcomes

Even though this is just the first of two rounds of stakeholder workshops, there is value in considering the extent to which the expected outcomes have been achieved as it may give a sense of direction for the organisation of the second round of workshops.

1. Concrete design suggestions which relate to the research and innovation at hand

All workshops produced concrete design suggestions, but this did not always lead to 'actionable' results in which it was clear who should undertake action and what steps should be taken. In the food workshop, participants discussed very concrete topics such as specific packaging solutions, but the discussions didn't lead to any particular courses of action for any of the stakeholders. In the energy workshop, the storyboards also define very concrete activities such as the organisation of a 'Piezo-festival' or educational activities at schools, but again they do not necessarily prescribe specific courses of action for any particular stakeholder present at the meeting. As the Spanish national report suggests, the need to involve all perspectives caused participants to choose the more general topics that appealed to all stakeholders present, and not to pursue the specific interests of one particular stakeholder.

The question is, to what extent should the interests of one particular stakeholder prevail in the discussion? It is reasonable to expect the discussion to be fair to all stakeholders, giving them equal opportunity to express their interests and concerns; however, the action-oriented perspective that is needed for co-creation requires a 'problem owner'. The sensor and diabetes workshops in the Netherlands, which did identify clear problem owners, did result in actionable results for specific stakeholders. However, it should be noted that the outcomes are not necessarily *product* suggestions, but rather additional considerations or boundary conditions that shape the further development of existing research lines and prototypes. Also, the benefit of defining actionable results for specific stakeholders came at the cost of prioritising one perspective over another.

The general programme structure proposed balancing fairness and self-interest by turning the exploration and ideation sessions into a 'market place', where all participants could express their interests and 'knowledge needs'. Participants could subsequently agree upon one particular interest (thus picking a problem owner by default) and then gather in subgroups to discuss possible contributions from each of the stakeholder perspectives to that problem. The Spanish workshop followed this structure very closely but as mentioned previously, participants converged on more general areas of interest rather than pursuing the specific interests of one particular stakeholder. Based on the overall workshop experiences, this might still be a way to offset fairness against personal interest – but it was perhaps too optimistic to assume this could happen in a such a short amount of time.

These considerations confirm the difficulty of facilitating or encouraging the co-creation processes that GoNano envisages.

2. Responsiveness of the design suggestions to societal needs and values

It proved difficult in all workshops to relate the design suggestions to the wishes and concerns expressed in the citizen workshop. This is partly due to the particular shape and form of the outcomes of the citizen workshops. They provided suggestions on a very high level of abstraction, such as 'nanotechnologies should be developed in a safe and sustainable way', 'citizens should have universal access to health technologies', or 'potentially harmful effects on future generations of humans, especially those caused by novel food products, should be investigated and avoided.' While these recommendations provide clear boundary conditions for research and innovation (indeed, the results confirm earlier findings on public perceptions and attitudes towards emerging technologies),[23] it is not immediately self-evident how these prescriptions apply to the micro-level of research and innovation decisions.

The results were therefore in need of 'translation' by the pilot partners, suggesting how these general insights might apply to the research topics at hand. Even though pilot partners undertook praiseworthy efforts to adapt the citizens' messages to their thematic areas, the list of recommendations seemed rather bland to many of the stakeholders. Understandably, the condensation of the wide variety of public views in a few sentences may have been difficult to follow.

Here again, time is an issue: given more time, it may have been possible to delve deeper into the meaning of the various views and recommendations. However, given the list of other priorities on the day, it proved difficult to derive actionable perspectives from the citizens' views.

Even in their condensed form, the citizens' messages were able to serve as a source of inspiration in some cases: The interests of citizens in sustainable development led stakeholders to suggest a 'Piezo festival' in Spain. Public concerns over data ownership led to data management considerations in the diabetes workshop. But even in those cases, the messages from citizens served as a 'token' for new insights: participants took up individual words or one-liners from the citizen workshops, without necessarily being able to assess the deeper thoughts behind those one-liners.

In retrospect, the expectation that the wishes and concerns which citizens spontaneously suggested could be directly integrated into design suggestions may have been somewhat optimistic.

3. 'Awareness' of participants: stakeholders see the *relevance* of citizen perspectives and multi-stakeholder engagement

There were significant differences between the workshops with respect to the perceived relevance of the citizen perspectives and the discussions by the stakeholders. A number of participants of the food workshop clearly had difficulty to see the relevance of societal considerations to the development of nanotechnologies. As the national report on the food workshop suggests, several participants did not see 'why would be concrete product suggestion useful [sic] for the whole policy making process'. The report also suggests that: 'there were many criticisms and necessary corrections of the citizens´ needs and values. Some participants suggested that the requirements from citizens are factually incorrect, and one critical voice suggested that: '…citizens don't have any

[23] See for example the Eurobarometer Study on Responsible Research and Innovation, Science and Technology, the Special Eurobarometer 419: Public perceptions of science, research and innovation, the NanoView study on public perceptions of nanotechnology, or the NanoDiode citizen survey and in-depth interviews.

awareness'. In the energy workshop, participants saw the value and of considering the values and concerns of other stakeholders and citizens in the early stages of nanotechnology research: "If the citizens are the end consumers, it makes sense to consider them in the creation process." However, they struggled to relate them to their own research or to specific research projects, which would have resulted in more concrete actionable outcomes than those that were realised at the workshop. In the workshops at UT, there seems to have been a clearer sense of relevance and ownership. This may be due to the size of the group (around 10 participants as compared to 30), the focused programme (discussing one application area instead of three), and the preparatory meetings with stakeholders (ensuring that the programme targets the interests of stakeholders).

4. Willingness of stakeholders to continue

It remains to be seen whether stakeholders are indeed willing to continue: responses to the online survey, follow-up interviews and the invitation to the second workshop will tell. But the enthusiastic responses seem to suggest that stakeholders may be willing to stay involved in the co-creation process.

4.2 Organisational considerations

The national workshop reports suggest a number of considerations on the organisational level. The overall workshop structure proved to be conducive to producing tangible outcomes, although the workshops have produced different types of outcomes with varying degrees of concreteness. This may be partly due to different organisation styles in the different countries: while they all integrated the overall workshop structure, pilot partners adapted the programme according to their national needs. Cultural specificities may also play a role, although it is very difficult to establish on the basis of such a small number of workshops whether certain outcomes can be ascribed to specific *cultural* traits, or whether they are the result of a particular group composition, group dynamics, or perhaps of certain organisational decisions or facilitation styles.

The storyboards, however, did not work so well. While the idea of switching from the familiar world of words to visual representations could, in principle, stimulate creative thinking within the group, it proved difficult for the majority of participants to make this shift in practice. The creative design approach was so unfamiliar to them that the exercise in most cases (notably at the workshop on diabetes in the Netherlands and the workshop on food in the Czech Republic) proved to hinder creative thinking rather than encourage it. In these cases, the participants were more comfortable sticking to familiar ways of working. The exception to this general trend was the workshop on energy in Spain, where participants did succeed in producing clear storyboards based on creative ideas – albeit with some guidance from the facilitators and taking slightly more time than was initially allocated for the exercise. This suggests that this format can work well, providing there are sufficient visualisation skills within the group or the moderating team. These conditions were realised in the energy workshop in Spain but not at the other workshops, and in hindsight should probably have been included in the general workshop blueprint. An alternative solution could be to include professional illustrators in the workshop, who could encourage participants to think more visually while providing some guidance and support in the visualisation process; however, this would bring an additional cost that would also need to be considered.

EngageSuite did not work very well. While digital meeting facilitation tools like EngageSuite can be useful when used appropriately (for instance, capturing data from the meeting directly in a digital format can save a lot of time in the post-meeting analysis and facilitate the visualization of collected data), the pilot partners felt that the program was not sufficiently tailored to their needs. Several partners used EngageSuite because it was mandatory, but felt that there are many tried and tested programs that provide better support. To avoid collecting a host of information that is not analysed or does not contribute to providing any new findings, the tool should be used sparingly and not for recording every piece of data from the meeting. Thus, the decision of what data to collect, and how to collect it, must be made in the early stages of planning for the meeting.

In some of the workshops, there was some confusion about the exact purpose of the different sessions. In the workshop on food in the Czech Republic for example, participants had difficulty distinguishing the prototyping session from the ideation process. While in the workshop on diabetes in the Netherlands, participants were not entirely clear about the purpose of the discussion. This underlines the importance of workshop facilitation. The facilitator has a crucial role in obvious ways: balancing monologues with interactive discussion, giving participants the opportunity to speak, summarising the discussion and highlighting major insights, and of course keeping time. Indeed, it seems that most of the workshops were short on time - but facilitation is also about helping the group navigate through the programme. When the objective isn't crystal clear, the discussion risks losing focus as a result and participants then have a tendency to make general recommendations and fall back on standard repertoires.

The workshop results also suggest that better results are achieved when the guidance process starts well before the event itself. Particularly in the diabetes and sensor workshops in the Netherlands, the organisers invested much time in identifying the interests of stakeholders before the workshop. As a result, there was a clear sense of purpose from the start of the meeting, which was reflected in the workshop discussions (although this focus comes at a cost, as will be argued forthwith). On the other hand, in the workshop on food in the Czech Republic on the other hand, it seems there was a mismatch between the objectives of the workshop and the commitment or expectations of participants, as about one third of the participants left the meeting after the plenary session. This underlines the importance of involving stakeholders in workshop programming to encourage ownership and achieve tangible results.[24]

Timing was an issue in several of the workshops and it proved difficult to fulfil all of the workshop objectives in a single day. Due to the diversity of stakeholders, it took time for participants to begin to understand one another. It also took time to grasp the purpose of the overall GoNano approach, to appreciate the outcomes of the citizen workshops, and to apply these to the workshop discussions.

These observations reconfirm the complexity of the GoNano co-creation process as a whole: it is far from self-evident how broader societal considerations can be applied directly to research and innovation practice. It requires insight into the individual, day-to-day decisions being taken in nanotechnology research and innovation (and respect for the limited room for manoeuvre at that level); a deep understanding of public perceptions of, and attitudes towards, nanotechnologies; a process where participants can build a relationship and a shared language in which their contribution to the problems at hand can be meaningfully brought to bear on the discussion; and

[24] The need to address the interests of stakeholders was also a key recommendation in the literature review of WP1, and in the review of best practices in co-creation. See for example the interview with Frank Kresin: https://youtu.be/au3uVptWJbU.

above all, the capacity to 'translate' needs and concerns from the social realm to practical options in the technological realm in real time. This is a tall order indeed, but it is exactly what needs to happen to realise the policy prescriptions underlying the notion of Responsible Research and Innovation and the Science in Society-movement in general: *"to encourage actors in their own disciplines and fields to participate in developing Science in Society perspectives from the very beginning of the conception of their activities."*[25]

4.3 Methodological considerations

Looking at the learning objectives for the stakeholder workshops, the results suggest that – at least in some cases – the workshops succeeded in raising awareness with stakeholders that early consideration of the needs and values of citizens and societal stakeholders can add value to innovation in nanotechnologies. To get a clearer sense of the extent to which this objective has been achieved, it may be helpful to distinguish different levels of commitment by stakeholders in the workshop (see Table 5), varying from disengaged (where participants walk out of the meeting or work on their laptop during the meeting) to committed (where participants demonstrably revise their actions as a direct result of the discussions). While it is impossible to assign an exact number to these levels of commitment, it is possible to get a sense of the 'atmosphere' from the national reports. In all the workshops, a significant number of participants showed interest and actively engaged in the discussion, and, in most cases, at least some participants were noticeably inspired to act on the insights gained during the workshop. The food workshop in the Czech Republic on the other hand had a significant number of participants who were clearly disengaged. The participants in the health workshops in the Netherlands were highly engaged and were able to see the value in incorporating the citizens' needs and values in their own research areas. The participants of the energy workshop in Spain were very engaged and enthusiastic, producing highly creative outcomes. They appreciated the need to consider the values and needs expressed by citizens, but had difficulty connecting these to their own work, for any number of reasons: perhaps because they did not want to dominate the discussion, or the citizens' values weren't expressed clearly enough, or they couldn't see the connection, or they did see the connection but did not want to make it explicit.

The latter observation touches on the second learning objective: to explore effective approaches to productively embed societal considerations in ongoing research and innovation. It holds an important message for the broader GoNano ambition to create a methodology for responsive design of nanotechnologies. On a very critical reading, one could argue that the workshops achieved many things: they managed to raise awareness of stakeholders for the importance of integrating broader societal considerations in research, and even encouraged stakeholders to consider citizens' views more deeply; which is no small feat, given the traditional scepticism of researchers and producers towards 'soft' interventions. However, in most cases this did not lead to *co-creation* (in the strict sense of the word: the collaborative development of new value by experts and stakeholders). The sensor workshop seems to have been the only workshop that reached the highest level of commitment, where at least one participant demonstrably modulated their research trajectory in light of the workshop discussions (this can be interpreted as an instance of 'responsiveness').

[25] European Commission. (2007). Work programme 2007, Capacities, Part 5, Science in Society. C(2007)563.

Table 5 – Different levels of participation observed in the stakeholder workshops

Level of commitment	Indicators	Food	Energy	Health policy	Diabetes	Sensors
Committed	Participants initiate follow-up meetings, demonstrably revise their actions as a result of the discussions					
Inspired	Participants are moved to act on the insights gained during the workshop, note that they see added value					
Engaged	Participants actively engage in the discussion, continue discussing the topic during the breaks and after the meeting					
Interested	Participants listen actively and contribute to the discussion					
Disengaged	Participants walk out of the meeting, or work on their laptop during the meeting					

The sensor workshop came closest to a from of co-creation where the 'users' and 'producers' of the biomedical sensor explored collaborative development of new value – but it came at the expense of direct citizen involvement.

The upshot of this is that GoNano faces a double bind: to enable co-creation, one needs to operate at the micro-level of individual research decisions. However, at this level of operation, many parameters are fixed, including those that some stakeholders may want to put up for discussion (for instance, the question: "should we be developing this product in the first place?"). It is of course possible to put those parameters up for discussion – but it is unlikely that it will lead to 'actionable' suggestions *within* the context of product development. In the case of the artificial pancreas, one might claim that the product developer should not just collaborate with diabetes patients who are interested and willing to cooperate, but also with patients who do not believe in a 'technical fix' for their disease at all. While this may serve to raise awareness of the product developer that different parts of the population will respond differently to the innovation (which can be a very relevant insight in itself) – it will probably not lead to insights that modulate the design of the artificial pancreas.

The benefits and drawbacks of engaging citizens versus professional end users is one that deserves further consideration within the consortium. How to combine the two? The importance of some citizen input is very important, even when it comes to more detailed health technology used only by health care providers. One of the lessons learned in the workshop on food in the Czech Republic was that it seemed to be easier for professional stakeholders to dismiss some of the citizens´ needs and values in those groups where no citizens were present. Therefore, it indeed seems that for the co-creation, a constant vis-à-vis exchange of all the stakeholders is necessary.

The double bind, then, is that there is a trade-off between inclusiveness and specificity: the decision to treat all stakeholder perspectives on an equal footing for reasons of inclusiveness comes at the cost of a clear action perspective. Conversely, the choice of one particular action perspective to enable specificity is – by definition – partial and exclusive. So while both approaches are entirely defensible in themselves, it is not possible to implement both at the same time. Perhaps responsiveness necessarily operates at a different scale than inclusiveness. This would imply that the overall objective of GoNano cannot be achieved by a single, unified approach, and will depend on different forms of societal engagement at different stages of the research and innovation process. For instance, citizen and multi-actor consultations could help to determine the sorts of research that we – as a society – do or do not want to pursue, and the ways in which we do or do not want nanotechnology to shape our society. Focused, in-depth co-creation approaches can be used to integrate specific societal considerations in concrete research trajectories. One could envisage a map of the different roles of societal engagement at different stages of the research and innovation process.[26]

4.4 Suggestions for the programme for workshops round 2

These observations may hold some suggestions for the second round of workshops to be organised in October/November 2019. First of all, it should be noted that for all the learning that the first round of stakeholder workshops provided, they did not lead to clear examples of 'concrete responsive design suggestions which can be fed back in ongoing research and innovation activities', as mandated by the Description of Action. These examples will be vital to future dissemination and communication activities in the GoNano project, as they demonstrate the added value of the overall GoNano approach: they are, in fact, the embodiment of 'the business case' for GoNano. It would therefore be very helpful to focus both the upcoming citizen consultation and the second round of stakeholder workshops towards defining those examples. This will require re-thinking the outcomes of the first round of workshops, and considering their potential impact in collaboration with stakeholders.

How can the lack of relevance and novelty that was evident in (some of) the first round of workshops be overcome in the second round? What needs to be done to maximize the chance of acquiring responsive design suggestions, in terms of workshop procedure, group composition, programming, stakeholder prepping, and so forth? Given the considerations above, this may require more focused discussions in smaller groups. It may also require more time for in-depth discussion, and more determined workshop facilitation to prevent participants from falling back on standard repertoires. The aim, as the Dutch national report also suggests, is to establish a so-called 'Trading Zone'[27] where stakeholders develop a 'pidgin', a shared language to exchange the value of one's own contribution to a shared problem in a way that makes sense from the perspective of the other. This inevitably takes time and commitment from all participants.

[26] A similar suggestion is made in a recent report on societal engagement from the Horizon 2020 Advisory Group on Nanotechnologies, Advanced Materials, Biotechnology, and Advanced Manufacturing and Processing (NMBP). See: https://publications.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/5be04f7f-ff55-11e8-a96d-01aa75ed71a1.

[27] See: Galison, P. (2010) 'Trading with the Enemy'. In M. E. Gorman (ed.) Trading Zones and Interactional Expertise: Creating New Kinds of Collaboration. Cambridge, Mass.: MIT Press. See also: Gorman, M.E, & Schuurbiers, D. (2013). Convergence and Crossovers in Interdisciplinary Engagement with Science and Technology. In: Doorn, N., Van de Poel, I., Schuurbiers, D., and Gorman, M. E. (eds.). Opening Up the Laboratory: Approaches for Early Engagement with New Technology. Dordrecht: Springer.

It could be interesting to experiment with different roles for citizens in this process - for example by involving them more deeply in the design process. Considering the trade-off between inclusiveness and specificity, this focus towards more concrete product suggestions may necessarily come at the cost of representativeness. Getting citizens to participate at that level will only be possible if they have a specific interest in the topic (i.e. a 'stake'). It will also require them to get up to speed with the technology, at least to the level of interactional expertise. This inevitably means they will be more 'biased' – but if the arguments above hold true, that is the price to pay for concrete responsive design suggestions.

ANNEX 1 – RESULTS OF THE EVALUATION QUESTIONNAIRE OF THE FIRST STAKEHOLDER WORKSHOPS

At the end of the stakeholder workshops in the first round, a questionnaire was handed out to every participant. The questionnaire is part of a larger evaluation measurement, aiming to evaluate the effectiveness of the whole co-creation methodology of GoNano, by measuring two key concepts:

1. Co-creation process: respondents' attitudes towards the workshop and the co-creation process in general;
2. Outcomes co-creation: respondents' perceptions of the outcomes of the co-creation process in general, and the product suggestion in particular.

In total, 63 stakeholders completed the questionnaire: 21 (75% of the stakeholders who participated) from the Netherlands, 23 from Spain, and 19 from the Czech Republic. The following constructs were measured:

Key concept	Construct	Questions that were asked in the questionnaire	Cronbach's Alpha
Co-creation process	Quality of group discussion	I felt comfortable and at ease to voice my opinions during the process.	0.74
		All participants were respectful to one another.	
		The moderators did a good job in ensuring a constructive and fair process during the discussions.	
	Relevance of citizens' messages	The citizens' make sense to me	0.76
		I can relate these messages to my own work	
		Today's discussions will help me to consider these messages in the future	
	Early consideration of social needs and values	It makes sense to consider values and concerns of other stakeholders, such as citizens, at early stages of nanotechnology research	0.77
		It could inspire new or unexpected developments	
Outcomes co-creation	Quality of overall output	I am satisfied with the overall quality of the output of the workshop	0.82
		Despite different opinions we were able to reach to consensus	
		I am convinced that the suggestions formulated today will serve as relevant input for the upcoming workshops	
	Outcomes product suggestions (question level)	Relevant	NA
		Novel	NA
		Feasible	NA

Co-creation process

	Total	The Netherlands	Czech Republic	Spain
	N = 63	N = 21	N = 19	N = 23
*Co-creation process**				
Quality of group discussion	4.40 (0.54)	4.62 (0.39)	4.06 (0.54)	4.52 (0.30)
Relevance of citizens' messages	3.84 (0.74)	4.09 (0.34)	3.40 (0.98)	3.93 (0.60)
Early consideration of societal needs and values	4.07 (0.80)	4.26 (0.60)	3.40 (1.06)	4.28 (0.54)
*Outcomes co-creation**				
Quality overall output	4.05 (0.63)	4.27 (0.65)	3.76 (0.71)	4.08 (0.45)
Outcomes product suggestions				
Relevance		4.19 (0.51)	3.69 (0.67)	3.82 (0.59)
Novelty		3.50 (0.54)	3.47 (0.52)	3.32 (0.49)
Feasibility		3.90 (0.89)	3.56 (0.98)	3.64 (0.49)

Table 1 – Mean scores and standard deviations on constructs

*Scores are on a five-point scale

To measure the stakeholders' perspectives on the co-creation process, participants were asked about their view on the quality of discussions during the stakeholder workshop and the quality of the overall output of the workshop.

Participants were very positive about the quality of the group discussion, as this was scored on average with a 4.40 (SD = 0.54) on a 5-point likert-scale. More than 75% of them agreed or strongly agreed that the group discussions were of good quality. In the Netherlands and Spain stakeholders were slightly, but significantly ($p < 0.05$), more positive than in the Czech Republic (see Table 1).

Around 65% of the participants thought the citizens' messages were relevant for the workshop, but they were less positive about them than about the quality of the group discussion (M = 3.84; SD = 0.74). In the Netherlands participants were most positive, followed by Spain and the Czech Republic. In the Netherlands participants were significantly ($p < 0.05$) more positive than in the Czech Republic. Most answers on the open question in the questionnaire asking for an explanation of the opinion on the citizens' messages came from the Netherlands and Spain. Participants from these countries emphasized that it is interesting to listing to others and that society's thoughts are important to take into account. One respondent said for example: "It is important to hear the citizens

as they will be the end-users" (Respondent 6 – the Netherlands). Another one stated: "the ideas are interesting and can improve daily life" (Respondent 33 – Spain).

Most stakeholders (more than 70%) thought it makes sense to consider the needs and values of citizens and societal stakeholders in an early stage (M = 4.07; SD=0.80). Participants in the Netherlands and Spain were more convinced about this value, than participants in the Czech Republic.

Participants gave different explanations to the open question in the questionnaire about why early consideration would or not would not be important. A number of them emphasized the importance of early engagement to enhance the acceptance and diffusion of an innovation, and to generate new ideas. One participant said for example: "innovations that are inspired on people's needs will have a better chance to be implemented" (Respondent 17 – the Netherlands). Another underlined: "brainstorming with people from different backgrounds are great to think outside the box" (Respondent 30 – Spain). A few participants thought there was little or no added value for early engagement, because nanotechnology in its early stages is abstract and theoretical, and the needs and values of the wider public make are not innovative or make little sense. A few other participants underlined that early engagement as being done in the GoNano-project only would make sense when it is very concrete, includes perspectives from stakeholders with different backgrounds, and result in output with real impact.

Outcomes product suggestions

More than 70% of the participants were positive about the quality of the output of the workshops (M = 4.05; SD = 0.63). Participants in the Netherlands were most positive, followed by Spain, and the Czech Republic. Whereas the participants in the Netherlands were significantly ($p < 0.05$) more positive about the overall output than the participants in the Czech Republic (see Table 1).

In the three countries, different answers were given to the open question in the questionnaire about how the stakeholders could use the output of the workshop in their own area of expertise. In the Netherlands participants emphasized that it was practical input for product development and research development. Furthermore, setting up new collaborations, creating support and awareness was mentioned. One participant mentioned for example that the output of the workshops helped to get "a sharper idea for product development, and go-to-market strategy" (respondent 5, the Netherlands). In the Czech Republic the usefulness of getting information during the workshop and input for possible applications was emphasized. One participant stated: "an idea for a new application came to me, I am sure I will test it" (respondent 62, the Czech Republic). In Spain getting information about nanotechnology and applications, getting input for research and development, and creating awareness about nanotechnology was mentioned. One participant said for example that the output of the workshop helped to: "steer my future research towards possible applications which have come up during the workshop" (respondent 30, Spain).

Regarding the product suggestions that were formulated as outcome of the workshops, participants in the Netherlands thought the suggestions were relevant and feasible, but they were less convinced of their novelty (see Table 1). In their explanation of the scores of the product suggestions,

participants in the Netherlands were especially enthusiastic about the product suggestion of the field lab in the health and policy workshop. All participants of this workshop gave an answer to this question, and explicitly referred to the concreteness of the idea which they thought was very positive. However, some participants questioned the feasibility of the idea. Also, in the other workshops participants were also positive and remarkably they mostly underlined the novelty of the suggestions. One participant said for example: "the focus was on embedding novel products in existing practices. This enhances chances of successful implementation" (respondent 2, the Netherlands).

In the Czech Republic, participants were also positive about the product suggestions, but less positive about than in the participants in the Netherlands regarding the relevance and feasibility (see Table 1). There were not many responses to the open question about the product suggestions. The participants who did give an answer, focused on the process of coming to the product suggestions. One participant said for example: "an interesting sharing of experience" (respondent 61, the Czech Republic). Another one said: "the set-up of the workshop was in wrong way, the public/consumers should have been informed at first and then there should have been a meeting held between the customers and experts" (respondent 54, the Czech Republic).

Also in Spain the participants were less positive about the product suggestions than in the Netherlands. Similar to the other two pilot countries, they rated the relevance of the product suggestions and the feasibility higher than the novelty (see Table 1). When asked for their opinion about the product suggestions in the open question, most participants were critical. They thought not all ideas were very novel, they questioned the impact and feasibility, and thought more time is needed to further elaborate on the suggestions. One respondent said for example: "I am not impressed by the relevance and the novelty of our group proposal. It stays too general" (respondent 39, Spain).

Conclusion

Overall, a majority of the participants in all three pilot countries who filled in the questionnaire were positive about the workshop, the co-creation process and the outcomes of the product suggestions. Participants in the Netherlands were most positive, followed by Spain, and then the Czech Republic. In Spain the highest percentage of participants filled in the questionnaire, and in the Czech Republic the lowest percentage of participants.

ANNEX 2 – PROPOSED STRUCTURE FOR THE FIRST GONANO STAKEHOLDER WORKSHOPS

This document proposes an overall structure for the programme of the first stakeholder workshops (T4.2), building on the DoA, D2.1, earlier discussions, agreed expected outcomes and draft programmes from pilot partners. Rather than providing minute-to-minute instructions (which was impossible given the maturity of the draft programmes), it presents an outline for the day, introduces the main objectives of the different sessions and suggests ways to achieve those objectives and produce expected outcomes. Partners are invited to create more detailed overviews of the day based on the overall structure presented here. They can choose to revise the programme according to their national needs (but would need to justify the change if they do).

Overall structure

The programme is structured in five sessions: a general introduction, followed by four interrelated co-creation sessions:

- Session A: **Exploration**, where participants get to know each other and their work and explore the wishes, needs and values and messages expressed by the citizens as well as their own needs and interests.
- Session B: **Ideation**, where participants imagine and co-create responses to the wishes, needs and values and messages expressed by the citizens by imagining revisions/adaptations of ongoing research and innovation trajectories, building on the varied expertise around the table.
- Session C: **Prototyping**, where participants generate a storyboard that visualizes how the resulting research lines and product suggestions are modified in relation to the wishes, needs and values and messages expressed by the citizens and suggests concrete actions to be taken by the stakeholders present to realise this vision.
- Session D: **Reflection**, where participants present and reframe their storyboards, reflect on the ways in which the citizen's needs have shaped the storyboards, identify actions to be taken in preparation for the next workshop and reflect back on the overall workshop objectives.

Introduction

(plenary session, 30 min or so)

The purpose of this session is for participants to become familiar with each other and settle in, and to introduce the objectives of GoNano.

There are many ways to introduce participants: participants could form pairs and introduce themselves to their partner, and subsequently ask each of the participants to introduce their partner to the rest of the table (10 minutes or so). Partners could also respond to trigger questions like: "what do you think you might need from the people in the room today?", or "What would you like to know from your neighbour?"

The introduction to GoNano probably requires a brief plenary presentation (10 minutes or so), followed by Q&A. Importantly, by the end of the session participants should have an idea of what the GoNano project is about (aim of the workshop, where we are now, what went on before (including the citizen workshops), and what will happen next), and especially what *this workshop* is about: the main hypothesis of GoNano is that the productive integration of societal considerations can add value to research and innovation. We are here today to test that hypothesis: we will explore to what extent the incorporation of the wishes, needs and values and messages expressed by citizens might lead to new insights and ideas for your own work. Please note that this is an *experiment*: we don't know whether this is at all feasible or what will come out: we merely aim to test our hypothesis. We will revisit the hypothesis towards the end of the meeting.

Expected result for the next session:

- participants are settled in and familiar with each other's backgrounds
- participants know what to expect today
- informed consent forms signed by all participants

Expected output for the report:

- participants and their backgrounds should be documented for the report, as this will have a significant impact on the discussions and outcomes.
    - (details on group composition is also needed to reflect on the inclusivity dimension later on: to what extent might group composition (gender, but also age, socio-economic background, etc., have influenced the discussion?)
- It would be nice to document telling quotes from participants on their expectations from the day.

Session A: Exploration

(match-making session, 60 min or so)

In this session, participants first need to get to know each other and their work a bit better. Subsequently, they explore the wishes, needs and values and messages expressed by the citizens and combine it with their own needs and interests.

All participants are asked to write 1) their background and expertise and 2) a specific knowledge need or interest that requires the expertise of another type of stakeholder *[related to the objective of the day! For instance: "I am a chemist, and I need to talk to a policy maker on substance regulation"; or: "I am a producer, and I need a material scientist to talk about vapor deposition"]* on a post-it note. Brief pitches on the state-of-art of the technology could form part of this introductory session. Participants read the post-its on the wall, mingle first to discuss their background, expertise, needs and interests, and then form groups based on matching or complementary expertise (i.e. they feel that they have something useful to exchange). Subgroup size for example 4 or 5, depending on group size. Importantly subgroups have to be as diverse as possible (i.e. equal spread of expertise)! *(total 20 min or so to form groups)*

Subsequently, the subgroups are introduced to the messages from the citizens workshops. This could be done by presenting statements on a screen, handing out cards with the citizens messages or

referring to the posters (as much supporting material from the citizen workshops as possible should be used: text, posters, videoclips, even the 'demonstrators' if possible). *[This step will require the 'translation' of the various wishes, needs and values and messages from citizens into coherent and concise messages that stakeholders can understand.]*

Subgroups are asked to familiarize themselves with these ideas, and then to select one idea that (somehow) connects to the expertise of the subgroup members and the reasons for them forming a group. They will work on this idea in the following session *(total 30 min or so to learn about ideas and select one)*.

Expected result for the next session:

- subgroups of stakeholders with complementary expertise
- specific citizen message selected

Expected output for the report:

- Evidence of how the groups were formed (who matches who, and why? What sorts of needs/interests are expressed by stakeholders?) Photos of combined post-its or groups, telling quotes with reasons why.
- Capture initial responses to citizen messages and reasons for selecting 'their' (through quotes, post-its, etc). Do they see the relevance? Does it inspire? Does it match their interests? Or not?

Session B: Ideation

(subgroup work followed by a brief plenary, 60 min or so)

Purpose: In this section, participants imagine and co-create responses to the wishes, needs and values and messages expressed by the citizens by imagining revisions/adaptations of ongoing research and innovation trajectories, building on the varied expertise around the table.

First, one of the subgroup members tries to explain to the others how the message from the citizens might impact their own work (this can be as 'open' and creative as possible: ranging from "we should explain citizens better, because they haven't understood" (which is to be expected) to "I am going to create the product in my factory tomorrow" and everything in between) and adds a description of this 'impact' on a sheet of paper directly below the original citizens message (could be in words or in a drawing). What is important, though, is that the others still recognize the original citizens message somehow), and that the suggested action or recommendation is directly related to this participant's own work!

Then, another subgroup member does the same: explaining how the message might impact their own work. This could *either* be a completely different suggestion (related to this participants' own work!), *or* it could add to the earlier suggestion (building on the expertise-matching above). This 'impact' is again added to the sheet.

[Please see the template for session B to get an idea of how this might look]

All subgroup members should have *the opportunity* to propose an impact on their own work. This means that the mind map (see template) may initially have several main branches (possibly with

further branches for some ideas). At some point during the session however, participants should select one idea to work on in the next session (i.e. one main branch); they could consider things like popularity, originality, feasibility, and the available expertise within the group when deciding on the ideas they want to develop further. All subgroup members subsequently *have to* include a suggestion how their specific expertise might strengthen that particular impact (i.e. they each add a sub-branches to the main branch that was ultimately chosen).

This session concludes with a brief plenary session, where the subgroups pitch their ideas in one minute to the whole group, explaining why they think it is worth developing further.

Expected result for the next session:

- one main idea from each subgroup that describes a possible impact of the citizens message on the work of the stakeholder (the main branch of the mind map), along with how the expertise of the other subgroup members contributes to this impact (subbranches in the mind map).

Expected output for the report:

- A selection of ideas, demonstrating the possible impacts of the citizen messages on the work of the stakeholders (take pictures of the sheets);
- A sense of the atmosphere during subgroup discussions (pictures of the subgroups, of drawings, telling quotes you overheard); note down quotes from the plenary pitches at the end)
    - *[Please note that these reporting tasks require skilled rapporteurs, who should be carefully instructed with respect to the expected outcomes!]*

Session C: Prototyping

(subgroup work followed by brief plenary session, 60 min or so)

In this session, participants generate a storyboard that visualizes the possible impact defined in the previous session. It should express how the work of the stakeholder is modified in relation to the wishes, needs and values and messages expressed by the citizens. The storyboards should show three perspectives on the impact: impact from the perspective of the researcher; from the perspective of the citizen; from the perspective of one of the other stakeholders. The storyboard should also show concrete actions to be taken by these stakeholders to realize this vision.

[Several copies of the first page of the template for session C can be printed out: subgroup members can work out specific elements of the storyboard, focusing on one of the perspectives, or perhaps one of the branches of the mindmap. Importantly however, the different pictures should combine to create a coherent storyboard (i.e. a single story, not 6 unconnected drawings); please see pages 2 of the template for some examples of how this might look)]

Expected result for the next session:

- Storyboards with one main idea for each subgroup, describing a possible impact of the citizens message on the work of the stakeholder, along with how the expertise of the other subgroup members contributes to achieving this impact.

Expected output for the report:

- Storyboards [combining expected outcomes #2: Concrete design suggestions which relate to the research and innovation at hand; and #3: Responsiveness of the design suggestions to societal needs and values]. Please note that these storyboards will play an essential role in further communication and dissemination in GoNano: in the ideal case, they immediately make it clear to all future viewers / readers that the workshops led to enhanced responsiveness of research and innovation trajectories to societal considerations, and explain how this is achieved (i.e. what concrete changes in practice will be / have been induced).
- To get as close to this ideal situation as possible, the storyboards should be visually attractive, intuitive, clear and compelling. This will require careful attention from both table facilitators and rapporteurs: is it clear what the storyboards intend to express? Are they concrete enough to inspire action? Is it clear what needs to happen? Is it clear how the original message is incorporated, and what effect it has had?

Session D: Reflection

(plenary session, 60 min or so)

In this closing session, subgroups present their storyboards in plenary, highlighting both the idea and the actions to be taken by the stakeholders, followed by reactions from the audience. This session could be used by the subgroup to reframe their storyboard and or actions.

Presentations are followed by a discussion of steps to be taken in the run-up to the next workshop:

- What do we want to do at the second workshop? Ideas for the programme?
- Who will do what in preparation for that meeting?
- Do you have specific questions related to your storyboard to ask citizens and other stakeholders and experts in the upcoming online consultation?

Towards the end of this session, we should also reflect back on the initial hypothesis with participants: *did* the incorporation of the wishes, needs and values and messages expressed by citizens lead to new insights and ideas for your own work? Was it feasible? Was it realistic to expect this? Too optimistic? Any other suggestions on how to encourage reflection on societal perspectives in nanotechnologies?

This discussion can give us some insights for expected outcome #1: *do stakeholders see the relevance of citizen perspectives and multi-stakeholder engagement?* and expected outcome #4: *willingness of stakeholders to continue* before and after the workshop.

The question of inclusivity could be revisited here as well: how did the group composition affect outcomes?

To wrap-up this session and the workshop, moderators can discuss next steps: what's next in the GoNano project? How will we stay in touch in the coming months: can we call you? Email you? Facilitate interactions between you? Can we help you realise the plans in your storyboards in the meantime? Share the results of the citizen consultation with you?

Expected output for the report:

- Overview of final presentations by the subgroups and responses from the audience (picture / quotes)
- Overview of participants' responses to the aims of the workshop / hypothesis of GoNano. Insights in expected outcome #1: *Do stakeholders see the relevance of citizen perspectives and multi-stakeholder engagement?* before and after the workshop.
- Expected outcome #5: *Questions for the online consultation*
  Reflections on inclusivity considerations.

ANNEX 3 – TEMPLATE FOR NATIONAL REPORTS ON THE FIRST STAKEHOLDER WORKSHOPS

The national reports from UT, RMIT and TC CAS on the first stakeholder workshops will provide input to D4.4, which aims to integrate all insights and lessons learned from WP1-4. To provide answers to the main evaluative questions outlined in the current draft of D4.4, the national reports should provide rich descriptions of the events themselves, the characteristics of the participants, the plenary and subgroup discussions, (implicit) group dynamics and tangible outputs (notably the initial responses from stakeholders to the messages from citizens and the storyboards) as well as reflections on the workshop objectives (testing the main hypothesis) and on the question of inclusivity. The questions below may offer a 'template' to help the pilot partners to collect and report on these outputs (please answer all questions below in as much detail as possible).

Both table facilitators and rapporteurs should be informed about these expected outcomes in advance, so they know what to look for and what to document during the meeting – if the 'raw data' required below isn't captured during the meeting, it will be lost forever!

1) The workshop overall

When and where was the workshop held?

…

Who attended? Composition of the group: background, expertise, etc. Did everyone come, or did people cancel?

…

Do you think group composition (gender, but also age, socio-economic background, etc.) has influenced the discussion? In what ways?

…

2) Session A: Exploration

How did you think this session went, overall?

…

How were the groups were formed (who matched who, and why? What sorts of needs/interests are expressed by stakeholders?) Please include photos of combined post-its or groups here, as well as telling quotes you picked up with reasons how and why people formed groups.

…

How did the participants initially respond to the citizens' messages? What were the reasons for selecting 'their' citizens' message? Please use quotes, pictures of post-its as supporting evidence.

…

Do you think participants saw the relevance of those messages, or was it more a matter of being polite (or even impolite)? Did you see differences between participants (or even between types of stakeholders)?

…

3) Session B: Ideation

How did you think this session went, overall?

…

Were the participants / subgroups able to relate the citizens messages to their work? did they understand what citizens wanted to express? Were they able to create a link with their own work? What sorts of ideas did they come up with? How did the other groups respond to these ideas? ***Please include pictures of the completed templates B to tell this story,*** along with supporting evidence like quotes picked up from the subgroup discussions, pictures from the subgroups, etc

…

How was the atmosphere during the subgroup discussions: were participants enthusiastic? Were they inspired by the citizens messages, or were they simply going through the motions? Did you see noticeable differences between the subgroups? could you explain those differences? Please add pictures of the subgroups, of drawings, telling quotes you overheard;

…

4) Session C: Prototyping

How do you think this session went, overall?

…

Were the participants able to create compelling storyboards? What sorts of things did they come up with? ***Please include pictures the storyboards here, along with quotes, and pictures of the subgroups***.

…

To what extent did the storyboards incorporate the original citizen's messages? Do they provide a direct response to those messages, an indirect response (e.g. the message inspired the stakeholders, but they decided to do something else in the end), or no response at all (i.e. the stakeholders weren't able or didn't want to respond to the messages)?

…

How did the group work go? Were people enthusiastic? Were there free riders, or did everyone participate? Did you see similarities or difference between the subgroups in relation to enthusiasm, division of labour, etc? Could this have to do with the subgroup composition?

…

5) Session D: Reflection

Did you detect a sense of 'ownership' during the presentations? In other words, do you think participants were keen to follow up on the recommendations co-created during the day?

…

How did participants react to the storyboards? Did they follow the work of the subgroup? Did it make them enthusiastic? Did they provide useful feedback, and did that lead to reframing of the storyboard by the subgroups? Please include supporting evidence of the final presentations here: pictures from the presentation, quotes from the audience, a description of the atmosphere, etc.

…

How did participants reflect on the overall hypothesis? Did they think it makes sense to include the considerations of citizens' in their work, and in research and innovation generally? Did they think they *succeeded* in creating responsive design suggestions?

Do you think participants were generally receptive to the general idea of responsiveness / 'opening up ' research decision making?

…

Did participants provide direct questions for the online citizen consultation? Or could you deduce implicit questions in their responses? Do you think participants generally saw the potential value of asking questions to citizens?

How did participants respond to the question of inclusivity? Did they raise specific suggestions or considerations? Do you think they saw the value of reflecting on inclusivity in this way?

…

6) Overall assessment of the workshop

Judging by the explicit (and implicit) reactions during the day, do you think stakeholders see the relevance of considering citizen perspectives and multi-stakeholder engagement? Do you think there were differences in attitude before and after the workshop? (in other words, did the workshop make the participants more or less 'responsive' to citizens' perspectives?)

…

How do you assess the workshop, overall? Are you happy with the way things went? Are you happy with the outcomes?

…

Do you think the workshop 'worked', i.e.:

1. Did it raise awareness with stakeholders that the early consideration of the needs and values of citizens and societal stakeholders can add value to innovation in nanotechnologies? (learning objective 1).

…

2. Did it constitute an effective approach to productively embed societal considerations in ongoing research and innovation? (learning objective 2).

…

If you could do the workshop all over again, what would you do differently? What would you keep the same? (think of group composition, overall approach, duration, location, specific work forms, outputs, etc.)

…